

PRAVARA INSTITUTE OF MEDICAL SCIENCES

(Deemed to be University)

Loni Bk. 413 736, Tal. Rahata, Dist. Ahmednagar, (MS)



Centre for Biotechnology



Syllabus of

M. Sc (Independent) Medical Biotechnology

PRAVARA INSTITUTE OF MEDICAL SCIENCES
(DEEMED UNIVERSITY)
RULES AND REGULATIONS
FOR THE

INDEPENDENT MASTER OF SCIENCE PROGRAM IN MEDICAL BIOTECHNOLOGY

1. General:

These rules and regulations are framed as per the directives of UGC and P.I.M.S. – Deemed University.

2. Faculty:

This course will be under The Faculty of Allied Health Sciences.

3. Nomenclature of Degree:

Master of Science Degree in Medical Biotechnology (M.Sc.)

4. Conditions for admission to the independent Master of Science Program in Medical Biotechnology:

4.1 Candidates who have passed the B.Sc. examination with minimum 50% marks (45% for the candidates belonging to SC/ST/OBC) in Microbiology/ Biochemistry/ Chemistry/Life Sciences (Zoology/ Botany) Physics with Biophysics specialization from any Statutory University in India or its equivalent.

4.2 Candidates who have appeared for and are expecting their results on or before 31st May of year of admission, of the respective final qualifying examinations.

5. Duration of the Program:

Duration of this program will be two calendar year.

6. Selection of Students for the independent Master of Science Program in Medical Biotechnology:

6.1 The selection of the students will be based on the merit of the marks obtained in the B.Sc. examination from any Statutory University in India or its equivalent

7. Program Objective:

7.1 Candidates will be trained in the advance and current art of medical biotechnology and in the skills of research methodologies, critical evaluation, problem recognition and problem solving in science.

7.2 Candidates will have:

1. Hands-on experience of handling most of the commonly used experimental protocols in molecular biology, genetics, protein and nucleic acid chemistry
2. Experience of independently designing, executing, observing and interpreting the results of experiments and build a hypothesis.

Course Structure: M.Sc (Independent) Medical Biotechnology (2016-17)

SEMESTER I	Subjects	Hours of Teaching/ Practical per week	Credits
Subject Code	Title of Paper/Practical	L/P	
BP 101	Cell Biology	4	4
BP 102	Molecular Biology	4	4
BP 103	Human Biochemistry	4	4
BP 104	Animal Tissue Culture	4	4
BP 110	Practical Course	16	8
SEMESTER II	Title of Paper/Practical	Hours of Teaching/ Practical per week	Credits
BP 105	Human Physiology	4	4
BP 106	Microbiology	4	4
BP 107	Industrial Biotechnology	4	4
BP 108	Bioinformatics	4	4
BP 111	Practical Course	16	8
Summer Training/ Workshop/ Mini project			2
Co & Extra Curricular Activity (Open elective) 1. Poster presentation 2. Paper presentation 3. Participation in Conference/ seminar/ CME 4. Extension activity			2
SEMESTER III	Title of Paper/Practical	Hours of Teaching/ Practical per week	Credits
BP 201	Genetic Engineering	4	4
BP 202	Immunology	4	4
BP 203	Medical Microbiology	4	4
BP 204 - Any one of the Following electives			
BP 204 EL1	Clinical Research	4	4
BP 204 EL2	Developmental Biology and Stem Cells	4	4
BP 204 EL3	Human Genetics	4	4
BP 210	Practical Course	16	8
SEMESTER IV	Title of Paper/Practical	Hours of Teaching/ Tutorials per week	Credits
BP 205	Research Methodology and Socio- Ethical aspects of Biotechnology	4	4
BP 206	Pharmaceutical Biotechnology	4	4
BP 211	Practical Course	8	4
BP 207	Project work/ Dissertation		12
			Total=100

ASSESSMENT OF COURSE (M.Sc. (Independent) Medical Biotechnology)**EVALUATION SCHEME (THEORY)****Semester I**

Semester	No. of subjects	Theory	Marks			
			Theory	Practical	Viva	Total
Sem I	4	100 per paper (70+30)	400	150	50	600
Sem II	4	100 per paper (70+30)	400	150	50	600
Sem III	4	100 per paper (70+30)	400	150	50	600
Sem IV	2	100 per paper (70+30)	200	150	50	400
	1 (Project)	100 (Dissertation) + 25 + 25 (Synopsis & Final Presentation)	150		50	200

Grand Total = Sem. I + Sem. II + Sem.III + Sem. IV

i.e. 600M + 600M + 600M + 600M = 2400Marks

600 M (100 each theory + 150 practical/project + 50 viva (Internal 10 marks + external 40 marks at university examination))

SEMESTER EXAMINATION PATTERN = 70:30 (70 EXTERNAL + 30 INTERNAL)

Internal Examination includes two tests

Test One (Mid Sem.) + Test Two (Preliminary examination) = 30 Marks

- 5 questions out of 6 questions
- Questions can be sub divided

External Examination (University Examination) = 70 Marks

Total = 30 (Internal Examination) + 70 (University Examination)

- Each question carries 14 marks.
- 5 questions out of 6 questions
- Questions can be sub divided

EVALUATION SCHEME (PRACTICAL)

All subjects having practical course will be evaluated as a single paper during that semester.

Internal Examination includes one practical test of 150 marks which will be converted to 30 marks + 10 Marks Seminar + 10 Marks Journal Club = 50 Marks

External practical examination (University Examination) = 100Marks

1 long question of 50 marks

2 short questions of 20 marks each

1 minor question of 10 marks

Total = 50 marks(Internal Examination) + 100 marks (University Examination) =150 Marks

Viva voce = 10 marks (Internal Viva) + 40 marks (University Viva)= 50 Marks

Practical examination mark system:

Internal (50 Marks) + University (100 Marks) + Viva (50Marks) =200 Marks

PASSING SCHEME

- External University examination of 50% out of 70 marks
- Internal examination of 50% out of 30 marks
- Eligibility to appear to the final university examination is 50%

GRADES AND GRADE POINTS

Grading system:

Conversion of marks to Grade Point & Letter Grade

(Performance of student in a paper/course)

Range of Marks	Grade Point	Letter Grade	Description
95-100	9.5-10.0	O	Outstanding
90-94	9.0-9.4		
85-89	8.5-8.9	A ⁺	Excellent
80-84	8.0-8.4		
75-79	7.5-7.9		
70-74	7.0-7.4	A	Very Good
65-69	6.5-6.9		
60-64	6.0-6.4		
55-59	5.5-5.9	B ⁺	Good
50-54	5.0-5.4	B	Above Average
00-49		F	Fail

Classification of final results:

CGPA	Letter Grade	Description
9.50-10.0	O	First Class with Distinction*
9.00-9.49		
8.50-8.99		
8.00-8.49	A+	
7.50-7.99		
7.00-7.49	A	First Class
6.50-6.99		
6.00-6.49		
5.50-5.99	B+	Second Class
5.00-5.49	B	
0.0-4.99	F	Fail / Reappear

* The candidates who have passed in the first appearance and within the prescribed semester of the PG programme (Core, Elective) are eligible.

Formula to calculate SGPA (S_i) = $\sum (C_i \times G_i) / \sum C_i$

Formula to calculate CGPA = $\sum (C_i \times S_i) / \sum C_i$

Transcript (Format): Based on Letter grade, grade points and SGPA and CGPA, the authority may issue the transcript for each semester and a consolidated transcript indicating the performance in all semester.

SEMESTER I

CELL BIOLOGY (BP 101)

Course Code	Category	Course Name	L	T	P	Hr	C
BP 101	Major	Cell Biology	4	0	4	48	6

Objective:

The objective of the course is to familiarize the students with the fundamentals of cell biology.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Cell Structure	Introduction to Prokaryotes and eukaryotes Prokaryotic cell structure Eukaryotic cell structure	8
Unit II	Cytoskeleton	Muscle contraction & ciliary movements General features of microtubules and actin filaments Microtubule organizing centers and microtubule-associated proteins Actin filaments and actin-binding proteins Intermediate filaments Organization of the cytoskeleton	8
Unit III	Cell Differentiation and the maintenance of tissues	Maintenance of the differentiated state Tissues with permanent cells: Renewal by simple duplication, Renewal by stem cells- epidermis, Renewal by pluripotent stem cells- blood cell formation Quiescent stem cells - skeletal muscle, Soft cells and tough matrix - growth turnover and repair in skeletal connective tissue	8
Unit IV	Cell Growth and Division	The control of cell division Tumor viruses as tools for studying the control of the cell cycle Events in the S phase The logic of the cycle Cell division	4
Unit V	Cell adhesion and extra cellular matrix	Cell adhesion & cell junctions Cell -cell interaction & cell matrix interaction Extracellular matrix	4
Unit VI	Chemical signaling	Cell surface, hormone receptor Signal Transduction, Secondary messengers	8
Unit VII	Cancer	Tumor cells and the onset of cancer Proto-oncogenes and tumor-suppressor genes Oncogenic mutations affecting cell proliferation Mutations causing loss of cell-cycle control	8

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books recommended:

- Cell and Molecular Biology by De Robertis.
- Molecular Biology of Cell by Bruce Alberts 2002.
- The cell by Cooper 2000
- Cell Biology, Genetics, Molecular Biology, Evolution and
- Ecology by P. S Verma and VK Agarwaal. Publisher S. Chand and Comp. 2005
- Cell Biology by Powar

PRACTICAL IN CELL BIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Microscopes- Compound microscopes
2. Observations of permanent slide
 - Different types of Animal Cell
3. Mitosis cell division in Onion Root-Tip Cells
4. Meiotic cell division in grasshopper testis
5. Buccal smear - Identification of Barr Body
6. Isolation of Mitochondria/chloroplast
7. Counting of cells using Haemocytometer
8. Permanent slide preparation

MOLECULAR BIOLOGY (BP 102)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 102	Major	Molecular Biology	4	0	4	48	6

Objective:

The objective of the course is to familiarize the student with the fundamentals concepts and technique in molecular biology and its use in the medical research.

Sr. No.	Topic	Description	Hrs
Unit I	Introduction to molecular Biology	The Structure of Nucleic Acids, DNA/RNA as a genetic material Features of prokaryotes and eukaryotes gene	4
Unit II	DNA Replication	Semi conservative mode of DNA replication Replication of DNA in prokaryotes-, Origin of replication, types of DNA polymerases, details of DNA synthesis process Eukaryotic DNA replication- multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication	10
Unit III	DNA damage, repair and mutation	a. Different types of DNA damages b. Mutation, types of mutation, spontaneous and induced mutation, Detecting mutation c. Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, SOS operon, Double strand break repair, transcription coupled repair	6
Unit IV	Recombination	Homologous and site specific recombination, Models for homologous recombination Proteins involved in recombination: RecA, B, C, D, Ruv A, B, C Gene conversion	6
Unit V	Mobile DNA elements:	General features of Transposable elements, Transposable elements in prokaryotes-IS element, Retroviruses Retrotransposon- Ty elements in yeasts, SINES and LINES	5
Unit V I	Transcription	Transcription in Prokaryotes: RNA polymerase, sigma factor, Initiation, elongation, termination, Transcription in Eukaryotes: RNA polymerases, transcription of protein coding sequences by RNA polymerase-II, post-transcriptional modification, RNA splicing and RNA editing	8
Unit VII	Translation	Genetic code, Translation in Prokaryotes and eukaryotes, post translational process- protein translocation	5
Unit	Control of Gene	Gene regulation in Prokaryotes, Operon model,	4

VIII	Expression	Gene regulation in eukaryotes, gene activators, enhancers and silencers	
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METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. Benjamin Lewin. (2008) Genes IX, Jones and Bartlett Publishers Inc.
2. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson (2004), Molecular Biology of the Cell, 4th Edition, Garland Publishing
3. Raff, Keith Roberts, Peter Walter, (2003) Essential Cell Biology, 2nd Edition, Garland Publishing
4. Watson James D., Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick (2004) Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
5. Weaver R., (2007) Molecular Biology, 4th Edition, McGraw Hill Science.

PRACTICAL IN MOLECULAR BIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Isolation of Genomic DNA from *E.coli* DH5 α
2. Purification of isolated genomic DNA
3. Quantification of DNA by UV Spectrophotometer
4. To perform Agarose Gel Electrophoresis
5. Replica Plate Techniques
6. Polymerase Chain Reactions
7. Isolation of genomic DNA from blood sample/tissues/any bio material

HUMAN BIOCHEMISTRY (BP 103)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP103	Major	Human Biochemistry	4	0	4	48	6

Objective:

The Objective of the course is to familiarize the students with the fundamental and advances in Human Biochemistry.

Sr.No.	Topics	Detail syllabus	Hrs.
Unit I	Macromolecules	Water & pH Amino Acids & Peptides Proteins: Myoglobin & Hemoglobin Carbohydrates of Physiologic Significance Lipids of Physiologic Significance	6
Unit II	Bioenergetics	First and second law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of chemical reaction, redox potential, ATP and high energy phosphate compounds The Respiratory Chain & Oxidative Phosphorylation	5
Unit III	Pathways of Hexose and Pentose Metabolism	<ul style="list-style-type: none"> • Glycolysis & the Oxidation of Pyruvate • The Citric Acid Cycle: The Catabolism of Acetyl-CoA • Gluconeogenesis & Control of the Blood Glucose • The Pentose Phosphate Pathway & Other Pathways of Hexose Metabolism 	8
Unit IV	Metabolism of Glycogen	<ul style="list-style-type: none"> • Biosynthesis and degradation of glycogen and its regulation • Starch and cellulose biosynthesis 	4
Unit V	Lipid metabolism and cholesterol synthesis, transport, excretion	<ul style="list-style-type: none"> • Biosynthesis of Fatty Acids • Oxidation of Fatty Acids: Ketogenesis • Metabolism of Unsaturated Fatty Acids & Eicosanoids • Cholesterol Synthesis, Transport, & Excretion 	6
Unit VI	Biosynthesis and degradation of amino acids	<ul style="list-style-type: none"> • Biosynthesis of the Nutritionally Nonessential Amino Acids • Catabolism of Proteins & of Amino Acid Nitrogen • Catabolism of the Carbon Skeletons of 	6

		Amino Acids • Conversion of Amino Acids to Specialized Products	
Unit VII	Metabolism of purine and pyrimidine nucleotides	• Nucleotides • Biosynthesis and degradation purine and pyrimidine nucleotides, regulation	4
Unit VIII	Hormonal Action	• Hormonal regulation and fuel metabolism	3
Unit IX	Enzymes	• Enzymes nature and classification • Enzyme function: • Enzymes affect reaction rates not equilibria, Reaction rates and equilibria , Principles behind catalytic power and specificity of enzymes, Weak interaction between enzyme and substrate are optimized in transition state, Enzyme use binding energy to provide reaction specificity and catalysis, Specific catalytic groups contribute to catalysis. • Enzyme Kinetics • Enzyme Inhibition	5

Books Recommended:

- Harper's Illustrated Biochemistry
- A text of biochemistry, - A.V.S.S. Rama Rao 9th ed. (UBS Publisher's and Distributors Pvt. Ltd.)
- Leninger: Principles of Biochemistry, 3rd Ed. – Nelson D. et al (Worth Publishers)
- Biochemistry, 5th, - Ed. Breg, J.M. Tymoczko J.L. and Stryer L. (W.H. Freeman & Co.)
- Lubert Stayer, (Latest) Biochemistry, II edition, W.H. Freeman and CO. NY

PRACTICALS IN BIOCHEMISTRY (4 Hrs. per Week)

LIST OF EXPERIMENT

1. Calibration of pH meter
2. Estimation of Proteins By Biuret Method
3. Estimation of Protein By Lowry Method
4. Estimation of Serum Albumin By BCG Method
5. Estimation of SGOT
6. Estimation of SGPT
7. Estimation of Serum Alkaline Phosphatase
8. Estimation of Serum Creatinine
9. Estimation of Urea Nitrogen
10. Estimation of Cholesterol By Zak's ferric Chloride Method
11. Estimation of Carbohydrates By Anthrone Method
12. Estimation of Carbohydrates By DNSA Method
13. Estimation of Carbohydrates By Phenol Sulphuric acid Method

ANIMAL TISSUE CULTURE (BP 104)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 104	Major	Animal Tissue Culture	4	0	4	48	6

Objective:

The objective of the course is to familiarize the students with the basics of Animal Tissue Culture Techniques and use in various fields of research and human welfare.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to animal tissue culture	Historical background, The application of tissue culture, Terminology, Stages in cell culture	4
Unit II	Outline of the key techniques of animal cell culture	Setting up the laboratory, Culturing cells, Maintaining the culture, Quantification of cells in cell culture, Cloning and selecting cell lines, Physical methods of cell separation, Hazards and safety in the cell culture laboratory	8
Unit III	Animal cell culture media	General cell culture media design, Natural media, Synthetic media, Further considerations in media formulation, Nutritional components of media, The role of serum in cell culture, Choosing a medium for different cell type	8
Unit VI	Characterization of cell lines	Species verification, Intra-species contamination, Characterization of cell type and stage of differentiation, Microbial contamination	8
Unit V	Preservation of animal cell lines	Variation and instability in cell lines, Preservation of cell lines, Freezing of cells, Thawing of cells, Quantification of cell viability, Cell banks	6
Unit VI	Hybridoma Technology	The limitation of traditional antibody preparation, The basis of hybridoma technology, The details of hybridoma technology, Long term storage of hybridoma cell lines, Contamination, Hybridomas from different species, Human hybridomas, Commercial scale production of monoclonal antibodies	8
Unit VII	Large scale animal cell culture	Culture parameters, Scale up of anchorage-dependant cells, Culture vessels, Suspension culture	6

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

BOOKS RECOMMENDED

1. Cell and Tissue Culture: Lab Procedures in Biotechnology by Alan Doyle (ed) J. Bryan Griffith (ed)
2. Culture of Animal Cell by Freshney

PRACTICALS IN ANIMAL TISSUE CULTURE (4 Hrs. per Week)

LIST OF EXPERIMENT

1. Layout of Animal Tissue Culture laboratory
2. Washing of glasswares
3. Sterilization of glasswares
4. Preparation of culture media
5. Thawing of cell lines
6. Passaging of cell lines
7. Cell quantification and Cell viability
8. Cryopreservation of cell cultures

SEMESTER II

HUMAN PHYSIOLOGY (BP 105)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 105	Major	Human Physiology	4	0	4	48	6

Objective:

The objective of the course is to study the physiological aspects of the human systems and its role in functioning of all the major organs of the body.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Basic concepts and principles	Introduction and background (homeostasis, control systems), Biophysics of blood flow Regulation of respiration., Auto regulation of renal blood flow and the concept of clearance	6
Unit II	Sensory Organs	Eye, Ear, Nose, Tongue and Skin: Functions & Disorders	4
Unit III	Digestive system	Functions & Disorders, Pharynx, oesophagus, Stomach and Intestines, Liver & Pancreas, Peritoneum	4
Unit IV	Circulation system	Heart rate and the significance, Cardiac cycle, HR factors ECG- Machine, Recording, Abnormalities types Causative Factors Reporting & Interpretation	6
Unit V	Respiration system	Respiration, Mechanism Inspiration, Expiration Gas exchange mechanism Lung surfactant, compliance Lung volume and capacity Respiratory Exercises Artificial Respiration Basis & Techniques	6
Unit VI	Genito-Urinary System	Kidney, Urethra, bladder, Urethra, Female Reproductive System, Male Reproductive System	6
Unit VII	Skeletal system	Mechanism of contraction, Difference between 3 types of muscles, Electro myography & mechanical recording of muscle contraction, Locomotion, Diseases of muscles Dystrophies,	6
Unit VIII	Nervous System	Nerve fibres, types ,functions, injuries, impulses & velocity	4

Unit IX	Endocrine system	Hormones, Functions & Disorders	4
Unit X	Genetic testing	Genetic testing, Eugenics and Aging	2

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. Textbook of Medical Physiology by C. Guyton
2. Physiology by C. Chatterjee
3. Human Anatomy & Physiology by Tortora
4. Medical physiology by Chaudhary
5. Anatomy and histology by Ross and Wilson
6. Human Anatomy and Physiology by Creager

PRACTICAL IN HUMAN PHYSIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Blood grouping
2. Haemoglobin estimation
3. Total WBC and RBC count
4. Erythrocyte sedimentation rate
5. Differential Counting of Blood
6. PVC count

MICROBIOLOGY (BP 106)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 106	Major	Microbiology	4	0	4	48	6

Objective:

The objective of the course is to familiarize the students with bacteria and viruses, their structures, metabolism, diseases caused by bacteria and viruses and their control.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Microbiology	Scope and history of Microbiology. Classification and identification of microorganism.	8
Unit II	Characteristics	Cultivation of bacteria. Culture media, preservation methods of bacterial cultures and maintenance	8
Unit III	Microorganism- Bacteria	Morphology and fine structure of bacteria. Cell wall structure in details - Gram positive and gram negative bacteria. Reproduction and growth. Growth kinetics. Bacterial genetics- extra chromosomal elements, gene transfer mechanisms	8
Unit IV	Control of Microorganisms	Control of by physical and chemical agents. sterilization and disinfection Role of antibiotics and chemotherapeutic agents antiviral agents, viral agents, and antiviral drugs	8
Unit V	Microbes as parasites	The host-parasite relationship Symbiotic associations, Characteristics of parasitism Entry, exit and transmission. Normal flora, various sites of normal flora, list of normal flora and its beneficial and adverse effects.	8
Unit VI	Microbial Pathogenesis	Types of infections - primary, secondary, nosocomial, iatrogenic, zoonotic etc Mechanisms of Bacterial pathogenesis - bacterial toxins, capsules, enzymes, intracellular parasitism, antigenic variations etc. leading to establishment of infections. Principles of lab diagnosis of infectious diseases	8

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. General Microbiology: Vol. I & 2 by Powar & Dagainawala
2. Microbiology by Pelzer
3. Microbiology by Prescott
4. General Microbiology by Stanier
5. Instant notes in Microbiology by Nicklin

PRACTICAL IN MICROBIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. To study different types of Microscope.
2. Sterilization and disinfections
3. Preparation of culture media
4. Staining procedures
5. Monochrome staining
6. Negative staining
7. Gram Staining
8. Capsule staining
9. Motility of microorganisms
10. Fungal mounting
11. Aseptic transfer techniques
12. Streak plate method
13. Spread plate method
14. Pour plate method
15. Biochemical tests
16. IMViC test
17. Urease test
18. Triple Sugar Iron test
19. Carbohydrate fermentation test
20. Catalase test
21. Oxidase test

INDUSTRIAL BIOTECHNOLOGY (BP 107)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 107	Major	Industrial Biotechnology	4	0	4	48	6

Objective:

To make the students aware of the overall industrial bioprocesses which requires for understanding the process and industrial demands.

Sr. No.	Topic	Description	Hrs.
Unit I	Bioreactor Technology	Types of bioreactors: Plug flow reactors, continuously stirred tank flow reactors, loop reactors, air lift reactors, fed batch reactors, fluidized bed reactors, rotatory disc reactors. Concept of Batch process, continuous process, recycled and non-recycled processes, liquid & solid state of fermentations. Concept of bioreactor designing & process optimization, mass transfer, heat transfer, mixing rheology of fermentation fluids, mean resistance time, substrate utilization rate, oxygenation, oxygen sag, yield coefficient.	12
Unit II	Downstream processing	Down stream processing: Bioseparation; filtration, membrane filtration, centrifugation sedimentation, flocculation, purification, solvent extraction, counter current extraction, ion exchange, affinity techniques, concentration, crystallization, reverse osmosis, ultrafiltration, drying, storage and packaging.	8
Unit III	Immobilized systems	Absorption, covalent bonding, entrapment, encapsulation, cross linking, types of reactors, diffusion characteristics, effective factors, instability factors, deactivation rates, relative length of half life.	8
Unit IV	Scale up, unit processes	Concept of control, basic control theory, turbidostatic & chemostatic control. Basic principles of scale up, working parameters	6

		UNIT processes- production of enzymes, antibiotics Biosensor technology	
Unit V	Production of Modern Biotechnology Products	Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.	6
Unit VI	Nanotechnology in medicine	Basics of nanotechnology, nanomaterials and nanoparticles, nanotools, Nanoparticles in cancer therapeutics, Nanodiagnosics. <i>In vitro</i> nanodiagnosics – nanobiochips and nanobiosensors, cantilever biosensors, nanoproteomics In vivo nanodiagnosics– gold nanoparticles, nanotubes, quantum dots– nanobiochips and nanobiosensors, cantilever biosensors, nanoproteomics In vivo nanodiagnosics– gold nanoparticles, nanotubes, quantum dots	8

METHODOLOGY

The course would be taught through lectures and practicals.

Books Recommended:

1. A.H. Patel “ Industrial Microbiology” Macmillan
2. Prescott, S.C. and Cecil G. Dunn, “Industrial Microbiology”, Agrobios (India), 2005.
3. Cruger, Wulf and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Panima Publishing, 2000.
4. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
5. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.
6. Bionanotechnology: Lesson from Nature, David S. Goodsell, Willey-Liss, First edition, 2004
7. Industrial microbiology: An introduction. Mike J. Waites, Neil Morgan, John Rackey, Gary Higton, John S. Rockey
8. Bioreactor recovery in bioprocess technology. Biotol Series
9. Principles of fermentation technology. P. F. Stanbury et al.

PRACTICAL IN INDUSTRIAL BIOTECHNOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Introduction to bioreactor and its parts
2. Antibiotic assay to determine MIC (Minimum inhibitory concentration)
3. Production of enzymes / industrial bio products
4. Study of Downstream processing
5. Industrial visit
6. Vitamin assay

BIOINFORMATICS (BP 108)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 108	Major	Bioinformatics	4	0	4	48	6

Objective:

The objective of the course is to enlighten the student with basic concepts and technique in Bioinformatics and its use in the field of Medical and health care.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Biology in the computer age: An Introduction to Bioinformatics	How Is Computing Changing Biology? Isn't Bioinformatics Just About Building Databases? What Does Informatics Mean to Biologists?? How Do I Understand Sequence Alignment Data? What Challenges Does Biology Offer Computer Scientists? What Skills Should a Bioinformatician Have? Why Should Biologists Use Computers? How Can I Configure a PC to Do Bioinformatics Research? What Information and Software Are Available? Can I Learn a Programming Language Without Classes? How Can I Use Web Information How Do I Understand Sequence Alignment Data? How Do I Write a Program to Align Two Biological Sequences? How Do I Predict Protein Structure from Sequence? What Questions Can Bioinformatics Answer?	8
Unit II	Computational approaches to biological questions.	Introduction Computational Methods in Bioinformatics What Biologists Model Accessing 3D Molecules through a 1D Representation Abstractions for Modeling Protein Structure. Mathematical Modeling of Biochemical Systems. Why Biologists Model	8

Unit III	Biological research on the web	<p>Introduction Using Search Engines Boolean Searching Search Engine Algorithms Finding Scientific Articles Using PubMed Effectively The Public Biological Databases Data Annotation and Data Formats 3D Molecular Structure Data DNA, RNA, and Protein Sequence Data Genomic Data Biochemical Pathway Data</p>	8
Unit IV	Sequence analysis, pairwise alignment, and database searching	<p>Introduction Genefinders and Feature Detection in DNA Predicting Gene Locations Feature Detection Pairwise Sequence Comparison Scoring Matrices Gap Penalties Global Alignment Local Alignment Tools for local alignment Sequence Queries against Biological Databases Local Alignment-Based Searching Using BLAST The BLAST algorithm</p>	8
Unit V	Multiple sequence alignments, trees and profiles	<p>Introduction Taxonomy and Evolution Concept of molecular evolution Terms: Orthologs, paralogs and xenologs. Multiple sequence alignment: MSA by Dynamic Programming MSA by progressive strategies MSA by Clustal-W Application of MSA Phylogenetic inferences Phylogenetic trees based on neighbor joining Software for phylogenetic analysis Profiles and motifs: General concepts</p>	8
Unit VI	Tools for genomics and proteomics	<p>Introduction From Sequencing Genes to Sequencing Genomes Analysis of Raw Sequence Data: Basecalling Sequencing an Entire Genome The shotgun approach The clone contig approach LIMS: Tracking all those minisequences Sequence Assembly Accessing Genome Information on the Web NCBI Genome Resources TIGR Genome Resources Ensembl Other Sequencing Centers Organism-Specific Resources</p>	8

		Annotating and Analyzing Whole Genome Sequences Genome Annotation MAGPIE Functional Genomics: New Data Analysis Challenges Sequence-Based Approaches for Analyzing Gene Expression DNA Microarrays: Emerging Technologies in Functional Genomics Bioinformatics Challenges in Microarray Design and Analysis Planning array experiments Proteomics Tools for Proteomics Analysis	
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METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. Developing Bioinformatics computer skills - Gibas C and Jambeck P
2. Introduction to bioinformatics - T.K. Attwood and Parry-Smith D.J.
3. Introduction to Bioinformatics: Lesk, A.M. Oxford University press.
4. Developing Bioinformatics Computer Skill: Cynthia Gibbs and Per Jambeck. O'Reilly & Associates.

PRACTICAL IN BIOINFORMATICS (4 hrs per week)

LIST OF EXPERIMENTS

1. Introduction to SPDBV (deep view).
2. Basic exercise in protein structure visualization.
3. Basic exercise in protein structure visualization coloring.
4. To study the PubMed using internet.
5. To study the NCBI website using internet
6. BLAST
7. FASTA

SEMESTER III

GENETIC ENGINEERING (BP 201)

Course Code	Category	Course Name	L	T	P	Credit Hr	C
BP 201	Major	Genetic Engineering	4	0	4	48	6

Objective:

To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology as well as to create understanding and expertise in wet lab techniques related to genetic engineering.

Sr. NO.	Topic	Detail of syllabus	Hrs.
Unit I	Recombinant DNA technology	The recombinant DNA concept, Milestones in genetic engineering, Tools of Genetic Engineering; Enzymes, Nuclease, The Restriction Endonucleases, Phosphodiesterase, Polynucleotide kinase, DNA ligase, DNA polymerase I, Reverse transcriptase, Terminal deoxynucleotidyl transferase, Poly A polymerase	8
Unit II	Vector System	Salient features of cloning vector, types of cloning vectors- plasmids, cosmids, phages (lambda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes- YACs and MACs	8
Unit III	The Means: Constructing, Cloning, and Selecting	Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors, Techniques of gene transfer - transformation, transfection, micro injection, electroporation, lipofection and biolistics, Screening Cloned Populations of Recombinants, Preparation of gene libraries and c-DNA libraries	12
Unit IV	Molecular Mapping of genome	Chemical synthesis of DNA, DNS sequencing techniques, PCR, Mapping of genome- genetic & physical map, physical mapping and map based cloning, molecular markers in genome analysis- RFLP, RAPD & AFLP analysis, molecular markers PCR based, FISH , Microarray, Northern Blotting, Southern blotting, MicroRNAs and RNA Interference,.	12
Unit V	Applications of Genetic Engineering	Transgenic & Gene knock out technologies, Targeted gene replacements, Applications of GE in medicine & industry	8

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METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

BOOKS RECOMMENDED:

1. Molecular Biology of the gene - J. Watson
2. Genes VI, VII and VIII - Benjamin Lewin
3. Molecular Biotechnology Principles and application of recombinant DNA
4. Molecular Biology - Robert F. Weaver
5. Plant Molecular Biology: A practical approach. - C.H. Shaw (2006), Panima Pub. Corp.
6. Molecular cloning Vol. 1-3. Sambrook and Russel. 2001. CSH press.
7. Principles of gene manipulation. 1994. Old and Primrose, Blackwell Scientific Publ.
8. Principles and techniques of biochemistry and molecular biology, 6th Ed. Wilson Keith and Walker John
(2005) Cambridge University Press, New York.
10. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, R.L. Press,Oxford, 1995

PRACTICALS:

List of Experiments:

1. Competent Cell Preparation
2. Transformation
3. Isolation of plasmid DNA by alkaline lysis mini preparation
4. Restriction digestion of vector DNA
5. Restriction digestion of lambda DNA
6. Gel Elusion
7. Random Fragment Length Polymorphism
8. Random Amplified Polymorphic DNA

IMMUNOLOGY (BP 202)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 202	Major	Immunology	4	0	4	48	6

Objective:

The objective of the course is to familiarize the student with the basics of immune system and its role in disease outcome

Sr. No.	Topic	Description	Hrs
Unit I	Introduction	Overview of Immune system: History and scope of Immunology, Types of immunity Immune dysfunction and its consequences. Cells and organs of the immune system	8
Unit II	Generation of B cell and T cell responses	Antigens Antibodies: Structure and Function Organization and expression of immunoglobulin genes Antigen-Antibody interactions: Principles and Applications Major Histocompatibility Complex Antigen Processing and Presentation T cell receptor T cell maturation, activation, and differentiation B cell generation, activation, and differentiation	8
Unit III	Immunoglobulins Structure and Function	Basic and fine structure of immunoglobulin: light chains, heavy chains and sequences Antigen determinants on Immunoglobulin: Isotopic, allotypic, Idiotypic Immunoglobulin super family	8
Unit IV	Immune Effector Mechanisms	Cytokines The Complement system Cell mediated effector responses Leukocyte migration and inflammation Hypersensitive reaction	8
Unit V	Immuno techniques	Strength of antigen and antibody interactions: Antibody affinity, antibody avidity · Cross reactivity · Precipitation reactions, agglutination reactions (immunodiffusion and immunoelectrophoretic technique) · Radioimmunoassay	8

		<ul style="list-style-type: none"> · Enzyme linked Immunosorbant./ Assay(ELISA) · Western Blotting · Immuno precipitation · Immunofluorescence Flow cytometry and Fluorescence	
Unit VI	The Immune System in Health and Disease	Immune response to infectious diseases Vaccines AIDS and other immunodeficiencies Autoimmunity Transplantation immunology Cancer and the immune system	8

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. Immunology - Kubly et.al
2. Cellular Interactions and immunobiology - BIOTOL series
3. Immunology - Roitt et. al.
4. Immunobiology - Janeway Travers et. al
5. Cellular and molecular Immunology - Abbas A.K., Lichtman A.H. and Pober, J.S.
6. Fundamental Immunology - Paul
7. Immunobiology 3rd ed. - Janeway Travers

PRACTICAL IN IMMUNOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Animal handling
2. Blood collection
3. Routes of drug administration
4. Dissection of mice lymphoid organ (spleen)
5. Latex agglutination method
6. Determination of Phagocytic index
7. Clinical diagnostic immunoblotting/ SDS PAGE
8. ELISA
9. Immunoassay - immuno diffusion method, rocket electrophoresis
10. ICT for malaria and HIV detection

MEDICAL MICROBIOLOGY (BP 203)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 203	Major	Medical Microbiology	4	0	4	48	6

Objective:

The objective of the course is to familiarize the students with infectious microbial agents and clinical aspects.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Bacteriology	Bacteria of medical importance Gram Positive Cocci- <i>Staphylococcus</i> , <i>Streptococcus</i> , <i>Pneumococcus</i> Gram Negative Cocci- <i>Neisseria</i> Gram Positive Bacilli- <i>Bacillus anthrax</i> , <i>C. diphtheria</i> , <i>Clostridium</i> Gram Negative Bacilli- members of <i>Enterobacteriaceae</i> , <i>Pseudomonadaceae</i> , <i>Vibrio cholerae</i> Other: <i>Mycoplasma</i> , <i>Rickettsia</i> , <i>Chlamydia</i> , <i>Mycobacteria</i>	16
Unit II	Virology	General properties of viruses, viral replication, viral genetics, classification of viruses, pathogenesis of viral infections and Bacteriophages. Laboratory diagnosis of viral infections, collection, storage and transport of specimen, viral cultivation, serological methods of viral diagnosis.	8
Unit III	Mycology	Structure and characteristics of fungi, differences between Bacteria and fungi, common terminologies, sporulation morphological classification, method of identification, culture and laboratory diagnosis, infections produced (Mycoses). Medical importance of fungi.	8
Unit VI	Epidemiological aspects	control of infection and disease Hospital acquired infection, prevention and control	4
Unit V	The clinical manifestations of infection	Respiratory tract infections Urinary tract infections Sexually transmitted diseases Gastrointestinal tract infections Meningitis Vector-borne infections Pyrexia of unknown origin Zoonotic infections	12

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

1. Medical Microbiology by Mims
2. Medical microbiology by C.P. Baweja
3. Medical microbiology by Ananthnarayanan
4. Parasitology by Chatterjee
5. Mycology by Jagdish chander
6. Diagnostic microbiology by Bailey & Scott

PRACTICAL IN MEDICAL MICROBIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. **Isolation and identification of bacterial pathogen from clinical specimen**
 - a. Urine sample
 - b. Pus sample
 - c. Blood sample/any other
2. **Antibiotic sensitivity test (Disk diffusion method and well diffusion method)**
3. **Widal test**
4. **Techniques for diagnosis of viral infections**
 - a. HIV
 - b. HBsAg
 - c. Dengue
5. **Techniques for diagnosis of parasitic infections**
 - a. Malaria
 - b. Intestinal parasitic infection
6. **Techniques for identification of pathogenic fungi**
 - a. Germ tube test
 - b. LPCB preparation for molds
 - c. Slide culture technique

CLINICAL RESEARCH (BP 204 EL1)

Course Code	Category	Course Name	L	T	P	Credit Hr	C
BP-204 EL1	Elective	Clinical Research	4	0	4	48	6

Objective:

The objective of the course is to impart the knowledge of clinical research which can be used for drug discovery and development.

Sr. NO.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Clinical Research	Introduction to Clinical Research Terminologies and definition in Clinical Research Origin and History of Clinical Research Difference between Clinical Research and Clinical Practice Types of Clinical Research Phases of clinical research Clinical Trials in India -The National Perspective Post marketing surveillance Pharmaceutical Industry - Global and Indian Perspective	5
Unit II	Pharmacology & Drug development	Introduction to Pharmacology Concept of Essential Drugs Routes of Drug Administration Introduction to Drug Discovery and Development- Hurdles in Drug Development Sources of Drugs Approaches to Drug Discovery Pharmacovigilance Factors affecting drug response	8
Unit III	Preclinical Studies	Guidelines For Care And Use Of Laboratory Animals Introduction To Preclinical Pharmacology Introductory Talk on Animal studies : present status Pre - Clinical Toxicity Lab Animals in Pharmacology Preclinical drug testing Calculation of first human dose Investigational New Drug Application Clinical trials New Drug Application and Approval	8
Unit IV	Guidelines and Regulations in Clinical Research	1.International Conference on Harmonization (ICH)- Brief history of ICH, Structure of ICH, ICH Harmonization Process	8

		<p>2.Good Clinical Practice: ICH guidelines 3.Indian GCP guidelines (CDCSO guidelines) 4.ICMR Guidelines - Ethical Guidelines for Biomedical Research on Human Subjects 5.Schedule Y 6.Institutional Review Board / Independent Ethics Committee Stakeholders in clinical research (Investigators, sponsors, CRO,SMO) 7.Clinical Trial Protocol and Protocol Amendment(S) 8.Investigator's Brochure 9. Essential Documents for the conduct of a Clinical Trial</p> <ul style="list-style-type: none"> • Introduction of Clinical Trial Regulation • European Medicine Agency • Food and Drug Administration (US FDA) • Drug and cosmetic act • GMP 	
Unit V	Clinical Development	<p>Research question Case report form Informed Consent Preparing data collection forms Protocol writing New drug discovery process- purpose, main steps involved in new drug discovery process, timelines of each steps, advantages and purposes of each steps, ethics in clinical research, unethical trials, Phase-I, II, III, IV trials.</p> <ul style="list-style-type: none"> -Introduction and designing -Principles of sampling -Inclusion and exclusion criteria -Methods of allocation and randomization -Informed consent process in brief -Termination of trial -Safety monitoring in clinical trials 	8
UNIT VI	Clinical Regulatory requirements	<p>Audit/ Inspection Fraud and Misconduct in Clinical Trials Conflict of interest in Clinical research Vaccine trails in children Bioavailability and Bioequivalence How to fill an ADR reporting form and methods for causality assessment Risk to benefit ratio bias and confounding factor Uses of placebo</p>	6
Unit VII	Marketing	Promotional inputs & development of Medico-Marketing, Prescribing Information (PI) Or Package	3

		Insert (PI), Publication issues	
Unit VIII	Data management	Clinical data management (CDM): Introduction, CRF Design, Electronic Data Capture, Data Validation, Discrepancy Management, Clinical Data Coding, SAE Reconciliation, Archiving clinical data	2

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

BOOKS RECOMMENDED

1. Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G.
2. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
3. Drug interaction, Basic Bussiness Publ, Bombay, J.K. Mehra
4. Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2001.
5. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996
6. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi

PRACTICAL IN CLINICAL RESEARCH (4 hrs per week)

LIST OF EXPERIMENTS

1. Introduction to animal house
2. Handling of lab animals
3. Various routes of drug administration (lab animals)
4. Assessment of adverse drug reaction
5. Documentation for clinical research

DEVELOPMENTAL BIOLOGY AND STEM CELLS (BP 204 EL2)

Course Code	Category	Course Name	L	T	P	Credit Hr	C
BP 204 EL2	Elective	Developmental Biology and Stem Cells	4	0	4	48	6

Objective:

The objective of the course is to develop insight of embryonic development of various organisms, with emphasis on human embryonic development. The course is designed include development at various levels.

Sr. No.	Topic	Description	Hrs.
Unit I	Introduction	Introduction to Developmental Biology-Origins and History, Early Beliefs Gametogenesis, Fertilization, Mechanisms of Preventing Polyspermy, Fertilized-Egg Activation	4
Unit II	Cleavage	Mechanisms of Cleavage, Cleavage Patterns, Holoblastic, Cleavage: Isolecithal and Mesolecithal; Meroblastic Cleavage: Telolecithal and Centrolecithal; Cleavage Patterns in Major Groups of Organisms; Cell Specification	6
Unit III	Gastrulation	Cell Movements, Germ Layers, Gastrulation in Major Groups of Organisms	5
Unit IV	Axis Formation	Types of Axes, Axis Formation in Drosophila, Amphibians, Birds Mammals	5
Unit V	Later Embryonic Development	The Central Nervous System (CNS) and Epidermis, Mesoderm, Endoderm differentiation, Cell Death, Front Limb vs. Hind Limb Formation	6
Unit VI	Post Embryonic Development	Sex Determination, Dosage Compensation, Unusual Sex Determination, Environmental Sex Determination, Metamorphosis, Regeneration	4
Unit VII	Stem cells and cellular pedigrees	Scope of stem cells - definition of stem cells - concepts of stem cells - differentiation , maturation Types, properties and sources of stem cells : Skeletal muscle stem cell - Mammary stem cells - intestinal stem cells - keratinocyte stem cells of cornea - skin and hair follicles - Tumour stem cells, Ebryonic stem cell biology - factors influencing proliferation and differentiation of stem cells - hormone role in differentiation.	12

Unit VIII	Applications of stem cells	Cellular therapies - vaccines - gene therapy - immunotherapy - tissue engineering - blood and bone marrow - Fc cells	6
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METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

Books Recommended:

- 1) Developmental Biology, Eighth Edition, Scott F. Gilbert, Susan Singer, Publisher: Sinauer Associates Inc.; ISBN-13: 978- 0878932504
- 2) Developmental Biology: A Very Short Introduction, Lewis Wolpert, Publisher: Oxford University, ISBN-13: 978- 0199601196
- 3) Essential Developmental Biology, Jonathan M. W. Slack Publisher: Wiley-Blackwell; 3 edition, ISBN-13: 978- 0470923511
- 4) Stem cells - Elsevier : CS Potten , 1997.
- 5) Essentials of stem cell biology , Robert Paul Lanza ,2006.

PRACTICAL IN DEVELOPMENTAL BIOLOGY AND STEM CELLS (4 hrs per week)

LIST OF EXPERIMENTS

1. Primary cultures of cells from chick embryo
2. Isolation of Fibroblast cells from chick embryo
3. Staining and fixing of fibroblast cells
4. Isolation of cells from Rat/ liver etc.

HUMAN GENETICS (BP 204 EL3)

Course Code	Category	Course Name	L	T	P	Hr	C
BP 204 EL3	Elective	Human Genetics	4	0	4	48	6

Objective:

The objective of the course is to familiarize the students with the importance & universality of Human Genetics. The students will be familiar with sub-disciplines in Genetics and their importance in applied medical sciences.

Sr. NO.	Topic	Detail of syllabus	Hrs.
Unit I	Mendelian Genetics	Historical views of heredity; Mendelian, Laws of Segregation, Law of Independent assortment, Trihybrid crosses; Gene-environment interactions, intralocus & Interlocus; Interactions	6
Unit II	Sex determination	Sex determination mechanisms & numerical; Genotypic Sex determination mechanisms; Environmental Sex determination mechanisms; Sex linked inheritance. Linkage and crossing over. Inactivation of the Sex chromosome	8
Unit III	Non Mendelian Genetics	Extra chromosomal inheritance; organelle heredity; Plasmid inheritance, Infectious heredity & Maternal effect	6
Unit VI	Chromosomal Aberrations & genetic disorders	Structural & numerical Chromosomal Aberrations and various genetic syndromes & disorders	6
Unit VII	Population Genetics	Genetic variability, Genotypic & allelic frequency, Hardy Weinberg's law & numerical; Factors affecting changes in allelic & genotypic frequency- Mutation; migration; selection & random genetic drift	8
Unit IX	Genetics Counseling & Pedigree Analysis	Introduction to genetics counseling, methods prenatal diagnosis of genetic disorders invasive and non-invasive, ethical issue of genetic counseling, eugenics Online Mendelian Inheritance in Man (OMIM), NCBI Genes and Disease in humans with single gene Disease, gathering family history, pedigree	12

		symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees	
Unit XII	Human Genome Project and	Introduction and Background, Major outcome, hurdles and solution	2

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

BOOKS RECOMMENDED

1. A text book of genetics by Sambhamurthy
2. The Human Genome: A user Guide, by R. Scott Hawley and Catherine A Mori, Academic Press.
3. Human Genetics: The Basics, By Ricki Lewise, Taylor and Francis
4. Genetics by Russel
5. Genetics by Klug
6. Genetics by Tamarind
7. Genetics by Snustad & Simmons
8. Genetics by C.B Powar
9. Genetics by B.D Singh
10. Genetics by Pierce

PRACTICALS IN HUMAN GENETICS (4 Hrs. per Week)

LIST OF EXPERIMENT

1. Induction of polyploidy in Onion root tips.
2. Methyl Green-Pyronin Staining of DNA
3. Dermatoglyphs of human fingers
4. Human Karyotype
5. ABO Blood Grouping
6. Hardy-Weingberg Law

SEMESTER IV

RESEARCH METHODOLOGY AND SOCIO- ETHICAL ASPECTS OF BIOTECHNOLOGY (BP 205)

Course Code	Category	Course Name	L	T	P	Total Hr	C
BP 205	Major	Research Methodology and Socio- Ethical aspects of Biotechnology	4	0	4	48	6

Objective: The objective of the course is to make students aware of research methodology and biostatistics used in biotechnology research as well as to aware them the legal, safety and public policy issues raised due to the progress in Biotechnology and development of new products as well as regulatory framework governing processing of bio-products.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Research Methodology	Introduction, Defining Research Problem, Research Design, Sampling Design, Methods of Data Collection, Interpretation and report writing	5
Unit II	Bioinstrumentation	Principles and Application of: Chromatographic techniques: Basic concepts, Gel filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Chromatography, High Performance Liquid Chromatography Electrophoresis: Concept, Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis, Isoelectric Focusing Centrifugation: Basic concept, Ultra Centrifugation, Density Gradient Centrifugation, Differential Centrifugation, Isopycnic Centrifugation Spectroscopy: Basic concept, UV/Visible Spectroscopy, Circular Dichroism (CD) & Optical Rotary Dispersion (ORD), Fluorescent Spectroscopy, Infra Red Spectroscopy, FTIR, Mass Spectroscopy, MALDI- TOF Radiography: Tracer Elements in Biology, Radio Active isotopes, Half Life of isotopes, Autoradiography, Pulse Chase experiment, Cerenkov radiation, Liquid Scintillation Counting, Phosphor Imaging	8
Unit III	Biostatistics	Measures of central tendency: mean, mode, and median. Measures of dispersion: range, mean deviation, standard deviation. Methods of sampling, sampling error, non-sampling errors, standard error.	11

		<p>Meaning of correlation and regression. Tests of significance - F & t tests, chi-square tests, ANOVA.</p> <p>Cluster analysis: phylogenetic clustering by simple matching coefficients.</p> <p>Presentation of statistical data: tabulation (simple tables, frequency distribution table); charts and diagrams (bar charts, histograms, pie charts, dendrogram).</p> <p>Research designs with basic principles and field layout.</p>	
Unit IV	Bioethics	<p>Bioethics- History & Introduction; Social, Legal & Ethical Issues in biotechnology, ethical concerns of biotechnology research, Bioethics Committees</p> <p>Animal ethics- Norms in India-Licensing of animal house- Ethical clearance norms for conducting studies on human subjects, IAEC</p>	4
Unit V	Intellectual Property Rights	<p>Introduction to IPR, IPR in India, IPR in abroad, Types of IPR- Patent, Copyright, Trademark, Design & Trade Secret</p> <p>Biotechnology & IPR- Commercial potential of biotechnology inventions; Patenting Biotechnological Inventions- Objective, Concept of novelty, Concept of inventive step, Microorganism, Moral issues in patenting biotechnological inventions.</p> <p>Plant Varieties Protections- Objective, Justification, International position, Plant Variety Protection in India.</p> <p>Protection of geographical indication- Objective, Justification, International position, Multilateral Treaties, National level, Indian positions</p> <p>Protection of traditional knowledge- Objective, Concept of traditional knowledge, Bioprospecting & Biopiracy, Protectability.</p>	9
Unit VI	Biosafety	<p>Introduction a& development of Biosafety; Practices & Principles; General lab equipments; Definitions & Biosafety levels, 1, 2, 3, 4,; Biological safety cabinets, centrifuge; Shipment of biological specimens; Biological waste management; Decontaminations, Biosafety manuals; Medical surveillance, Emergency response.</p>	6
Unit VII	Social Issues and the Environment	<p>Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation: Case studies. Environment protection Acts: Air (Prevention and control of Pollution) Act. Water (Prevention and control of Pollution) Act Wildlife protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation.</p>	5

METHODOLOGY

The course would be taught through lectures and tutorials.

Books recommended:

1. Research Methodology- Methods & Techniques by C. R. Kothari
2. Principles & Techniques of Biochemistry & Molecular Biology by Wilson & Walker
3. Methods in Biostatistics by B. K. Mahajan
4. Fundamentals of Biostatistics by Khan & Khanum
5. Fundamentals of Biostatistics by U.B.Rastog
6. T. M. Murray & M. J. Mehlman, Encyclopedia of ethical, legal and policy issues in biotechnology, John Wiley & sons 2000.
7. Ethical Issues in Biotechnology by Richard Sherlock & John D. Morrey, Rowman & Littlefield Publishers
8. Agarwal, K.. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

PRACTICALS IN RESEARCH METHODOLOGY AND SOCIO- ETHICAL ASPECTS OF BIOTECHNOLOGY (4 Hrs. per Week)**LIST OF EXPERIMENT**

1. Manuscript preparation for research article.
2. Research proposal formation and submission.
3. Data analysis of case study.
4. Collection, classification and tabulation of data.
5. Measures of central tendency.
6. Student t - test.
7. Chi - square test.
8. Correlation coefficient and rank correlation.

PHARMACEUTICAL BIOTECHNOLOGY (BP 206)

Course Code	Category	Course Name	L	T	P	Total Hr
BP 106	Major	Pharmaceutical Biotechnology	4	0	2	48

Objective:

The objective of the course is to give strong base and advanced information on biopharmaceutical aspects in relation to drug development.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Bio-processing system	Expression system Cultivation systems Cultivation medium Contaminants	8
Unit II	Formulation of biotech products, including biopharmaceutical Considerations	Microbiological consideration Excipients used in Parental formulations of Biotech products Shelf life of protein based pharmaceuticals Delivery of proteins: Routes of administration and adsorption enhancement Approaches for rate controlled and target site specific Delivery by the parental route	12
Unit III	Pharmacokinetics and Pharmacodynamics of peptide and protein drugs	ADME of protein therapeutics Bioavailability and Bioequivalency Pharmacodynamics of protein therapeutics Interspecies scaling Heterogeneity of protein therapeutics Chemical modification of protein therapeutics Immunogenicity	10
Unit IV	Genomics, Proteomics and additional biotechnology-related techniques	Genomics, proteomics and pharmacogenetics/genomics Genetically engineered animals Protein engineering Peptide chemistry and peptidomimetics Nucleic acid technologies Catalytic antibodies Glycobiology Biotechnology and drug discovery	10
Unit V	Nanobiotechnology	Nanotechnology: An overview Characteristics of Nanoparticles	8

Sr. No.	Topic	Detail of syllabus	Hrs.
		Method's for Nanoparticles preparation Wet Chemical Processes, Mechanical Processes, Form-in-Place Processes, Gas Phase Synthesis Bioinspired Approaches to Building Nanoscale Devices Biology as Model system for Building Nanoscale Devices Nanotechnology food and biomedical applications	

METHODOLOGY

The course would be taught through lectures, demonstrations and tutorials classes

BOOKS RECOMMENDED:

1. Proteins: Biochemistry and Biotechnology - Gary Walsh
2. Foye's Principles of Medicinal Chemistry -William David A. and Lemke Thomas L.
3. Pharmaceutical Biotechnology, 2nd ed. by Crommelin D.J.A. & Sindelar R. D.
4. C. M. Niemeyer and C. A. Mirkin- (Editor), Nanobiotechnology: Concepts, Applications and Perspectives, Wiley Press
5. Nanobiotechnology by Subbiah Balaji

PRACTICAL

LIST OF EXPERIMENTS

1. Antibiotic production from biological sources.
2. To perform antibiotic assay.
3. Determination of Minimum Inhibitory Concentration (MIC) of given antibiotics.
4. Sterility testing of pharma products.
5. Toxicity testing.
6. Industrial visit.

PROJECT WORK/ DISSERTATION (BP 207)

BP 207	M.Sc. Dissertation Project: Each candidate needs to complete a short dissertation project. Prior to proposing a project, the students must have identified a research topic and a mentor who is familiar with their prospective inquiry and who is willing to provide guidance and oversee the project.
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