DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/M.Sc.Biophy./College/27/2024

It is hereby inform to all concerned that, the syllabus prepared by the Ad-hoc Board and recommended by the Dean, Faculty of Science & Technology, Academic Council at its meeting held on 08 April 2024 has accepted the **Revised Syllabus of M.Sc. Biophysics (Ist to IVth semester) under the Faculty of Science & Technology as per National Education Policy-2020** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Chhatrapati Sambhajinagar.
REF.NO.SU/2024/3642-50
Date:- 08.07.2024.

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, MS-431004

Faculty of Science & Technology

2 Years/1 Year P.G. Programme

Course Structure

Subject: Biophysics

(Effective from 2024-25)

Dr. V. N Wadekar
Chairman
Ad-Hoc Board
Biophysics,
BAMU Chhatrapati Sambhajinagar

1. Preamble

The National Education Policy (NEP) 2020 aims to revolutionize the education system in India, fostering an interdisciplinary and holistic approach to learning. With a focus on promoting scientific temper and innovation. Biophysics, at the intersection of biology and physics, plays a vital role in understanding the principles governing living systems, their structures, and functions.

The M.Sc. Biophysics syllabus, as per NEP 2020, is designed to provide students with a comprehensive understanding of the fundamental concepts and methodologies of this interdisciplinary field. The syllabus aims to nurture scientific inquiry, critical thinking, and problem-solving skills while fostering a deep appreciation for the intricate workings of biological systems.

The University Grants Commission (UGC) emphasizes the urgent need for comprehensive academic and administrative reforms in higher education to enhance its quality and excellence. In line with this, UGC has put forth an Action Plan that advocates embracing the new educational policy (NEP) of 2020 and fostering flexibility in curriculum development and examination procedures. The objective is to adopt a Continuous Evaluation Pattern, reducing the emphasis on only semester examinations, and thereby creating a less stressful learning environment for students. UGC expects all higher learning institutions, including Dr Babasaheb Ambedkar Marathwada University in Chhatrapati Sambhajinagar, to develop a time-bound roadmap to implement these reforms successfully.

Dr Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, determined to bring about radical changes in the curriculum, teaching methodologies, and evaluation methods. The university's vision is to nurture the finest generation of individuals who possess both knowledge and talent, dedicated to serving society. Aiming to benchmark its academic practices against global standards, the university is committed to advancingforward in this pursuit of excellence.

2. Vision

Dr Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, plans to bring about radical changes in the curriculum, teaching and evaluation. The vision of the university is to groom the finest breed of citizens equipped with knowledge and talent to serve the society. The university aspires to march forward to achieve benchmarking of our academic practices against world class standards.

3. Mission

Dr Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, implementing thenew educational reforms of NEP 2020 is to empower future generations through a holistic and inclusive education. It aims to revolutionize the educational landscape by equippingstudents with knowledge, skills, and values to thrive in a rapidly changing world. The key pillars of this mission include universal access and equity, promoting lifelong learning and skill development, fostering a multidisciplinary and flexible curriculum, embracing technology for personalized learning, empowering teachers, promoting inclusivity and diversity, encouraging research and innovation, and integrating sustainable development and environmental consciousness. By uniting stakeholders, NEP 2020 envisions a transformative educational landscape that empowers future generations to contribute positively to society and build a brighter future.

4. Programme educational objective:

Understanding the principles of biophysics and its applications in various fields. Developing analytical and problem-solving skills relevant to biophysical research. Gaining proficiency in advanced laboratory techniques and experimental methods used in biophysics. Acquiring knowledge of biophysical instrumentation and data analysis tools. Demonstrating the ability to critically analyze scientific literature and communicate research findings effectively.

5. Programme Outcome and Programme Specific Outcome

Program-specific outcomes, on the other hand, are more specific to the M.Sc. Biophysics program offered by this university. These outcomes are tailored to the specific curriculum, resources, and expertise of the program. It includes demonstrating

expertise in specific areas of Biophysics such as Structural Biology, Molecular Biophysics, or Bioinformatics. Conducting independent research projects and presenting findings in seminars or conferences. Collaborating effectively in interdisciplinary research areas. Understanding the ethical considerations and societal implications of biophysicalresearch.

6. Eligibility Criteria for M.Sc. Biophysics Course:

A Candidate shall be held eligible for admission to Two-year course for the Master's Degree (M.Sc.) in Biophysics or One-year P.G. Diploma in Biophysics under faculty of Science, if candidate is B.Sc. with Physics or Chemistry or Zoology or Biochemistry or Botany or Microbiology or Mathematics or Statistics or Electronics or Biotechnology or Bioinformatics or Computer Science or Forensic Science or Analytical Chemistry as one of the Optional Subjects. OR B.Sc. [Integrated] Biotechnology or Bioinformatics OR B.Pharm OR B.Sc Agriculture/Horticulture and BSc Paramedical Sciences.

7. Admission / Promotion:

Admission to the course in the concerned department will be done on the performance of CET score and / or on their performance in the qualifying graduate level examination/ the guidelines given by the university for the admission process time to time for concern academic year. The student will apply on the application form provided with the prospectus. Once the student is admitted to the concern department/course, he/she will be promoted to next semester with full carryon; subject to the registration of student in every consecutive semester. Dropout student will be allowed to register for respective semester as and when the concerned courses are offered by the department, subject to the condition that his/her tenure should not exceed more than twice the duration of course from the date of first registration at parent department. The admission of concern student will be automatically get cancelled if he/she fails to complete the course in maximum period (Four years/Eight semesters).

8. Detailed Course Structure

Two-Year Post-graduate Program

Course and Credits Distribution of Two years PG/Master's Degree Program with Entry & Exit Option

Faculty of Science & Technology

Year / level	Sem.	Major Subject		RM	OJT /FP	RP	Credits	Degree
		DSC Core Mandatory	DSE (Elective)					
First year 6.0	I	3(4) +2=14	4	4			22	PG Diploma (after 3 years degree)
	II	3(4) +2=14	4		4 Complete during summer break		22	
Cum. Cr. For PG Diploma		28	08	4	4		44	
Exit option with Post-graduate Diploma (44 credits) after first year or two semesters with completion of courses equivalent to 44 credits								
Second Year 6.5	III	3(4) +2=14	4			4	22	PG Degree after 3 years UG or PG Degree after 4 years UG
	IV	3(4) =12	4			6	22	
Cum. Cr. For 1 year PG Degree		26	8			10	44	
Cum. Cr. For 2 years PG Degree		54	16	4	4	10	88	
2 Years -4 sem.PG Degree (88 credits) after three-year UG Degree or 1 Year -2 sem. PG Degree (44 credits) after four-year UG degree								

ABBREVIATION:

Major: A course, which should compulsorily be studied by the student as requirement of core or major subject is termed as a core course.

DSE: Generally, a course which can be chosen from a pool of course and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called as elective course.

OJT: On-the- Job Training

FP: Field Project/Internship/Apprenticeship (Corresponding to the Major (Core) Subject

RP: -Research Project Corresponding to the Major (Core) Subject

M.Sc. Biophysics Course structure:

The Outcome Based Credit System as a part of NEP 2020 is adopted progressivelyfrom the academic year 2023-2024.

1. **M.Sc. Biophysics course is covered in four semesters and assesses for total 2200 marks (Marks 550/Semester)**
2. The Master Degree course in **Biophysics (MSc. Biophysics)** is of **Four semesters**. Every semester (semester I to V) offers **22 credits**.
3. Student has to complete **88 Credits (I to V semester) to obtain M.Sc. Biophysics (Master) degree**.
4. Students completing **44 credits during Semester I and II** are eligible for getting **PG Diploma in Biophysics**.

MSc. First Year:

Semester- I (Total 22 Credits):

14 credits are for Major Mandatory (**DSC**)Courses,
04 credits are for Discipline Specific elective (**DSE**) course
04 credits for Research Methodology (**RM**).

Credits should be earned from the concerned subject, includes theory/ practical.

Semester-II: (Total 22 Credits):

14 credits are for Major Mandatory (**DSC**) courses,
04 credits are for Discipline Specific elective (**DSE**) course
04 credits for **On Job Training (OJT)/Field Project (FP)**

(OJT/FP may be completed either within or outside the college/ industry/other Institution/ Department etc.)

Semester-III: (Total 22 Credits):

14 credits for Major Mandatory (**DSC**)Courses,
04 credits for Discipline Specific elective (**DSE**) course
04 credits for **Mini Research Project**

Semester-IV: (Total 22 Credits):

12 credits are for Major Mandatory (**DSC**) courses,
04 credits are for Discipline Specific elective (**DSE**) course
06 credits for **Major Research Project**.

- **One Credit shall mean one teaching period of one hour per week for one semester (of 15 weeks)**

a) Under the One-year PG Diploma program, and two-year master's Degree program, the students must complete on-the-job training/internship of 04 credits during summer break, after completion of the second semester of the first year in the respective Major Subject.

b) The 4 Credits Research Methodology Component is mandatory in the First Year

c) The students will have to undertake a research project of 4 credits in Semester III and a research project of 6 credits in Semester IV in the second year of the two-year master's degree program. This is also applicable to the students admitted to one year PG program after completion of four-year UG Program.

d) The exit option at the end of one year of the Master's degree program will commence from AY 2024-25. Students who have joined a two-year Master's degree program may opt for exit at the end of the first year and earn a PG Diploma.

e) The PG Diploma may be awarded to a student provided they have earned the requisite credits in one year including **on-the-job training of 04 credits during summer break,** after completion of the second semester of the first year in the respective Major Subject.

f) The one-year Master's Degree Program will begin with effect from Academic Year 2027-28.

Re-entry to complete the PG degree, after taking the exit option, will be permissible up to 05 years from the date of admission to the PG program

9. M.Sc. Biophysics Course Workload and General Instructions:

1. Every Major Mandatory Discipline Specific Course (DSC) will have workload of 30 periods, each of 60 minutes duration, distributed unit wise as indicated in this syllabus. **[2periods/wk X 15 weeks= 30]**
2. Every Lab Course Based on (DSC) will have workload of 60 periods, each of 60 minutes duration. [4 periods/wk X 15 weeks=60]
3. Lab Course Based on Microscopic Techniques **(Skill Enhancement)** haveworkload of 60 periods, each of 60 minutes duration.**[4 periods/wk X 15 weeks=60]**
4. In **Semester 3, three major Mandatory Discipline Specific courses (DSC) and Lab Course based on it and one Skill /advance technique course of 2 credits are included. Student can opt One Discipline Specific elective from the list / group of the elective mentioned in the syllabus.**
5. In **Semester-3 Research Project-1, (RP-1) Minor-project** may be allotted to each student depending on his/her efficiency, available Faculty/expertise and resources availability. For guiding mini-projects **Four students per faculty** be allotted. **8 periods/wk X 15 weeks=120]**
6. In **Semester 4, three major Mandatory Discipline Specific courses (DSC) and Lab Course based on it are included. Student can opt One Discipline Specific elective from the list / group of the elective mentioned in the syllabus.**
7. In **Semester-4 Research Project-2 , (RP-2) Major-project** may be allotted to each student depending on his/her efficiency, available Faculty/expertise and resources availability. For guiding mini-projects **Four students per faculty** be allotted. **12 periods/wk X 15 weeks=180**
8. The internal evaluation process include the events viz. test, tutorial, seminar, journal paper presentation, group discussion, open book test and mid-term exam (based on 40% completed syllabus) and term-end exam (based on 60% completed syllabus). The internal marks are computed by taking average of marks obtained in these internal evaluation events. The number of internal evaluation events and pattern of paper are decided by departmental internal evaluation committee in respective department.
9. The practical component in lab courses, skill enhancement courses, On Job Training /Field work and mini-projects are performed in respective semesters. The semester end examination of practical components will be held at the end of respective Semester.
10. The university evaluation method, grade awards, Grievances Redressal, computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average), Grade card and cumulative grade card are as per university rule narrated below.

Monitoring Committee of Post Graduate Programme:

Every P. G. programme of the University/College shall be monitored by a committee constituted for this purpose by the college. The Committee shall consist of Principal as a Chairman and all the teachers of the college as its members.

Results Grievances Redressal Committee: -

The college shall form a Grievance Redressal Committee for each course in each department of the college with the Course Teacher and the Principal. This Committee shall solve all grievances relating to the Assessment of the students.

Grade Awards: -

(i) A ten point rating scale shall be used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Masters Programme. Grade points are based on the total number of marks obtained by him/her in all the heads of examination of the course. These grade points and their equivalent range of marks are shown separately in Table-I.

Table I: Ten point grades and grade description

Sr. No.	Equivalent Percentage	Grade Points	Grade	Grade Description
1	90.00-100	9.00-10	O	Outstanding
2	80.00-89.99	8.00-8.99	A++	Excellent
3	70.00-79.99	7.00-7.99	A+	Exceptional
4	60.00-69.99	6.00-6.99	A	Very Good
5	55.00-59.99	5.50-5.99	B+	Good
6	50.00-54.99	5.00-5.49	B	Fair
7	45.00-49.99	4.50-4.99	C+	Average
8	40.01-44.99	4.01-4.49	C	Below Average
9	40.00	4.00	D	Pass
10	< 40	0.00	F	Fail

ii.) Nonappearance in any examination/assessment shall be treated as the student has secured zero mark in that subject examination/ assessment.

iii.) Minimum D grade (4.00 grade points) shall be the limit to clear / pass the course/subject. A student with F grade will be considered as failed in the concerned course and he/she has to clear the course by reappearing in the next successive semester examinations. There will be no revaluation or recounting under this system.

iv.) Every student shall be awarded Grade points out of maximum 10 points in each subject (based on 10 Point Scale). Based on the Grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and cumulative Grade card with CGPA will be given on completion of the course.

Computation of SGPA (Semester grade point average) & CGPA (Cumulative grade point average)

The computation of SGPA & CGPA, will be as below:

a. Semester Grade Point Average (SGPA) is the weighted average of points obtained by a student in a semester and will be computed as follows:

$$\text{SGPA} = \frac{\text{Sum [Course Credit*Number of Points in concerned course gained by the students]}}{\text{Sum [Course Credit]}}$$

The Semester Grade Point Average (SGPA) for all the four semesters will be mentioned at the end of every semester.

b. The Cumulative Grade Point Average (CGPA) will be used to describe the overall performance of a student in all semesters of the course and will be computed as under

$$\text{CGPA} = \frac{\textbf{Sum (All four semester SGPA)}}{\textbf{Total Number of Semesters}}$$

Equivalent Percentage of CGPA should be shown on Grade sheet as equivalent percentage = CGPA

(10) The SGPA and CGPA shall be rounded off to the second place of decimal.

Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

M.Sc. Biophysics First Year [Semester-1]

Total Credits for semester-1: 22 AS PER NEP 2020

Illustrative Credit distribution structure for Two Years Programme with Multiple Entry and Exit options

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credits Assigned		Total Credits	Scheme of Examination			
								Theory Maximum. Marks 50		Practical Maximum Marks 50	
			Theory	Practical	Theory	Practical		CA- 40% Min/ Max	UA 60% Min/ Max	CA 40% Min/ Max	UA 60% Min/ Max
Major Mandatory DSC	BPT/MJ/500	Molecular Biophysics	2	-	2	-	14	08/20	18/30		
	BPT/MJ/501	Biophysical Chemistry	2	-	2	-		08/20	18/30		
	BPT/MJ/502	Cellular Biophysics	2	-	2	-		08/20	18/30		
	BPP/MJ/503	Practical based on BPT/MJ/500	-	4	-	2				08/20	18/30
	BPP/MJ/504	Practical based on BPT/MJ/501	-	4	-	2				08/20	18/30
	BPP/MJ/505	Practical based on BPT/MJ/502	-	4	-	2				08/20	18/30
	BPP/MJ/506	Microscopic Techniques	-	4	-	2				08/20	18/30
DSE (Choose any one from pool of courses)	BPT/DSE/ 507	A/B	2	-	2	-	04	08/20	18/30		
	BP/DSE/ 508	Practical based on BPT/DSE/507	-	4	-	2				08/20	18/30
RM	BP/RM/509	Research Methodology	-	8	-	4	04			16/40	24/60
			08	28	08	14	22	80	120	140	110

1. **Major Mandatory (DSC) - Master Programme is based on DSC Specialization**

BPT/MJ/500: Molecular Biophysics

BPT/MJ/501: Biophysical Chemistry

BPT/MJ/502: Cellular Biophysics

BPP/MJ/503: Practical based on BPT/MJ/500

BPP/MJ/504: Practical based on BPT/MJ/501

BPP/MJ/505: Practical based on BPT/MJ/502

BPP/MJ/506: Microscopic Techniques

2. **DSE: (Choose any one from Pool /Basket)**

BPT/ DSE/507: A- Molecular Enzymology

BPT/ DSE/507: B- Assisted Reproductive Technology (ART)

BPP/DSE/508: Practical based on BPT/ DSE/507 (A/B)

BP/RM/509: Research Methodology

BPT/MJ/500: Molecular Biophysics

[Total Marks: 75] [Total Workload: 30 hrs.] [Credits: 2] [2 hrs./week]

Unit 1: Molecular alphabets of Life & Other Biological Polymers. (10 hrs.)

Amino acid, Nucleic acid bases & Lipids, Classification & Properties of Amino acid, Peptides & Polypeptides, Nucleosides, Nucleotides, Polynucleotide, Pentose & Hexose Polysaccharides, Amino acid to Peptides, Polypeptides, Different types of linkages.
Structure and conformation of polysaccharide cellulose, Amylase, Chitin, Carbohydrates conjugates, Classification & biological role of vitamins & hormones.

Unit 2: Nucleic Acids (10 hrs)

Double helical structure of DNA, Conformational parameters of Nucleic acids & their constituents, Chargaff's rule, DNA polymorphism, DNA supercoiling, Hyperchromicity, Circular DNA, Types & structure of RNA, mRNA, rRNA, tRNA & modified nucleotides, nucleic acid sequencing.

Unit 3: Proteins. (10 hrs.)

Structural level of proteins & stabilizing forces, Conformational properties of polypeptides, Ramchandran plot, Helical parameters & Conformation, organization & interaction of angles, Conformational structure of alpha-keratin, Silk fibrin, Collagen, Actin, Myosin, Folded conformation of globular proteins (e.g.- Hemoglobin, Myoglobin, Lysozyme, Cytochromes) mechanism & side chain conformation, Classification & role of Beta- bends & bulges, Super secondary structure, Domain & motifs, Proteins in solution & protein sequencing, Concept of protein evolution, Cytochrome & Hemoglobin evolutionary studies.

Recommended books: Refer annexure for book titles.
1,2,4,5,6,7,10,11,14,15,18,19,20,21,23,24,26,29,30,31,32,58,60,61,69,70,72,73,74,105, 114,115,118,155.

BPT/MJ/501: Biophysical Chemistry

[Total Marks: 30+20] [Total Workload: 30 hrs.] [Credits: 2] [2 hrs./week]

Unit 1: Water, Acids-Bases & Redox Potential. (10 hrs.)

Molecular structure, Association of Water molecules through H- bonding, Nature of hydrophobic interactions, Physico Chemical properties of Water, State of Water in biostructures & its significance.
Acids and Bases, Mole & Normality, Weak acids, Amphoteric electrolytes, pH, Calculation of pH from H & OH Concentration, measurements of pH, Henderson Haselbatch equation,

Titration curve & pK values, Buffers & Stability of their pH, Numerical problems.
Oxidation & Reduction, Equivalence of electrical & chemical energy, Electro chemical cell, Contact potentials, Galvanic cell, Potential of half cell, Redox potentials & its calculations by Nerst equation, Examples of Redox Potential in biological system.

Unit 2: Thermodynamics & Bioenergetics. (10 hrs.)

Laws of Thermodynamics, Concept of free energy, Unavailable energy & Entropy, Negative entropy change in living system, Heat content of food, Bomb calorimeter.
Energy generation & energy transfer processes in biochemical reactions, Metabolism of glucose & formation of ATP. Energy requirements in cell metabolism, Role & Structure of mitochondria, High-energy phosphate bond, Electron transfer phenomenon & biological energy transfer.

Unit 3: Macromolecular Interactions. (10 hrs.)

Ligand interaction at equilibrium, Identical independent sites, Scatchard plot, Multiple classes of independent sites, Interaction between binding sites, Allosterism, MWC model, Sequential model, Oxygen Hemoglobin binding, Binding of two different ligands, Energetics and dynamics of binding, Structures of protein- ligand complexes, Relationship between protein conformations and binding, Binding of Immunoglobulins and DNA binding proteins, Free radicals in biology and medicine.

Recommended books: - Refer Annexure for detail book titles.
1,2,4,5,6,7,12,14,15,18,19,20,21,23,24,26,27,29,30,32,58,60,65,69,70,73,74,82,86,87,105,106,118,155.

BPT/MJ/502: Cellular Biophysics

[Total Marks: 30+20] [Total Workload: 30 hrs.] [Credits: 2] [2 hrs./week]

Unit 1: Cell Organization and Membrane Structure &Function, (15 hrs.)

Cell as the basic structural unit, Origin & organization of Prokaryotic and Eukaryotic cell, Cell size & shape, Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell), Internal architecture of cells, cell organelles, compartment & assemblies membrane system, Ribosome, Polysomes, Lysosomes & Peroxisomes, Connection between cell & its environment, Glycocalyx, Extracellular Matrix.
Membrane Structure & Function: Various membrane models, Composition of biological membranes- lipid molecules, proteins, glycoprotein, membrane skeletons, electrical properties of lipids and proteins, Principles of membrane organization & stability, Biogenesis of cell membrane, Self-organization of lipids and proteins- linear aggregates

of membranous components, aggregation of lipid molecules in mycelia and lipid double layers, biologically important non-lamellar lipid phases, formation of flexible membranous nanodomains (Lipid Rafts), lateral phase separation of membranous components, aggregation of nanodomains, formation and stability of membranous nanotubes.

Elastic properties of membranes: deformations in levels of a membrane, flexible energy, influence of forms of membrane components and direct interactions between membranous components in elastic properties of membranes, lateral distribution of membranous components and elastic properties of membranes, elastic properties of membranes and forms of cells and organelles, influence of cytoskeleton on forms of cells, Molecular motion in membrane & membrane fluidity, Protein lipid interactions, Phase properties of biological membranes.

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Unit 2: Cell Growth & Division (08 hrs.)

Kinetics of cell growth, The Cell Cycle, Interphase-G1,S,G2,M molecular events at different cell cycle phases, A cytoplasmic clock times, cell cycle in early embryogenesis, Polypeptide Growth Factors &Control of cell proliferation, Mitosis & Cell division-Molecular mechanism , Events in mitosis, Role of mitotic apparatus, Meiosis & Sexual reproduction, Molecular mechanism of meiosis, DNA metabolism during meiosis, Dividing & Non-dividing cells, Synchronization of cell cycles, Cell transformation & Malignancy, Cell aging & death-Apoptosis, Cell Cycle Control, Role of MPF, Cd2 Proteins& G-1* Cyclins

Unit 3: Cell-Cell Interaction (07 hrs.)

Connection between the cell and its environment, Glycocalyx, Extracellular Matrix, collagen, Elastin, Fibronectin, Lamin, Proteoglycans, Integrins, Cell Junctions, Desmosomes, Gap junction, Tight Junctions, Plasmodesmata, Synapse and synaptic vesicles*, Cell Signaling, General principle of cell signaling, Paracrine, Autocrine, Endocrine &synaptic signaling, Heat Shock Proteins, G- Protein structure and role in signaling, Intracellular Cyclic AMP, Role Ca ++ in cell signaling, CAM Kinases, (Calmodulin/Ca++ dependent protein kinases), Interaction between cyclic AMP & Ca++. Role of Methylation in adaptation & bacterial chemotaxis.

Cell differentiation, General characteristics of cell differentiation, Localization of cytoplasmic determinants, Molecular mechanism of cell differentiation, Morphological movements & the shaping of body plains* Cell memory, Concept of positional values, maintenance of differentiated state, Tissue with permanent cells, neuronal networks & centre of the lens of adult eye.

Recommended books: - Refer annexure for detail book titles.
3,5,6,7,10,11,15,16,18,21,22,24,27,29,30,58,61,64,68,69,72,77,78,110,118.

BPP/MJ/503: Practical Based on BPT/MJ/500

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 2] [4 hrs./week]

1. To verify the Lambert Beer's law.
2. To determine the beer's limit and measurement of molar and percent extinction coefficient.
3. To estimate the percent purities of dyes and inorganic compounds.
4. To establish the absorption spectrum and determine the absorption maxima of p-Nitro phenol.
5. To study the characteristics of UV absorption spectra of Aromatic Amino Acids.
6. To study the characteristics of UV absorption spectra of Proteins.
7. To study the characteristics of absorption spectra of Nucleic Acids and Nucleotides.
8. To study the mutarotation of simples Sugars using Polarimetry.
9. Spectrophotometric assay of electron transport in intact Mitochondria using Dye Reduction methods.
10. Light induced proton pumping (uptake) in hypotonically swollen Chloroplast from Spinach Leaves.
11. To estimate light driven Chloroplast electron transport by Dye Reduction method.
12. Acid – Base titration using pH meter and determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base.
13. To estimate the inorganic phosphate.
14. To analyze of Oil-Iodine number, saponification value & acid number.
15. Model building using Space filled & Ball and Stick models.

BPP/MJ/504: Practicals Based on BPT/MJ/501

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 2] [4 hrs./week]

1. To estimate the DNA molecules.
2. To estimate the RNA molecules.
3. Studies the simple molecular structures using DTMM and other basic molecular modeling softwares.
4. To prepare the buffers & measurement of pH.
5. To determine the titration curve of amino acids & calculate the pKa values.
6. To determine the titration curve of Proteins & calculate the pKa values.
7. To determine the Tm of DNA.
8. Denaturation & Renaturation of DNA.
9. To isolate the Proteins- Casein from milk, Hb from RBC.
10. Study of UV absorption spectra of Proteins.
11. Study of UV absorption spectra of Nucleic acids.
12. To study the macromolecular interactions using ultrasonic interferometer.
13. To study the effect of temperature, concentration, macromolecular size, shape on ultrasonic velocity

14. To isolate the Phospholipids from Egg Yolk.
15. To study the interactions of Acridine orange with DNA.
16. To estimate quantitatively the Amino acids using the ninhydrin reaction.
17. To estimate proteins by Biuret assay.
18. To estimate the Protein by Folin's-Lowry method.
19. To prepare the Cytochrome C & its characterization.
20. To identify the C-terminal Amino acids of a protein.
21. To identify the N-terminal Amino acids of a protein.
22. To study the protein structure by using DTMM (Desk top molecular modeling)
23. To analyze the major types of vertebrate collagen by SDS PAGE.

BPP/MJ/505: Practicals Based on BPT/MJ/502

[Total Marks:30+20] [Total Workload: 60 hrs.] [Credits: 2] [4 hrs./week]

1. To familiarize with bright field, phase contrast, fluorescence & polarizing microscopes.
2. To observe the stained & unstained Prokaryotes & Eukaryotes
3. To characterize the sub cellular fractions.
4. To study the chromosomal DNA morphology by Feulgen reaction (root tip cells)
5. To identified the cellular carbohydrate by the Acid Schiff (PAS) reaction.
6. Demonstration of Chemo taxis.
7. To identify the Cytochemical DNA/RNA with the Methyl green-pyronin method.
8. Blood analysis: Estimation of RBC count, WBC count, Differential count, Hb%, Packed cell volume, E.S.R.
9. To measure the mean corpuscular diameter.
10. To count the Reticulocytes & Platelets.
11. Microscopic studies of Mitosis & Meiosis stages & determination of mitotic index.
12. To establish the cell growth curve & determination of generation time.
13. To maintain the cell culture protocols.
14. To study the charge characteristics of cells through micro Electrophoresis.
15. To study the histochemical localization of Alkaline & Acid Phosphatase, Glycogen & Lipids in the tissue.
16. To Isolate and characterize the bacteria from leaf tissue.

BPP/MJ/506: Microscopic Techniques-I
(Physicochemical Techniques)

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 2] [4 hrs./week]

Unit 1- General Introduction to Microscopy (Optical Microscopy) (10 hrs.)

Electromagnetic radiations, properties of light, light intensity, amplitude, frequency, wavelength, polarization. Microscope, general design, objective, magnification, resolution, numerical aperture. Light microscopy: principle, design, & application, types of light microscope Image formation, Resolution, Aberrations, Imaging modes, Specimen preparation. Bright field light microscope, phase contrast light microscope, dark field light microscope.

Unit 2- Electron microscopy (10 hrs.)

Transmission electron microscopy (TEM), Basics of TEM, Electron sources, Specimen preparation, Image modes, Image contrast, bright field, dark field, high resolution, energy filtered TEM, electron diffraction. Techniques of TEM, negative staining, shadow casting, freeze fracture replication, freeze etching. Application & limitations of TEM.

Scanning electron microscopy (SEM), Instrumentation, Electron beam-specimen interaction, Specimen preparation, Energy dispersive spectroscopy (EDS) in electron microscopes; types of signals produced by SEM x-ray, light-ray, secondary electrons, back scattered electrons (BSE), applications & limitations of SEM.

Scanning Probe Microscopies: Analytical electron microscopy (AEM). Scanning Transmission electron microscopy (STEM), Working principles, working modes, Image artifacts, applications & limitations.

Unit 3- Advanced microscopic techniques (10 hrs.)

Fluorescence microscopy: principle, design and working. Choosing a probe, choosing a light source, choosing a filter set. Controls for antibody staining, bleed through, autofluorescence. FRAP, FRET, Fluorophores. Types of Fluorescence Microscopes, Epifluorescence microscopes, Confocal microscope, Multiphoton microscope, Total internal reflection fluorescence (TIRF). Applications & Limitations of Fluorescence Microscope. Introduction to cryo-electron microscopy, application & limitations. Atomic force microscopy, applications and limitations.

Practical based on Microscopic Techniques-I

1. Study of microscope deigns, simple microscope, components & their uses.
2. Use & care of the microscope.
3. Observation of the micro-organism through microscope.
4. Stains – basic staining: methylene blue, crystal violet, hematoxylin, basic fuchsin, neutral red, acetocarmine, ethylene green, acetic acid, safranin, fehlin1+2, Iodine/potassium Iodide. Acid stains: eosin, orange G, Aniline blue & fast green,

cytochemical stains, acid fast stains.

5. Specimen preparation for different microscopic techniques.
6. Collection of dry specimens.
7. Observation of onion cells &their components.
8. Observation of chloroplast & movement of chloroplast.
9. Observation of chromoplast in tomato.
10. Preparation of fresh specimens of human & animal origin.

a. Observation of epithelial cells from oval mucus membrane.
b. Observation of shredded muscle tissue specimens.

11. Detection of intracellular components.
12. Microscopic observations of algae.

BPT/DSE/507/A: Molecular Enzymology

[Total Marks: 30+20] [Total Workload: 30 hrs.] [Credits: 2] [2hrs./week]

Unit 1: Enzymes as Biocatalysts. (7 hrs.)

Remarkable properties of Enzymes as Catalysts, Active sides, three-point attachment, Mechanism of enzyme action, Flexible enzymes, Induced-fit hypothesis, Catalytic efficiency of enzymes, Micro environmental approach to enzyme dynamics, Nomenclature & classification, Hydrolases & Transferases, Peptidases, Esterases, Kinase, ATPases, Oxidoreductases, Lyases, some examples of Isomerization, Rearrangement & condensation reactions, Molecular dynamics & Transient states of Enzyme catalysis.

Unit 2: Basic principles of chemical kinetics & Enzymes Kinetics.(12 hrs.)

Chemical Kinetics: Velocity, Order and Molecularity of a chemical reaction, Kinetic equations for zero, first, second & third order reactions, Determination of order of the reaction, Arrhenius equation, Activation energy & its estimation, Collision & transition state theories of reaction rate, Catalysts, Mode of action of catalysts, Nucleophilic, Electrophilic & Acid-Base Catalysis.

Enzyme Kinetics: Kinetics of single substrate reaction, Michaelis equation, steady state kinetics, transient phases of enzyme reactions, Lineweaver-Burk, Eddie-Hofstee plot, Woolf plot. Effect of pH, temperature, metal ions on enzyme activity. Enzymes turn over mechanisms of multisubstrate enzyme reactions (conceptual approach), kinetics of reversible enzyme inhibition, Mechanisms of action of Chymotrypsin and Ribonuclease.

Unit 3: Enzyme Regulation & Enzyme Technology (11 hrs)

Enzyme Regulation: Control of enzyme activity, feedback inhibition, kinetic behavior of allosteric enzymes, mechanism of allosteric interactions, subunit structures and protein

assembly-Aspartic transcarbamylase, Proton ATPase, Metalloenzymes-carboxypeptidase A, Role of Zinc.

Enzyme Technology: Enzyme Immobilization techniques, use of isolated enzymes in industrial processes, Enzymes in clinical diagnosis, Isozymes, Abezymes, Ribozymes, Enzyme therapy, Extremozymes, Solventogenic and non-aqueous enzymes.

Recommended books:- Refer Annexure for detail book titles
2,5,11,12,15,18,21,24,25,26,30,56,60,64,66,67,69,71,73,74,82,83,84,85,86,119,155

BPP/DSE/508: Practical based on BPT/DSE/507/A: Molecular Enzymology

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 2] [4hrs./week]

1. To study the first order kinetics of inversion of cane sugar using Polarimetry and determination of rate constant K.
2. To determine the energy of activation for a chemical reaction.
3. To study the characteristics of different catalytic reactions (Nucleophilic, Electrophilic & Acid-Base).
4. To measure the enzymatic activity.
5. To isolate and purify the Enzymes- Isolation of muraminidase from egg white.
6. To isolate & fractionate the dehydrogenase from Yeast.
7. To study the effect of temperature on Enzyme activity & Kinetics.
8. To study the effect of pH on Enzyme activity & Kinetics.
9. To study the effect of metal ions on Enzyme activity & Kinetics.
10. To study the Kinetics of Enzyme and determination of Kinetic parameters.
11. To study the effect of substrate concentration and Inhibitors on lactate dehydrogenase.
12. To prepare the Enzyme crystals and their microscopic characterization and storage.
13. To separate the isoenzymes from lactate dehydrogenase by Polyacrylamide Gel Electrophoresis (PAGE).
14. To study the protein inhibition by Polyacrylamide Gel Electrophoresis (PAGE).
15. To study the protein-ligand interactions by Scatchard plot.
16. Immobilization of Enzyme on Solid support.
17. Comparative study of properties of Immobilized and free Enzymes.

BPT/DSE/507/B: Assisted Reproductive Technology

[Total Marks: 30+20] [Total Workload: 30hrs] [Credits:2] [2hrs./week]

Unit 1: Human Reproductive Biology

Gamete biology: spermatogenesis and oogenesis, andrology: detailed composition of seminal plasma, Semen examination: introduction, sample collection methods, sample collection for diagnostic or research purposes, Sterile sample collection and microbial analysis, safe handling of specimens. initial examination: liquifaction, semen viscocity, semen appearance, semen volume and pH, Initial microscopic examinations, sperm mobility, vitality test, concentration estimation, morphology assesment, assesment of defect, assesment of leukocytes and immature germ cells in semen, structure of spermatozoa. Poor semen parameters.

Unit 2: Physiology of Infertility

causes of female infertility: Failure to ololate, problem in menstrual cycle, infection, failure to mature egg properly, endometriosis, primary ovary insufficiency, uterine anatomy and fibroid.

infertility trends worldwide, infertility in India, Various environmental factor effects onmale and female infertility, female infertility: disordes of female reproductive system, fallopian tubal block, hydrosalphinx, polycystic ovary syndrome (PCOS), physiology of ovulation, ovarian cycle, menstrual cycle, ovulationa and anovulation, ovarian stimulation protocol, human early embryology development, fertilization, early cleavage, blastocyst, implantation, gastrulation and placentation.

Unit 3: Techniques in ART

history of assisted reproduction, gonado tropins in ART, Follicle stimulation Hormone (FSH), luteal hormone (LH) estradiol and progesterone, ovarian reserve test, by AMH/ Antral follicle count. Assisted Reproductive Technology (ART) includes in vitro fertilization-embryo transfer (IVF-ET), gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT), and frozen embryo transfer (FET). Intra Uterine Insemination (IUI).

BPP/DSE/508: Practical Based on BPT/DSE/507/BAssisted Reproductive Technology

[Total Marks: 30+20] [Total Workload: 60 hrs] [Credits:2] [4hrs./week]

1. Handling of different types of microscope
2. Study of different mitotic stages
3. Study of different meiotic stages
4. Preparation of mitotic chromosome using onion root tip.
5. Brief account of equipment: Laminar airflow, various types of microscopes, stereo zoom microscope, inverted microscope, incubator us for IUI/ Dry bath, centrifuge unit, refrigerator, Makler chamber, Neuber chamber, sperm concentration.
6. Sperm preparation: Introduction , choice of method, efficiency of sperm separation from seminal plasma and infectious organism, sample washing

procedure, direct swing –up, diffuse density gradient.

7. Sperm examination with Kruger's criteria.
8. Semen cryopreservation protocol: Standard procedure, modified freezing protocol for poor semen sample, labeling of straws and record.
9. sperm survival test.

sperm concentration calculator for IVF.

10. Use of CASA to assess sperm mobility.
11. Use of CASA to assess sperm morphology assessment
12. Follicle fluid screening
13. Identification of Oocytes, washing & pre-incubation.
14. Extraction of oocytes from ovaries
15. Culture media in ART: Media preparation for ART, detailed account of culture media, media preparation for intre uterine insemination(IUI) and IVF-ET
16. Method of fertilization, number of good quality oocytes, fertilization and number of embryos, and quality of available embryos

BP/RM/509: Research Methodology

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 4] [4hrs./week]

Research Fundamentals: Introduction: Definition, research career, essentials for research career, objectives of the research, characteristics of the research, what makes people to do research, importance of research, pre-requisite for research.

Identification of Research Problem: Types of research, why-why analysis, defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of research problem definition, some facts involved in defining research problem

Formulation of Research Problem: Difficulties encounter while doing research, overview of science and the scientific method, empirical approach, essentials and dispensable in research, formulation of the problems: steps involved in defining a problem: i) Selection of problem/Broad topic for research ii) Literature review iii) Fine tuning of research topic iv) Formulation of hypothesis v) Formulation of objectives & Methodology of the study vi) Preparation for collection of data vii) Collection of data viii)Interpretation / analysis of data ix) Evaluation of data and testing of hypothesis x) Makingcorrections in hypotheses and repeating steps (v to ix) xi) Writing the report.

Research Report and drafting Research Proposal: Types of research reports: Synopsis / Synopsis for Projects (beginning), Masters Synopsis (End) / Synopsis for Projects, M.Sc. Thesis / Project Report,

Quantitative and Statistical Methods

Data Collection: Sources of Data – Primary and Secondary, Types of Data – Categorical (nominal and ordinal), Numerical (discrete, continuous, ratio and interval). Methods of Data Collection: Survey, Interviews (in-depth or Key Informant interviews), Focus

Group Discussion (FGD), Observation, Records and Experimental Observations.

Sampling methods: Basic of sampling, need of sampling method, sampling errors types of sampling (Probabilistic and Non-Probabilistic sampling) and sample size. Design of questionnaire, validity and checking of questionnaire. Data processing, editing of data and data cleaning

Data Management: Measures of central tendency (Mean, Median, Mode) Measures of dispersion (Range, quartile deviation, mean deviation, standard deviation, coefficient of variation), Correlation and regression, Positive and Negative correlation and calculation of Karl-Pearsons Co-efficient of correlation, Linear regression and regression equation, multiple linear regression, Calculation of an unknown variable using regression equation, Types of estimation, Confidence interval level of confidence. Confidence interval estimate of mean and of proportion.

Hypothesis testing: Types of hypothesis, level of significance, errors in testing hypothesis, Parametric and Non Parametric Tests: Meaning and purpose of parametric test and non-parametric test.

Experimental Designs: Meaning and purpose of basic experimental design and basic types of errors, basic principal of experimental design, types of basic design (CRD, RBD and LSD) and its need ANOVA one way and two way ANOVA , multiple comparison test. Basic of Factor-Analysis.

Parametric and Non Parametric Tests: Meaning and purpose of parametric test and non-parametric test - Difference between parametric and non-parametric test, "H" test, its meaning, purpose; assumptions and uses, Analysis of variance technique of "F" test, Analysis of co-variance technique, Regression, step regression, X2=test, its purpose and use, Median test and sign test.

Use of Statistical Software in data analysis: Using SPSS (For Social Science) /R Programming (For Sciences and Technology): Introduction of SPSS/ R Programming, input of data and coding in SPSS/ R Programming.

Research Related Tools and Utilities

MS-Office and its application, File handing in window, various versions of MS- Office, Research publishing tool- MS-Word, Adobe acrobat, Graphics tool- MS- Excel, MS-Power Point: Creating presentations and adding effects, Subject/field specific tools on www.freeware.com

Practical & Assignments on BP/RM/509: Research Methodology

1. Representation of Statistical data by:- Histogram, Ogive curves, Pie diagram.(3 assignments)
2. Measurement of central tendencies: - Arithmetic & Geometric mean mode and median. (3 assignments)
3. To calculate the measures of dispersion. :(6 assignments)
    a) Mean deviation.
    b) Standard deviation and Coefficient of variation.
    c) Quartile deviation.

4. Test of Significance. (6 assignments)
    a) Chi-Square Test.
    b) t- Test.
5. To evaluate the standard error & interpretation of results in terms of Accuracy and precision. (4 assignments)
6. Basic operating procedures of computer. To create File, Folder, Directories. (2 assignments)
7. Familiarity with the Basic operations of MS-office. (7 assignments)
8. Familiarity with use of Internet, Search engines, Web sites, Surfing, Browsing, Downloading text and Graphics. (4 assignments)
9. Creating Email account, Sending and Receiving mails.
10. Performing Literature survey and compilation.
11. Writing Review articles.
12. Writing research Papers and abstracts.
13. Five assignments on Proposal writing
14. Writing Conference / Symposium reports
15. Resume Writing for various employments
16. Writing research proposal for financial assistance
17. Giving Presentations in group discussion,
18. Giving oral & poster presentation
19. Writing general informative articles in science & technology

Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar

M.Sc. Biophysics First Year [Semester-2] Total Credits for semester-2: 22

Syllabus based on Outcome Based Credit System

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credits Assigned		Total Credits	Scheme of Examination			
								Theory Maximum. Marks 50		Practical Maximum Marks 50	
			Theory	Practical	Theory	Practical		CA- 40% Min/ Max	UA 60% Min/ Max	CA 40% Min/ Max	UA 60% Min/ Max
Major Mandatory DSC	BPT/MJ/550	Physiology and Biophysics	2	-	2	-	14	08/20	18/30		
	BPT/MJ/551	Molecular Biology and Genetics	2	-	2	-		08/20	18/30		
	BPT/MJ/552	Membrane & Ion- channel Biophysics	2	-	2	-		08/20	18/30		
	BPP/MJ/553	Practical based onBPT/MJ/550	-	4	-	2				08/20	18/30
	BPP/MJ/554	Practical based onBPT/MJ/551	-	4	-	2				08/20	18/30
	BPP/MJ/555	Practical based onBPT/MJ/552	-	4	-	2				08/20	18/30
	BPP/MJ/556	Biophysical Techniques-I	-	4	-	2				08/20	18/30
DSE (Choose any one from pool of courses)	BPT/DSE/ 557	A/B	2	-	2	-	04	08/20	18/30		
	BPP/DSE/ 558	Practical based on BPT/DSE/557	-	4	-	2				08/20	18/30
OJT/FP	BP/OJT/559	OJT/FP	-	8	-	4	04			16/40	24/60
			08	28	08	14	22	80	120	140	110

1. Major Mandatory (DSC): Biophysics

BPT/MJ/550: Physiology and Biophysics

BPT/MJ/551: Molecular Biology and Genetics

BPT/MJ/552: Membrane & Ion-channel Biophysics

BPP/MJ/553: Practical based on BPT/MJ/550

BPP/MJ/554: Practical based on BPT/MJ/551

BPP/MJ/555: Practical based on BPT/MJ/552

BPP/MJ/556: Biophysical Techniques-I

2. **DSE- 3&4 (T/P): (Choose any one from Pool /Basket)**
   BPT/DSE/557/A: Cell and Tissue Culture

   BPT/DSE/557/B: Aviation High altitude, Space & Deep-Sea physiology

   BPP/DSE/558: Practical based on BPT/DSE/557

3. **BP/OJT/559: On Job Training OR Field Project -1**

BPT/MJ/550: Physiology & Biophysics

[Total Marks: 30+20] [Total Workload: 30hrs] [Credits:2] [2hrs./week]

Unit 1: Brain, Neurophysiology & Special Senses (10 hrs.)

Brain & Neurophysiology: General anatomy of brain, Central peripheral nervous system, Mylenated & unmylenated nerve cells, Blood brain barrier generating nerve impulse, Synaptic transmission, Physicochemical basis of membrane potential, Resting and action potential, Propagation of action potential, Voltage clamp and patch-clamp techniques, Hadgkin-Huxley analysis, Motor and cortical control, Sleep and consciousness Neuromuscular junction, Excitation contraction coupling Neuronal networks, Processing of information, Memory and neuropeptides.

Special senses: Biophysics of sensory mechanism and function of receptor cells, Cutaneous, Olfactory and gustatory sensations, Vision. Physical aspects, Neurophysiology colour vision, Visual evoked potentials. Audition: - Physical aspects, auditory transduction, Acoustic encoding.

Unit 2: Cardiovascular and Pulmonary Physiology. (10 hrs.)

Physical characteristics of blood, Hemodynamics principles & equations, Genesis & spread of cardiac impulse, Cardio dynamics, Regulation of blood pressure & blood volume, Heart rate, Cardiac output & venous return, Cardiovascular responses to stress (exercise, shock & hypertension),Biophysical aspects of lung expansionrespiratory mechanics & gas exchange process, Gas diffusion & transport, Pulmonary circulation & ventilation, Respiratory control & response to stress, Pulmonary function test & it's significance.

Unit 3: Renal & Reproduction Physiology. (10 hrs.)

Ionic composition & distribution of body fluids, Body fluid osmolality dialysis & dehydration. Biophysical aspects of renal filtration & blood flow, Renal tubular function, Concepts effective circulation volume, Autoregulation, Reabsorption &secretion, Renal regulations of acid base balance. Hormonal control of reproductive mechanisms, Morphology & dynamics of sperm, kinematics parameters of sperm movement & sperm motility, Basic principles of assisted reproductive technology- IUI, IVF techniques.

BPT/MJ/551: Molecular Biology & Genetics

[Total Marks: 30+20] [Total Workload: 30hrs] [Credits:2] [2hrs./week]

Unit 1: Genome Organization (10hrs)

Nucleic acids as a genetic material, Topology of nucleic acid & role of Topo-isomerases, concept of gene, Chromosomal organization in prokaryotes, eukaryotes & Viral systems, Spatial arrangement & role of histone, chromatin subunit, Nucleosomes, Solenoid model, loops, domains & scaffolds in chromatin, Laws of DNA constancy& C- value paradox, Concept of Repetitive DNA, Selfish DNA, Split genes, Pseudogenes, cryptic genes, Promiscuous DNA, Multigene families, DNA replication in prokaryotes and eukaryotes-mechanism, enzyme involved.

Unit 2: Gene Expression & Its Regulation. (10 hrs)

Gene Expression: Central dogma of molecular biology, Genetic code, silent features of genetic code, protein synthesis-mechanism of transcription in prokaryotes and eukaryotes, m-RNA synthesis and processing (capping, splicing, RNA editing, poly adenylation) role of ribozymes, ribosome's structure and function of different components, shine-dallgarno sequence, TATA box, termination of transcription. Mechanism of translation, formation of aminoacyl t-RNA initiation, elongation, termination of polypeptide synthesis, translation in chloroplast and mitochondria, post translational modifications.

Unit 3: Regulation of Gene Expression, Mutation & Repair. (10 hrs)

Regulation of gene expression in prokaryotes, concept of inducer and repressor, operons and transcriptional regulation (lac operon, tryptophan operon, sigma (σ) factor and transcriptional control. Post transcriptional regulation, Leader sequences and attenuators, alternative splicing, Gene expression control in eukaryotes-role of specific DNA sequences, modifications in DNA transcripts and histone proteins. Regulation at translational level, phosphorylation of translational machinery, masking of m-RNA, regulation by gene rearrangement, W-D repeat proteins.

Mutation & Repair: Molecular basis of Mutation, types of mutations, spontaneous mutations, base analogues (5-Bromo Uracil, 2-amino purine) tautomeric shift and frame shift mutations. chemical mutagens, intercalating substances, mutator genes, site specific mutagenesis and mutational hot spots, methods for isolation of mutants. Physical mutagen, biochemical mechanism of repair, photo reactivation, excision repair, SOS repair etc.

Recommended books: - Refer Annexure for detail book titles.
5,10,11,21,23,24,29,30,31,55,58,59,61,62,63,72,76,79,80,81,88,118.

BPT/MJ/552: Membrane & Ion Channel Biophysics

[Total Marks: 30+20] [Total Workload: 30hrs] [Credits:2] [2hrs./week]

Unit 1: Membrane Potential. (10 hrs)

Nature & magnitude of cell surface charge, Electric properties of membranes: electric double layer, Poisson-Boltzmann theory of electric double layer, Gouy-Chapman model of electric double layer, free energy of electric double layer, Hodgkin Huxley equation, membrane impedance, Relation between membrane potential & cell characteristics, Zeta, Stern & total electrochemical potential, Helmholtz-Smoluchowski equation; it's correction by Debye-Huckle theory. Thermodynamic & kinetic approaches to membrane potential, Calculation of electrochemical potential by Nernst equation, Transmembrane potential & it's measurement by microelectrodes.

Unit 2: Transport across the membrane. (10 hrs.)

Osmosis and Diffusion as experimental techniques Electrostatic interaction between membrane surfaces: adhesion of membranes, Diffusion, Fick's law. Diffusion in two compartment & multi compartment systems, Mechanisms of simple diffusion & facilitated diffusion, Diffusion of no electrolytes across the membrane, Rate theory of membrane transport, electro diffusion, Osmosis, Osmotic pressure, Osmotic equilibrium, Donnan equilibrium, flow of water & of solute, Electro osmosis, Molecular basis of aqueous channels. Surface tension- Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect, preparation of liposomes & their utility, significance of surface tension in membrane biophysics.

Unit 3: Active Transport (15 hrs.)

Nature, Selective permeability of biomembrane, Selectivity & ion specificity of biomembrane, Ion channel structure and gating function, Ion channel types and characterization, Role of carriers in ion transport (ex: -Valinomycin & gramicidin), Transporting ATPase-Na-K ATPase, Calcium ion transporting ATPase of sarcoplasmic reticulum, Transport of macromolecules with & without vesiculation (Secretory Pathway, Exocytosis and Endocytosis, Mitochondrial transport, Nuclear Pore Transport), mechanisms of micro- and nano-vesiculation, influence of electrical properties of membranes and solvents on the vesiculation of membranes and formations of membrane nanotubes and their role in the transport of substances between cells and between cell organelles. Microvesiculation of membranes and its role in spreading tumours and creation of blood clots. Mechanisms of creation and stability of membrane pores.

Recommended books: - Refer Annexure for detail book titles.
1,3,5,6,7,11,13,14,15,16,18,21,22,24,29,30,32,58,60,61,64,69,70,73,74,78,102,103,105,

106,107,108,110,111,112,113,115,116,117,118,155

BPP/MJ/553: Practicals Based on BPT/MJ/550

[Total Marks: 30+20] [Total Workload: 60 hrs] [Credits:2] [4hrs./week]

1. To record the Respiratory movements in man using stethograph.
2. To determine the Breath holding time in man.
3. To study the effect of maximum voluntary ventilation on respiration.
4. To study the effects of swallowing, yawning and talking on respiration.
5. To study the effects of exposure to cold and hot environment on human subject.
6. To measure the pulse rates at various parts of the human body using stethoscope.
7. To measure the Heart beat rate in man using stethoscope.
8. To record the compound action potential and conduction velocity in frog's sciatic nerve.
9. To record the simple muscle twitch and study of the effect of stimulus response relationship.
10. To study the properties and excitability patterns of muscle and nerve fibre types in intact and isolated preparations.
11. To study the genesis of tetanus.
12. To study the effect of free and after loading on frog's gastronemacus muscle.
13. To study the effect of Fatigue.
14. To study the physiological changes under extreme conditions (high RCF, low oxygen pressure, zero gravity conditions.)
15. Assignments on various aspects using signal acquisition systems. ADInstruments-LAB Tutor and other protocols

BPP/MJ/554: Practical Based on BPT/MJ/551

[Total Marks: 30+20] [Total Workload: 60 hrs] [Credits:2] [4hrs./week]

1. To isolate the chromosomal DNA from Prokaryotes and Eukaryotes.
2. To isolate the RNA.
3. Induction of mutation and Isolation of Mutants.
4. To study the chromosomal aberrations due to radiation.
5. Conformation of Nucleic acid by Spectral study.
6. To isolate and characterize Plasmid DNA.
7. To hydrolyze the t-RNA and separation of Nucleotides by TLC and paper chromatography.
8. Experiments on transformation.
9. Restriction digestion and agarose gel electrophoresis of DNA

10. Demonstration on Southern Blotting.

11. Demonstration on Western Blotting.

12. To study the Giant chromosomes (Lamp brush or Polytene chromosome).

13. To isolate the Antibiotic resistant Mutants.

BPP/MJ/555: Practicals Based on BPT/MJ/552

[Total Marks: 30+20] [Total Workload: 60 hrs] [Credits:2] [4hrs./week]

1. To study the Erythrocytes Membrane Permeability and Transport effects of Hypotonic & Hypertonic shock.

2. To determine the osmotic fragility of RBC.

3. To determine the partial characteristics of Membrane Protein by SDS-PAGE.

4. To analyze the Erythrocytes membrane lipids by TLC.

5. To determine Osmolarity of solutions using Osmometer.

6. Passage of molecule through dialysis membrane and demonstrations of Donnan Membrane equilibrium.

7. To study the interactions of Detergent and other Membrane active agents with RBC membrane & effect of incubation time, Temperature & concentration.

8. To study the Permeability of model membrane (Liposome) anions.

9. To study the effect of cholesterol on the anion permeability of a Phospholipid membrane.

10. Preparation of Liposome.

11. To demonstrate the cell fusion using high DC (Direct current) field.

12. To isolate the chloroplast and characterize the chloroplast membrane protein.

13. To measure the Membrane potential using Fluorescence techniques.

14. To measure the membrane conductance.

15. To study the phase transition in lipid bilayer membrane.

BPP/MJ/556: Biophysical Technique-I
(Physicochemical Techniques)

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits:2] [4hrs./week]

Unit 1: Hydrodynamic Techniques. (10 hrs.)

Centrifugation & Ultracentrifugation - Basic principles, Forces involved, RCF Centrifugation, techniques- principles, types and applications. Centrifuges &Ultracentrifuges- types, optical methods used and applications of preparative [Differential, Density Gradient]and analytical [sedimentation velocity, sedimentation equilibrium] ultracentrifugation.

Viscometry- General features of fluid flow nature of viscous drag for streamlined motion. Definition of viscosity coefficient. Stroke's law and terminal velocity. Determination of viscosity coefficient of liquids, viscometric measurement, Types of viscometers, Relation between intrinsic viscosity and molecular weight, Measurement of Viscoelasticity,

Unit 2: Physicochemical Fractionation (10 hrs.)

Chromatography -Basic Concepts of Adsorption & Partition Chromatography, Principle Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods-chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas(GC,GLC)and HPLC: types of HPLC, Mobile phase elution , normal phase and reverse-phase HPLC, column packing material, efficiency of column ,types of HPLC – principles of methodologies ; HPLC pumps -efficiency and suitability, Different injectors and Detectors; Ion Chromatography.

Membrane Techniques - Criteria of protein purity, equilibrium dialysis, ultra filtration and various membrane techniques,

Unit 3: Electro-analytical Techniques. (10 hrs.)

Electrophoresis- Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free & Zone (Paper, Cellulose acetate, Agarose & Starch gel gel, Pulsed-field, PAGE, SDS-PAGE, Capillary) Electrophoresis techniques, Principle, Experimental set-up, Methodology & Applications isoelectric focusing, 2D electrophoresis

Recommended books: - Refer annexure for detail book titles.
1,5,7,8,9,14,15,17,19,21,26,28,29,60,69,98,101,140,155.

Practicals on Biophysical Technique-I (Physicochemical Techniques)

1. To familiarize in the use of pH meter and Colorimeter.
2. One-dimensional Ascending & Descending Paper chromatography of Amino acids & sugars
3. Two-dimensional Ascending & Descending Paper chromatography of Amino acids.
4. One-dimensional Ascending & Descending TLC of Amino acids & sugars

5. Two-dimensional Ascending & Descending TLC of Amino acids & sugars.
6. HPTLC of Amino acids & sugars
7. Fractionation of Sugars from fruit juice using TLC/HPTLC
8. Column Chromatography for Proteins, Pigments, amino acids.
9. Paper Electrophoresis of Amino acids.
10. Cellulose acetate strip Electrophoresis of Amino acids.
11. Paper Electrophoresis of Proteins.
12. Cellulose acetate strip Electrophoresis of Proteins
13. Agar Gel Electrophoresis of Proteins
14. Polyacrylamide Gel Electrophoresis (PAGE).
15. SDS- Polyacrylamide Gel Electrophoresis (PAGE).
16. To study the structure based visco-elastic properties of proteins, nucleic acids, sugars, lipids using Ostwald's Viscometer.
17. To perform image analysis using CCD camera of Microscopic dynamic Images.
18. To study the renal stone using Infra-Red (IR) Spectroscopy.
19. To determine the oil content of oil seeds using Nondestructive IR Spectrophotometry.
20. To perform the separation of Proteins using Capillary Electrophoresis.
21. To perform the separation of Proteins using HPLC
22. To study the co-relation between Concentration, Size, Shape of the molecules and Viscosity characteristics using digital viscometer.

BPT/DSE/557/A: Cell and Tissue Culture

[Total Marks: 30+20] [Total Workload: 30 hrs.] [Credits: 2] [2hrs./week]

Unit 1- Basics of Cell & Tissue Culture (10 hrs)

Introduction to plant tissue culture- Definition, History, Cellular totipotency, techniques in plant tissue culture. Infrastructure & Organization of Plant Tissue Culture Laboratory General and aseptic laboratory- different work areas, equipment's and instruments required and other requirements. Aseptic Techniques- Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation and precautions to maintain aseptic conditions. History and Introduction of Animal Cell culture- History of animal cell culture Animal Cell Culture laboratory design and layout- Construction and services, layout of aseptic room (sterile handling area, laminar air flow, service bench), incubation (incubators, hot room), preparation area (media preparation, washing area, storage). Cultured cells- Biology and Characterization- Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation, metabolism of cultured cells, Initiation of cell culture, Evolution and development of cell lines.

Unit 2- Plant Tissue Culture (10 hrs.)

Culture Medium- Composition of basal M.S. medium and preparation of media. Callus Culture Techniques- Introduction, principle, protocol, morphology and internal structure, genetic variations and applications. Somatic Embryogenesis- Introduction, principle, protocol, factors affecting, applications and limitations. Estimation of growth, Cell viability Test, Totipotency in culture, Importance of totipotency, Cyto-differentiation in cultured cells, Soma clonal variations. Organogenesis- Introduction, principle, protocol, applications. Ovary and ovule Culture Technique- Introduction, principle, protocol, and applications. Anther & Pollen Culture Technique- Introduction, principle, protocol, factors affecting and applications. Micropropagation- Introduction, stages of Micropropagation, factors affecting, advantages and applications.

Unit 3- Animal Cell Culture (10 hrs.)

Requirements of Animal cell culture- Characteristics of animal cell in culture, substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO2 incubator, Centrifuge, Inverted microscope) Culture media- Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media). Characterization of cultured cells- Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines. Measurement of growth parameters of cultured cells- Growth cycle of cultured cells, plating efficiency of cultured cells Cell synchronization- Cell separation by physical means, cell separation by chemical blockade Senescence and apoptosis- Cellular senescence, Measurement of senescence, Apoptosis, Measurement of apoptosis. Basic technique of mammalian cell culture- Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintenance of cell culture, Subculture, Stem cell cultures. Applications of cell culture-In transplantation, and tissue engineering, monoclonal antibodies, culture-based vaccine, valuable recombinant product, cloning, ethics and morality.

BPP/DSE/558: Practical based on BPT/DSE/557/A: Cell & Tissue Culture

[Total Marks: 30+20] [Total Workload: 60 hrs.] [Credits: 2] [4hrs./week]

1. Suspension culture technique-Initiation of culture.
2. Preparation of M.S. stock solutions & medium.
3. Aseptic in vitro seed germination.
4. Embryo culture technique.
5. Anther Culture technique.
6. Micropropagation stage I-Initiation of micropropagation of shoot tip.

7. Micropropagation stage I-Initiation of micropropagation of axillary bud.
8. Callus culture technique- Initiation of culture and study of callus morphology.
9. Preparation of glass wares for cell culture.
10. Isolation of cells by enzyme digestion.
11. Separation of cells by suitable methods.
12. Viable cell count.
13. Primary cell culture and its maintenance.
14. Measurements of growth parameters.
15. Cell cycle analysis.

BPT/DSE/557/B: Aviation, High Altitude, Space & Deep Sea Physiology

[Total Marks: 30+20] [Total Workload: 30hrs] [Credits:2] [2hrs./week]

Unit 1: Aviation, High Altitude Physiology

Effect of low oxygen pressure on body, mountain sickness, clinical lessons at high altitude, High altitude physiology including respiratory physiology in flight, hypoxia and prevention, oxygen systems, decompression sickness. Rapid decompression, aero-medical problems in highaltitude operations, hyperbaric oxygen medicine. Environmental physiology including thermalstress, thermal regulation and prevention of thermal effects.

Unit 2: Space Physiology

Effect of acceleratory forces on the body in aviation & space physiology. Radiation & temperature, Problems at high altitude & space, weightlessness in space, Physiological adaptation to space flight. cardiovascular and respiratory changes during acceleration, protection against +Gz, effects of –Gz, Transverse and lateral G. Fundamentals of space physiology simulation of micro G, conditioning, training and evaluation, life support systems, escape and survival, weightlessness, space sickness, countering gravitational and thermal stresses.

Unit3: Deep Sea Physiology

Concept of Deep sea environment, diving on ambient pressure, Physiological effects of high external pressure on systems on different external systems of the human body. Decompression sickness- pathophysiology & prevention. Preventive measures for hypo & hyperbaric pressure. Physiology in deep sea diving & other high-pressure operations. Brief idea on Caissons disease, Cyanosis, dyspnoea, hyperopnea, apnoea & asphyxia

BPP/DSE/558: Practicals Based on BPT/DSE/557/B

[Total Marks: 30+20] [Total Workload: 60 hrs] [Credits:2] [4hrs./week]

1. To study the physiological changes under extreme conditions (high RCF, low oxygen pressure, zero gravity conditions.)
2. Assignments on various aspects using signal acquisition systems. ADInstruments-LAB Tutor and other protocols.
3. Determination of dynamic lung functions by single breath max expiratory effort method
4. Evaluation of cardiovascular reflexes by a change of posture from supine to 70 degree head up tilt (HUT).
5. Assessment of thermal stress of a given environment and comment on its suitability for fighter flying.
6. Simulate the given environment (viz. Temperature dry bulb 45 degree C, RH 60 %) in a hot cockpit and calculate various heat stress indices.
7. Determination of heat strain on 1 hr exposure to a given simulated hot environment in hot cockpit and calculate body heat storage.

ANNEXURE: -

Recommended Books and Journals

1. Ackerman E.A. Ellis, L.E.E. & Williams L.E. (1979), Biophysical Science, Prentice-Hall Inc.
2. Barrow. C. (1974), Physical Chemistry For Life Sciences, McGraw-Hill.
3. Berns M.W. (1982), Cells, Holt Sounders International Editors.
4. Bloomfield V.A. and Harrington R.E. (1975), Biophysical chemistry, W.A.Freeman and CO.
5. Bulter l.A.V. And Noble D.Eds. (1976), Progress in Biophysics and Molecular Biology (all volumes) pergamon, Oxford.
6. Cantor C.R. and Schimmel P.R. (1980), Biophysical chemistry, W.A.Fremman and Co.
7. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west press.
8. Chang R. (1971), Basic principles of spectroscopy, McGraw-Hill.
9. Crabbe P. (1972), ORD and CD in chemistry and biochemistry, Academic Press.
10. De Robertis E.D.P. and De Robertis E.M.P. (1981), Essentials of cell and molecular Biology, Holt sounders International Editions.
11. Dickerson R.E.& Geis I. (1972), Proteins: structure, function and evaluation, Benjamin.
12. Dugas H. and Penney C. (1981), Bioorganic chemistry, Springer-Verlag.
13. Fleischer S. Hatefi Y. McLennan D.H. and Tzagoloff A. (1977), The molecular biology of Membranes, Plenum press.
14. Haschemyer R.N. and Haschemyer A.E.B.V. (1973), Proteins, John willey and sons.
15. Hughes W. (1979), Aspects of Biophysics, John willey and sons.
16. Jain M.K. and Wanger R.C. (1980), Introduction to Biological Membranes, John willey and sons.
17. James T.L. (1975), Nuclear Magnetic Resonance in Biochemistry, Academic press.
18. Lehninger A. (1981), Biochemistry, Butter Worth Publication.
19. Pesce A.J., Rosen C.G and Pasty T.L., Fluorescence Spectroscopy: An introduction for Biology and Medicine, Marcel Dekkar.
20. Pullman B. (1978), Molecular Association in Biology, Academic Press.
21. Quagliokiello E., Palmieri F. and singer, T.P. (1977), Horizons in Biochemistry and Biophysics (all volumes) Addison Wesley Publishing Company.
22. Quinn P.J. (1984), The Molecular biology of cell Membranes, Macmillan.
23. Saenge W. (1984), Principles of Nucleic acid structure, Springer-Verlag.
24. Schule G.E. and schirmer R.H. (1984), Principles of protein structure, Springer-Verlag.
25. Segel F.H. (1975), Enzyme Kinetics, John willey and sons.
26. Setlow R.B. and pollard E.L. (1962), Molecular Biophysics, Pergamon Press.
27. Sheelk P. and Birch D.E. (1983), Cell Biology Structure, Biochemistry and function, John willey and sons.
28. Spragg S.E. (1980), Physical Behavior of macromolecules with biological functions, John willey and sons.
29. Stanford J.R. (1975), Foundation of Biophysics Academic press.
30. Stryer L. (1981), Biochemistry, W.A. Freeman and Co.
31. Szekely M. (1984), From DNA to protein, Macmillan.
32. Volkenstein M.V. (1977), Molecular Biophysics, Mir Publication.
33. Bach J. F. (1978), Immunology, John willey and sons.
34. Basar E. (1976), Biophysical and physiological system Analysis, Addition-Wesley.
35. Cameron J. R. and skofronick J.G. (1978), Medical Physics, John willey and sons.
36. Casarett A.P. (1968), Radiation Biology, Prentice-hall Inc.
37. Castellan A. and Querela I.F. (1979), Synchrotron Radiation, Applied to Biophysical and

Biochemical Research, Plenum Press.
38. Clause W.D. (1958), Radiation Biology and Medicine, Addison-Wesley.
39. Eisen H.N. (1980), Immunology, Harper and Row publishers.
40. Geides A. (1979), Electrodes and Measurements of Bioelectric events, John Willey and sons.
41. Grosch D.S. (1979), Biological effects of Radiation, Academic Press.
42. Guyton A.C. (1981), Textbook of Medical Physiology, Sounders co.
43. Horrocks D.L. (1971), Organic and liquid scintillation counting, Academic Press.
44. Howard L. A. (1974), Radiation Biophysics, Prentice Hall Inc.
45. Knoll G.E.(1979), Radiation detection and measurement, John willey and sons.
46. Martin A. & Harbisan S.A. (1982), An introduction to Radiation Protection, Chapman and hall Publication.
47.Moorse B.M., Panker R.P. and Pullman B.R. (1981), Physical aspects of medical imaging, John willey and sons.
48. Banks S.M. (1983), Photosynthetic system: structure function and symmetry, John willey and sons.
49. Rahatgee K.K. (1978), Fundamentals of photochemistry, John willey and sons.
50. Roit I.M. (1977), Essential immunology, Blackwell scientific Publication, Oxford.
51. Ruch J. and Patton H.D. (1973), Physiology and Biophysics (all volumes), W.B. sounders co.
52. Dhurnburn C.C. (1972), Isotopes and Radiation in Biology, Butter worth and Co.
53. Vince-Paupe D. (1975), Photoperodism in plants, McGraw Hill
54. Wilkum C.B. (1966), Fundamentals of immunology, Interscience publishers.
55. Old R.W., Primriose S.B. (1980), Principles of gene manipulation (An introduction to genetic Engineering), Blackwell sciences.
56. H.Gutfreund (1972), Enzymes-Physical principles, John willey and sons.
57. David M.Gates (1981), Biophysical Ecology, Springer-verlag.
58. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance. (1995), Principles of Biochemistry, Wmc.Brown Publishers.
59.Sambrook and Russell (2001), Molecular cloning (A laboratory Manual) cold spring Harbor Laboratory Press.
60. Henry B. Bull (1971), An Introduction to physical biochemistry, F.A.Devis Co.
61. Gerald Karp (1996), Cell and Molecular biology concepts and experiments, John willey and sons, Inc.
62. Beniamin Lewin (2000), Gene-VII. Oxford Uni. Press.
63. Beniamin Lewin (1994), Gene-V. Oxford Uni. Press.
64. Loewy Sickevitz, Menninger, Gallant (1991), Cell structure and function, Sounders college pub.
65. Laszlo, Patthy (1991), Protein Evolution, Blackwell science.
66. Christopher H. Wharton, Robert Elsenthal A.B. (1981), Molecular Enzymology Thomson Litho ltd.
67.Nicholas C. Price, Lewis Stevens (1999), Fundamentals of Enzymology (The cell and Molecular Biology of catalytic proteins), Oxford University.
68. Jean Brachet (1985), Molecular cytology, Academic press.
69. Hans Netter (1969), Theoretical Biochemistry, Oliver and Boyd, Springer-verlag Press.
70. Carl Branden and John Tooze (1991), Introduction to protein structure, Garland publishing, Inc.
71. Myron L. Bender, Raymond J.Bergeron, Makoto Komlyama (1984), The Bioorganic chemistry of Enzymatic catalysis, John willey and sons.
72. David Freifelder (1987), Molecular Biology, Narosa Publishing house.
73. Thomas E. Creighton (1994), Proteins: Structure and Molecular properties, W. A. Freeman and co.

74. M. Satake, Y.Hayashi, M.S. Sethi & S.A.Iqbal (1997), Biophysical chemistry, Discovery publishing house.
75. N. B. Strazhevskaya (1972), Molecular Radiobiology, John willey and sons.
76. Rogor L.Miesfeld (1999), Applied molecular genetics, John willey and sons.
77. C.Edward Gasque (1992), A manual of lab. Experience in Cell biology, Universal stall.
78. F. Heinmets (1970), Quantitative Cellular Biology, Marcal Dekker, Inc.
79. Ernst L. Winnacker (1987), from gene to clones. Introduction to gene. Technology.
80. Daniel L. Hartl (1995), Essential genetics, Jones and Barlett Publishers.
81. Bernard R. Glick and Jack J. Pastermak: (1994), Molecular Biotechnology Principles and Applications of Recombinant DNA.
82. C. Kalidas (1996), Chemical Kinetics Method (Principle of Relaxation Techniques and applications).
83. Malcolm Dixon, Edwin C. Webb & C.J.R Thorne K.F. (1964), Enzyme, Academic press.
84. B.I.Kurganov, Trans.by R.F.Brookes, Ed. By V.A. Yakoves (1982), Allosteric enzymes, John willey and sons.
85. G. Rickey Welch (1996), The Fluctuating Enzyme, John willey and sons.
86. Clearance H. Suelter (1985), A practical guide to enzymology, John willey and sons.
87. Robert K. Scopes (1994), Protein Purification Principles and practice, Narosa Pub. House.
88. Stanley R. Maloy (1983), Experimental techniques in bacterial genetics, John and Bartlett pub.
89. Victor Arena, Ionizing Radiation and life.
90. B.L.Diffey (1989), Radiation Measurement in photobiology, Academic press.
91. T. Kobayashi (1987), Primary Processes in photobiology, Springer-verlag.
92. D.M.Weir (1967), Immunochemistry, Handbook of Experimental immunology vol-I, Blackwell Scientific publishing house.
93. K.G. Zimmer, Trans by H. D.Griffith (1961), Studies on Radiation Biology, Oliver and Boyd.
94. V. A. Bernstam (1997), V.YA. Alexandrov: Cells, Molecule and temperature, Springer-verlag.
95. M. M. Rehani (2000), Advances in Medical physics, Jaypee Brothers.
96. B.R. BAIRI, B.Singh, N.C.Rathod, P.V. Narurkar (1994), Handbook of nuclear medicine instrumentation. Tata McGraw Hill.
97. J. Roberts and D.G Whitehouse (1976), Practical plant physiology, Longman.
98. H. H. Perkampus (1992), UV-VIS Spectroscopy and Its applications, Springer-Verlag.
99. Felix Franks (1985), Biophysics and Biochemistry at low temperature, Cambridge University Press.
100. Alan Johnston and Robin Thorpe (1982), Immunochemistry in practical, Blackwell science.
101. Garry D. Christian, James E.O'reilvy (1986), Instrumentation analysis, Alien and Bacon, Inc.
102. Ryo Sato, Yasuo Kagawa (1982), Transport and Bioenergetics in Biomembrane, Japan Scientific Societies Press.
103. Clarsson I., M. Moller (1990), The plant Plasma Membrane (Structure, function and molecular biology), Springer-verlag.
104. Jurgen Kiefer (1990), Biological Radiation Effects, Springer-verlag.
105. Bernard Pullman (1978), Proteins in physicochemical Biology, Academic Press.
106. A.Kotyk, K. Janacek and J. Koryta (1988), Biophysical chemistry of membranes functions, John Wiley and sons.
107. E. Edward Bittar (1980), Membrane structure and function, John Wiley and sons.
108. N. Lakshminararyanaiah (1984), Membrane Structure and function, John Wiley and sons.
109. David J. Swosett, Patric A. Kenny, R. Eugene, Johnston (1987), The physics of diagnostic imaging, Chapman and Hall Medical.
110. R.Glaser, D. Gingell (1990), Biophysics of the cell surfaces, Springer-verlag.

111. J. B. C. Findlay and W. H. Evans (1987), Biological Membranes a practical approach, ORL P.
112.G.Giebisch, D. C. Tosteson, H.H. Ussing (1978), Membrane Transport in Biology, Springer-verlag.
113. Vladimir P. Skulachev (1988), Membrane Bioenergetics, Springer-verlag.
114. D.C. Posteson (1969), The Molecular basis of membrane function, Prentice-Hall, Inc.
115.Charles F. Stevens, Richard W. Teisan (1978), Membrane transport process Vol.- III, Reven Press.
116.C. Nicolau and A. Paraf (1977), Structural and Kinetic approach to plasma membrane functions, Springer-verlag.
117. Gregory Gregoriadis and Anthony C. Allison (1980), Liposome in biological systems, John Wiley and sons.
118. Darnell, Lodish, Baltimore (1986), Molecular cell biology, W.H.Freeman Press.
119. M. H. Gupta (1993), Thermostability of enzymes, Springer-verlag, Narrosa publishing house.
120.P. W. Arora, P.K. Malhan (2002), Biostatistics, Himalayas pub. House, Mumbai.
121.Vijaya D. Joshi (1995), Prep. Manuals for Physiology, B.I.Churchill living stone Pvt. ltd.
122.R. N. Roy (1998), Viva and Practical Physiology, Biochemistry and Biophysics, Books and allied Pvt. Ltd.
123.P. S. S. Surnder Rao and J. Richard (1996), An introduction to Biostatistics, Prentice Hall of India.
124. Robert Glambos (1965), Nerves and Muscles (An Introduction to Biophysics pub by Vakils Veffer and Simons Pvt. ltd.
125. Dr. B.M. Rao (2002), Radioactive Materials, Himalayas publishing House.
126.S. Surendara Rajan, R. Balaji (2002), Introduction to Bioinformatics Himalayas publishing house.
127.T. K. Attwood and DJ Parny. Smith (1999), Introduction to Bioinformatics: Cell and Molecular biology in action series, Pearson education Asia.
128.R. Mannhold, H. Kubinyi, H. Timmerman (2002), Bioinformatics form genomes to drugs. Vol.-I, Wiley- VCH.
129.Reiner Westermeier, Tom Naven (2002), Proteomics in practice, Wiley- VCH.
130.C. STAN TSAL (2002), An introduction to computational biochemistry John Willey and sons Inc.
131. John bullock, Joseph Boyle, Michael B. Wang (2001), Physiology, Lippincott, Williams and Wilkins.
132. Pal Kalla, Ravishankar (2000), Health effect on computer uses, Himalayas publishing House.
133.Leslie, Cromwell, Fredj-weibell, Erich A. Pteltter (1980), Biomedical Instrumentation and measurements, Prentice-Hall of India.
134.H. J. Arnikar (1982), Essentials of Nuclear chemistry, Wiley eastern ltd.
135.Manisha Dixit (2000), Internet an Introduction, Tata McGraw-Hill.
136.Timontry J. O'Leary, Linda I. O'Leary (1999), Microsoft windows 98, Tata McGraw Hill.
137.Timothy J. O'Leary, Linda I. O' Leary (2000), Microsoft office-2000, Tata McGraw Hill.
138.Pitter Norton's (1999), Introduction to Computers, Tata McGraw Hill.
139.S.P.Yarmonenko (1988), Radiobiology of human and animals, Mir publishers.
140.S.M.Khopkar (1984), Basic Concepts of Analytical chemistry, Willey eastern lit.
141.Campbell R.C. (1974), Statistics for biologist, Cambridge University Press.
142.Bliss C. I.K. (1967), Statistics in biology vol. 1 Mac-Graw Hill.
143.Wardlaw, A.C (1985), Practical Statistics for Experimental biologist.
144. Bailey, (2000), Statistical Method in biology.

145. Daniel Wayle W., Biostatistics (A foundations for analysis in health sciences).
146. Khan, Fundamental of Biostatistics.
147. Lachin, Biostatistical Method.
148.Kendrick C.Smith, The Science of Photobiology, plenum Press.
149.Andreas D. Baxevanis, B. F. Francis Oulellette, (2001), Bioinformatics – A practical guide to analysis of Genes and Proteins, Wiley-Interscience.
150.Hooman H. Rashidi, Lukas K. Buehler (2000), Bioinformatics- Applications in Biological Science and Medicine, CRC.
151.Stephen Misener and Stephen A. Krawetz (2000), Bioinformatics methods and protocols, Humana press.
152.Andrew R. Leach (2001), Molecular modeling principles and applications, Prentice Hall,
153.Oren M. Becker and others, Computational biochemistry and biophysics, Marcel Dekker Inc.
154.T. Schlick (2002), Molecular modeling and simulation- an interdisciplinary guide, Springer.
155.Friefelder D, Physical Biochemistry, W. H. Freeman and co.
156. Brobeck J. R., Best and Taylor's Physiological bases of medical practice, The Williams and Wilkins co.
157. Coggle J. E., Biological effects of Radiation, Taylor and Francis.
158. Altman K. I., Gerber G.B. and Okada S. Radiation Biochemistry Vol. -I, II. Academic press.
159.Orton C. G., Radiation Dosimetry: Physical and Biological aspects, Plenum press.
160.Dunn F. & O'Brien W. D., Ultrasonic Biophysics, Dowden-Hutchinson & Ross Inc.
161.Steel C. G., The Biological basis of Radiotherapy, Elsevier.
162.Johns H. E. & Cunninghan J. R., The physics of Radiology, Charles C. Thomas USA.
163.Attix F. H., Roesch, W. C. & Tochilin, E., Radiation Dosimetry Vol.- I, II, III, Academic press.
164.Saylor W. L. & Ames T. E. Dosages calculation in Radiation therapy, Urban and Schwarzenberg, Baltimore.
165.Harbert J. C. & Rocha A. F. C. Text Book of Nuclear Medicine, Lea & Febiger, Philadelphia.
166.Sorensen J. A. & Phelps M. E. Physics of Nuclear Medicine, Grune and Stratton.
167.Belcher E. H. & Vetter H. Radioisotopes in Medical Diagnosis, Butterworths.
168.Wagner H. N. Principles of Nuclear Medicine, W. B. Saunders & Co.
169. Khandpur R. S.,Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Co. Ltd.
170. Stuart A. Hoenig & Daphne H. Scott, Medical Instrumentation and Electrical Safety, Wiley Medical.
171. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and Sons.

JOURNALS: - Recent advance Pertaining to various sections are generally reported in the following generals; Students are encouraged to keep themselves abreast of the subject from them.

Nature
Science
Scientific American
Journal of Molecular Biology
Journal of Biological chemistry
Annual Review of Biochemistry
Biochemica Biophysica Acta
Radiation Research
Immunology today.

International Journal of Radiation biology.
Radiation and Environmental Biophysics.
Photochemistry and Photobiology.
Physiological Reviews.
Current Science.
Resonance.
Annual Reviews in Biophysics and Bimolecular chemistry.
Indian Journal of Biophysics and Biochemistry.
Indian Journal of Experimental Biology.
Proceedings of Indian National Science Academy Part-B (Biological sciences).
Annual Review in plant physiology.
Annual Review in Microbiology.
Bio-techniques ……..

Most Important Note :-
The use of internet surfing for exploring the Latest Information should be compulsory to enrich the knowledge.

Class: M.Sc. Biophysics: Second Year — Semester- III

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credits Assigned		Total Credits	Scheme of Examination			
								Theory Maximum. Marks 50		Practical Maximum Marks 50	
			Theory	Practical	Theory	Practical		CA- 40% Min/ Max	UA 60% Min/ Max	CA 40% Min/ Max	UA 60% Min/ Max
Major Mandatory DSC	BPT/MJ/600	Immunology	2	-	2	-	14	08/20	18/30		
	BPT/MJ/601	Bioinformatics & Structural Biology	2	-	2	-		08/20	18/30		
	BPT/MJ/602	Genetic Engineering	2	-	2	-		08/20	18/30		
	BPP/MJ/603	Practical based on BPT/MJ/600	-	4	-	2				08/20	18/30
	BPP/MJ/604	Practical based on BPT/MJ/601	-	4	-	2				08/20	18/30
	BPP/MJ/605	Practical based on BPT/MJ/602	-	4	-	2				08/20	18/30
	BPP/MJ/606	Immuno-diagnostic techniques	-	4	-	2				08/20	18/30
DSE (Choose any one from pool of courses)	BPT/DSE/ 607	A/B	2	-	2	-	04	08/20	18/30		
	BPP/DSE/ 608	Practical based on BPT/DSE/607	-	4	-	2				08/20	18/30
RP	BP/RP-1 /649	Research Project-1	-	8	-	4	04			16/40	24/60
			08	28	08	14	22	80	120	140	110

1. **Major Mandatory (DSC)**
   - BPT/MJ/600: **Immunology**
   - BPT/MJ/601: **Bioinformatics & Structural Biology**
   - BPT/MJ/602: **Genetic Engineering**
   - BPP/MJ/603: **Practical based on BPT/MJ/600**
   - BPP/MJ/604: **Practical based on BPT/MJ/601**
   - BPP/MJ/605: **Practical based on BPT/MJ/603**
   - BPP/MJ /606: **Immunodiagnostic Techniques**
2. **DSE:** (Choose any one from Pool /Basket)

   a) BPT/DSE/607 -A : **Environmental & Photo-biophysics**

   BPP/DSE/608: **Practical based on BPT/DSE/607 -A**

   OR

   b) BPT/DSE/607 -B: **Biophysical & Bioanalytical Techniques**

   BPP/DSE/608 : **Practical based on BPT/DSE/607 -B**

   OR

   c) MOOC Course) Or any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits {with biology basis}-C

3. **BP/RP-1 /649: Research Project -1**

BPT/MJ/600: Immunology

(Total Marks 30+20 Credits: 2; Workload: 2hrs/Wk Total : 30 hrs)

Unit 1: - Concepts of Immunology.

General principles of immune system, Molecules, Cells and tissues of immune system, Primary and Secondary lymphoid organs (Thymus, Bursa of Fabricius, Lymph nodes, Spleen), B and T lymphocyte and their functions, Lymphocyte cell mediated cytotoxicity.

Unit 2: - Antigens and Antibodies.

Fate of antigen, Antigenic determinant, Antigenicity, Immunogen and Immunogenicity, Factors affecting Antigenicity, Hapten, Carrier effect, Cross reactivity, Adjuvants, Freund's adjuvants and its significance.

Immunoglobulin, Structure of Immunoglobulin, Types and properties of Immunoglobulin, Theories of Antibody formation, Clonal selection, Ig genes, Immunoglobulin synthesis and metabolism, Antibody diversity.

Antigen- Antibody reaction, Physico-chemical basis of Ag- Ab interaction, Avidity, strength of binding between Ag and Ab and its measurement, Detection of Ag-Ab interaction, Precipitation, Agglutination and Complement fixation, The complement system, Cytokines. Nanobodies & their application

Unit 3: - Histocompatibility.

MHC, MHC antigen: - Class I, Class II, Class III, Antigen presentation, MHC restriction, Immune response gene (Ir), Immune response, Humoral and cell mediated immune response, BCR, TCR & generation of biodiversity, lymphocytes, T cells regulation, Graft rejection, Allograft, Autograft and Xenograft, Immunological tolerance and autoimmunity, Hypersensitivity, Allergy and anaphylaxis, Blood transfusion.

BPT/MJ/601: Bioinformatics & Structural Biology

(Total Marks 30+20 Credits: 2; Workload: 2hrs/Wk Total : 30 hrs)

Unit 1: Information theory and Bioinformatics Network

Information theory, Relation between information & entropy, Redundancy theorem & noise, Information content of biological system, Biological data exploration through internet Resources – EMB net, NCBI, BTIS network, Bioinformatics landscape intrinsic & extrinsic view, Cheminformatics & medical informatics. Biological databases: Sequence databases, Protein sequence databases, Structural databases, PDBs, Motif databases, Protein motif database, Genome databases, Proteome databases etc.

Unit 2: Genomics and Proteomics, NGS

Genome information resources, Functional Genomics DNA sequence analysis, Gene bank, cDNA library, pharmaco-genomics, ESTs analysis method for recognition of functional signals, Consensus sequences, approaches to gene identification using internet resources, Concept & applications of DNA microarray technology, Protein sequences information

& features, Proteomic analysis using internet resources, Prediction of protein structure, Protein folding, Problem & functional sites, Phylogeny, Methods of phylogenetic analysis, Application of sequence analysis & phylogenetic information in diversity studies. Introductionto Next-Generation sequencing (NGS): Overview, history and development of sequencing techniques; Basic terms and principles; NGS applications and workflow; NGS technologies and platforms; Library preparation; Standard applications and techniques.

Unit 3: Bioinformatics tools

Pair wise Alignment, Alignment algorithms, sequence analysis tools, BLAST (Basic Logical Alignment Search Tool) FASTA, Multiple Alignment, Sequence analysis using EMBOSS. Molecular Modelling: Introduction to computer graphics, Visualization of bimolecular structures, concepts in molecular modelling, Energy minimization, Dynamic stimulation & conformational analysis, Applications of molecular modelling packages, structural similarity & overlaps, structural prediction & molecular docking, Applications of protein modelling.

BPT/MJ/602: Genetic Engineering

(Total Marks 30+20 Credits: 2; Workload: 2hrs/Wk Total : 30 hrs)

Unit 1: Genetic Recombination in Prokaryotes & Eukaryotes (10 hrs)

Transformation- transforming principle, competence, uptake and fate of DNA, Conjugation-mechanism of conjugation, Role of F plasmid, Hfr. Transduction-lytic and lysogenic cycles, generalized and specialized transduction. Transposition-Transposable Elements, Insertion Sequences, bacterial transposons.

Concept of Recombinant DNA and Steps in gene cloning, Enzymes-Restriction endonucleases and their restriction sites, ligases, polymerases, other DNA modifying enzymes, Vectors-properties of good vector, Plasmid vectors- pBR322, pUC18/19, pGEM3z, λ phage vectors, Phagemid vectors, Artificial Chromosome Vectors-BAC, YAC, Shuttle vectors, Vectors for animals & plants.

Unit-2: Techniques in Recombinant DNA Technology (10hrs)

Enzymatic synthesis of DNA-PCR: Denaturation, PCR primers, annealing, primer extension, DNA sequencing, Nucleic Acid blotting, Southern blotting, Northen blotting, Western blotting, Colony Hybridization and Dot-blot technique.

Gene transfer methods in animals and plants- Agrobacterium mediated transformation (Ti & Ri plasmid-based vectors of Agrobacterium), Transfection with modified viral vectors Physical delivery methods- microinjection, macro injection, microprojectile & electroporation; Chemical methods -DNA use of polyethylene glycol, Calcium phosphate, DEAE Dextrose, Use of polycation DMSO etc.

Unit-3: Applications of Genetic Engineering (10hrs)

Agriculture- Transgenic Plants for disease resistance, protein production, herbicide resistance, Delayed ripening , Transgenic animals- as bioreactors for the production of regulatory proteins, vaccines and hormones. Transgenic and gene knockout technologies to study molecular biology and oncology, Stem Cell Therapy, Gene therapy in Cystic Fibrosis DMD, SCID. RNAi as a tool of gene therapy , Industrial Applications- Production of recombinant therapeutic proteins- r-insulin, r-hGH, r- Erythropoietin, r-Factor VIII & IX , r-Hepatitis B vaccine, Construction of Genomic Library and cDNA library.

BPP/MJ/603: Practical based on BPT/MJ/600

(Total Marks 30+20 Credits: 2; Workload: 4 hrs/Wk Total : 60 hrs)

1. To prepare the blood film and identify the blood cells.
2. To observe and count the lymphocytes of blood.
3. To isolate the lymphocytes from blood and solid tissues.
4. To characterize the blood group antigens and determine the Rh factor.
5. To raise antisera and to collect the antibodies.
6. To isolate the IgG from chicken eggs/ serum.
7. To fractionate the serum by paper electrophoresis.
8. To fractionate the serum by Agarose gel electrophoresis.

BPP/MJ/604: Practical based on BPT/MJ/601

(Total Marks 30+20 Credits: 2; Workload:4hrs/Wk Total : 60 hrs)

1. Internet search for Bioinformatics resources.
2. DNA and Protein sequence, file format conversion.
3. EST's Contig assembly and ORF analysis.
4. Nucleic acids and Protein sequence database search.
5. Biophysical parameters and Protein diagnostics.
6. Multiple sequence alignment and Conserved Amino acid residues.
7. Cladograms and Dendrograms and evolutionary relationship.
8. The PROSITE Database.
9. Conserved Domains and Protein super families.
10. Two-dimensional and three dimensional structure, Prediction resources.
11. Protein structure model from x-ray diffraction and NMR data.

BPP/MJ/605: Practical based on BPT/MJ/602

(Total Marks 30+20 Credits: 2; Workload: 4hrs/Wk Total : 60 hrs)

1. Isolation of genomic DNA from bacteria and purification
2. Isolation of DNA from animal and plant tissues.
3. Isolation of plasmid DNA from bacteria cells.
4. Electrophoretic separation of plasmid DNA by agarose gel electrophoresis
5. Molecular size determination of DNA by gel electrophoresis-Agarose, Polyacrylamide
6. Restriction fragment digestion analysis of DNA
7. Ligation of DNA.
8. Case studies and problems on gene cloning.
9. Demonstration of PCR

BPP/MJ /606: Immunodiagnostic Techniques

(Total Marks 30+20 Credits: 2; Workload: 4 hrs/Wk Total : 60 hrs)

1. To demonstrate Ag-Ab interaction by SRID (Single Radial Immuno- Diffusion)
2. To demonstrate Ag-Ab interaction by Double diffusion.
3. To characterize Antigen- Antibody interaction by Immunoelectrophoresis.
4. To estimate Ag-Ab interaction quantitatively by Rocket Immuno-electrophoresis.
5. To demonstrate Ag-Ab interaction by Counter- Current Immuno- electrophoresis.
6. Electrophoretic characterization of Immunoglobulins by SDS-PAGE.
7. To study Antibody heterogeneity detected by isoelectric focusing.
8. To estimate the CH50 tube assay.
9. ELISA Demonstration.
10. Demonstration of RIA.
11. ELISPOT (Enzyme- Linked Immuno- Spot Assay): For detection & quantification of Individual cell secreting a specific cytokines or antibody.
12. Demonstration of Production & purification of the Monoclonal Antibodies.
13. Demonstration of Neutralization assays
14. Demonstration of Immunofluorescence

BPT/DSE/607 -A: Environmental and Photo-biophysics

(Total Marks 30+20 Credits: 2; Workload: 2hrs/Wk Total : 30 hrs)

Unit 1: Biophysical Ecology

Introduction to Ecosystem Micro climate & energy environment, Influence of physical factors, Interaction between environment & Biosystems, solar radiation, Photochemical filtering of solar radiation. Atmospheric absorption, spectrum & thermal emission spectra, atomic scattering, Comparative distribution of natural light, spectral properties of liquid water, plant & animals, Green house effect, Non-ionizing & Ionizing radiation.

Unit 2: Photophysics & Photochemistry

Nature and measurement of light, Physical properties of excited molecules, Phophysical processes, fluorescence, Photophosphorescence, Internal conversion, Intersystem crossing, Photophysical spectra, Actionspectra, Optical activity, Photophysical kinetics of bimolecular processes.

Basic principles and laws of photochemistry, Quantum photochemical principles, Photochemical primary processes, Types of photochemical reaction, Photochemistry of amino acids and proteins, Photochemistry of DNA & RNA and its constitutes, Recovery from photochemical damage, Photophysical and photochemical aspects of photosensitization, Chemiluminisence, Mechanism and significance, Techniques for study of transient species in photochemical reaction

Unit 3: Photobiological phenomenon & Circadian Rhythm

Photoactivation of biological systems, Photodynamic dyes and mechanism of photodynamic action on cells, Viruses, Proteins and nucleic acids, Concepts, Mechanism and Significance of photomorphogenesis, Photoperiodism, Phototaxis, Phototropism, Photosynthesis, Light acceptor, system, Photosystem as Photosynthetic reaction centre, Photophosphorelation, Bioluminescence

General failures of circulation rhythms, Entrainment to environmental cycles, Mechanisms of circadian rhythms, Circadian organization in multicellular organism including human,

BPP/DSE/608 : Practical based on BPT/DSE/607 -A

(Total Marks 30+20 Credits: 2; Workload: 4hrs/Wk Total : 60 hrs)

1. Measurement of Light Intensity and effect of various factors.
2. Effect of High and Low temperature on Biomolecules and cells.
3. Measurement and Detection of Noise at various places by sound meter.
4. Effect of electric and magnetic field on Biomolecules and cellular system.
5. Trace element analysis of Polluted water by polarography.
6. Determination of Nitrates and water sample by UV Spectroscopy.
7. Analysis of trace elements in Animal and Plant tissue by Atomic absorption spectroscopy.
8. Radiation Exposure survey using area survey meters and Dosimeters.
9. Effect of distance on incident UV flux using Actinometry.
10. Determination of Calcium, Sodium, Potassium & Lithium by Flame photometry.
11. Determination of Element concentration by X-ray Fluorescence method.
12. Effect of lead on Nerve conduction velocity in animals.
13. Effect of microwaves and radio frequency radiations on biomolecules and cellular systems
14. To study the Effect of sound pollution on auditory impairment by Audiometry.
15. Preparation and use of Cryoprotectants for cell preservation.
16. Demonstration of Neutron activation analysis for elemental estimation.
17. To study the effect of Ultrasound on Biomolecules and Cellular Systems

18. To study the Photo reactivation process in E. Coli
19. To study the effect of visible light intensity and time of irradiation on photo reactivation process.
20. To study the Photoacoustic Spectra of Oat Seedlings.
21. To study the Action Spectrum for Bacterial killing.
22. To study the Photo Inactivation of Enzymes.
23. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
24. To study the photomorphogenisis using seedlings.
25. To isolate chloroplast from spinach leaves.
26. To study bioluminescence of live fire flies by correlating light intensity with time.
27. To study chemiluminescence in a chemical transformation.
28. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
29. To study the spectrophotometric assay of Hill reaction and estimation of chlorophyll.
30. To demonstrate Hill reaction using Oxygen Electrode.
31. To study the effect of Inhibitors and Light Intensity on Hill reaction.
32. Effect of Lasers on Biomolecules and Cellular Systems.

BPT/DSE/607 -B: Biophysical & Bioanalytical Techniques.

(Total Marks 30+20 Credits: 2; Workload: 4hrs/Wk Total : 60 hrs)

Unit 1: Fluorescence & Optical spectroscopy

Fluorescence spectroscopy: Principle, Instrument Design FRET, & Applications- Fluorescent probes, modification in methionine, histidine, tryptophan, amine and carboxylic groups, fluorescence life-time and quenching studies & applications in proteins & membrane studies. Energy transfer for distance measurement in proteins & membranes. Use of fluorescence polarization and anisotropy, measurement of anisotropy decay. Comparative study of rigid proteins i.e.; lysozyme and lactalbumin. Internal flexibility of multidomain proteins, i.e. myosin, fraction, fibrinogen. Fluorescence dye-Nucleic acid complexes.

Principle and Instrument Design of Optical spectroscopy, Methods & Applications of Polarimetry, Light scattering, Refractometry, Circular dichroism (CD), optical rotatory disperson (ORD): Plain, circular and elliptical polarization of light, Absorption by oriented molecules, Relation between CD and ORD, Dichroic ratio of proteins and nucleic acids. application of ORD in conformation and interactions of biomolecules, Determination of structural correlations in biomolecules using CD & ORD, Relationship between molar ellipticity of CD, Conformational dependence of CD helical structure, coupling between chromophore etc. Secondary and tertiary structures of peptides and proteins, effect of pH, temperature, organic solvents and neutral salts. Conformational information- aromatic and disulphide side chains. CD spectra of di, oligo and polypeptides, structure of supra- molecular structure i.e. membranes and ordered aggregates of chromophore

Unit 2: ESR Spectroscopy:

Magnetic moment of unpaired electrons and paramagnetic resonance, Principle of operation and working of electron spin resonance, E.S.R. spectrometer, Hyperfine ESR spectroscopy, representation of ESR spectrum, E.S.R. spectra of organic radicals in solution-- isotropic hyperfine splitting, ESR spectra of organic radicals in solids-anisotropic hyperfine splitting, ESR spectra of inorganic radicals-g-value anisotropy. ESR of organic molecules in triplet states-Electron spin-spin interactions. Relaxation processes and line shapes, 'g' –value, spectra of simple organic free radicals, hyperfine coupling, prediction of expected number of lines and intensities. Spectra of transition metal complexes, Zero-field splitting, utility for identification of radical; spin labelled probes, spin-labelling: A reporter group technique, requirement of such a group, Nitroxides spin label probes and their molecular structures, Anisotropy of the value order parameters, information obtained from ESR motion, polarity, biochemical data, orientation Intra- molecular distances etc. Applications of these concepts to (i) studying the structure and function of enzyme, i.e. lysozyme etc. (ii) conformational change of molecular artifact in try spin, spin labelled ligands as probe for rigidity of binding sites, lipid spin labels in the biological membranes etc. applications in biology, pharmacy.

Unit 3 : Mass Spectroscopy

Basic principles, brief outline of instrumentation, fragmentation processes & ion formation, molecular ions, meta-stable ions, fragmentation patterns and fragment characteristics in relation to parent structure and functional groups, Detectors & their designs, relative abundances of isotopes and their contribution to characteristic peaks, mass spectrum; its characteristics, presentation and interpretation, chemical ionization mass spectrometry, GC- MS including recent advances in MS, Fast atom bombardment mass spectroscopy; analysis of drugs in biological samples by combined GC- MS. Chemical ionization mass spectroscopy (CIMS), Field ,Ionization Mass Spectrometry (FIMS), Fast Atom Bombardment MS (FAB MS), Matrix Assisted laser desorption / ionization MS (MALDI-MS), interpretation of spectra and applications in biology, Pharmacy etc

BPP/DSE/608: Practical based on BPT/DSE/607 -B

(Total Marks 30+20 Credits: 2; Workload: 4hrs/Wk Total : 60 hrs)

1. To perform the structural analysis of amino acids, small peptides using NMR spectrometer
2. To perform the Free radical spectral analysis using ESR spectrometer
3. To perform the conformational analysis of amino acids, small peptides, large proteins using CD spectrometer and spectro polarimeter
4. To perform the Mass spectral analysis using Mass spectrometer
5. To perform image analysis using CCD camera of Microscopic dynamic Images.
6. To determine the sugar and protein concentration using Refractometer
7. To obtain relation between concentration and Refractive Index (RI) using Refractometer.
8. To interpret the X-ray diffraction pattern, NMR & ESR spectrum, Mass spectrum, ORD & CD spectra.

Class: M.Sc. Biophysics: Second Year Semester- IV

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credits Assigned		Total Credits	Scheme of Examination			
								Theory Maximum. Marks 50		Practical Maximum Marks 50	
			Theory	Practical	Theory	Practical		CA- 40% Min/ Max	UA 60% Min/ Max	CA 40% Min/ Max	UA 60% Min/ Max
Major Mandatory DSC	BPT/MJ/650	Radiation Biophysics	2	-	2	-	14	08/20	18/30		
	BPT/MJ/651	Medical Biophysics	2	-	2	-		08/20	18/30		
	BPT/MJ/652	IPR, Biosafety &Bioethics	2	-	2	-		08/20	18/30		
	BPP/MJ/653	Practical based on BPT/MJ/650	-	4	-	2				08/20	18/30
	BPP/MJ/654	Practical based on BPT/MJ/651	-	4	-	2				08/20	18/30
	BPP/MJ/655	Practical based on BPT/MJ/652	-	4	-	2				08/20	18/30
	BPP/MJ/656	Recombinant DNA (RDT)Techniques	-	4	-	2				08/20	18/30
DSE (Choose any one from pool of courses)	BPT/DSE/ 657	A/B	2	-	2	-	04	08/20	18/30		
	BPP/DSE/ 658	Practical based on BPT/DSE/657	-	4	-	2				08/20	18/30
RP	BP/RP-2 /699	Research Project-2	-	8	-	4	04			16/40	24/60
			08	28	08	14	22	80	120	140	110

1. **Major Mandatory (DSC)**
   BPT/MJ/650: Radiation Biophysics
   BPT/MJ/651: Medical Biophysics
   BPT/MJ/652: IPR, Biosafety & Bioethics
   BPP/MJ/653: Practical based on BPT/MJ/650
   BPP/MJ/654: Practical based on BPT/MJ/651
   BPP/MJ/655: Practical based on BPT/MJ/652
   BPP/MJ /656: Recombinant DNA(RDT) Techniques.
2. **DSE:** (Choose any one from Pool /Basket)
   a) **BPT/DSE/657 -A: Genomics and Proteomics**
   BPP/DSE/658 : Practical based on BPT/DSE/657 -A
   OR
   b) **BPT/DSE/657 -B: Cellular and Molecular Neurophysiology**
   BPP/DSE/658: Practical based on BPT/DSE/657 -B
3. **BP/RP-2 /699: Research project-2**

BPT/MJ/650: Radiation Biophysics

(Credits: 2; Workload: 30 hrs.)

Unit 1: Radiological Physics

Atomic structure and atomic nuclei, Radioactivity, Isotope, laws of Radioactivity, Alfa, Beta, Gamma rays, Properties of Electromagnetic radiation, Radiation Units- Units of radioactivity, exposure & dose, Dose equivalent Unit, X & Gamma ray interaction with matter (Photoelectric & Compton effect, Ion pair production Heavy charged particles & Neutrons, linear, mass, electronic & atomic attenuation coefficient-, HVL, Mean free path, Absorption edges, LET.

Unit 2: Radiochemistry and free Radicals

Radiolysis of water, Production of free radicals & their interactions, Pulse radiolysis, Role of scavengers, G-value, Direct and Indirect action, Oxygen and temperature effect, OER,

Target theory, Single & Multi hit theory, Multi target theory, Calculation of target, Mass, Volume & Molecular weight, Effect of radiation on Nucleic acids, Proteins, Enzymes & Carbohydrates, Cellular effects of radiation, Mitotic delay, Inhibition of mitosis, Giant cell formation, Cell death, Cell recovery & Modification of Radiation damage, Genetic Effect of radiolysis, Factors affecting frequency of radiation induced mutation, Chromosomal breakage and Aberrations, Somatic effect of radiation, Physical factors influencing somatic effects, Dependence on dose, Dose rate, Acute radiation damage, LD-50, Radiation syndrome, Early and late effects of radiation, Effect of Chronic exposure to radiation, Dose effect relationship, Genetic burden, Concept of doubling dose & its effect on genetic equilibrium.

Unit 3: Radiation detection, Measurement and Safety measures

Principles of radiation detection and measurement, General requirements of Dosimeters, Radiation sources, Tele gamma Unit (Cobalt Unit), Gamma chamber, Nuclear reactors, Thermal & fast neutron sources, Basic principles, Design & Working of physical dosimeters- Ionization chamber, Proportional counters, GM- Counter, Concepts of Gas amplification, Resolving time & Dead time, Scintillation Detectors, Thermolumeniscent Dosimeter, Semiconductor, Surface barrier & Lithium detectors, Area survey meter & Pocket dosimeter, Film badge, General principle of chemical dosimetry, Salient Features of Chemical dosimeter, Dose evaluation formula for chemical dosimetry, Principles of radiolytic reaction, Experimental methods- Influencing factors of Fricke dosimeter methyl orange, FBX dosimeter, Free radical dosimeter, Ceric sulphate dosimeter, PMMA, PVC, chlorobenzene dosimeter, High & low dose indicators.

Natural & Man-made radiation exposures or Principles of dose equivalent limit (DEL) radiation protection, Maximum permissible dose (MPD), Evaluation of external & internal radiation hazards, Radiation protection measures in industrial establishment, Radioisotope labs, diagnostic & therapeutic installation & during transportation of radioactive substances, disposal of radioactive waste, administrative & legislative aspect of radiation protection.

BPT/MJ/651: **Medical Biophysics**

(Credits: 2 ; Workload : 30 hrs.)

Unit 1: Electrophysiology.

Principles of Electrocardiography, Heart- an electric potential sources, ECG waveforms, Standard lead systems, ECG preamplifiers, ECG readout devices, ECG machine, Measurements, Trouble-shooting, Principles of Electroencephalography, EEG Electrodes, 10-20 Electrode system, EEG Amplitude & Frequency band, Multichannel EEG recording, EEG in Sleep, Diagnostic Application of EEG, Recording of visual & auditory evoked Potentials, EEG Telemetry system, EEG System artifacts, Faults, Troubleshooting & Maintenance, Other electrophysiological recordings, EMG, ERG, EOG & their applications.

Unit 2: Medical-Imaging Techniques & Nuclear Medicine.

Physical aspects of Medical-imaging, Principle, Practical System, Medical utility of X-ray imaging, Mammography, Xeroradiography, Fluoroscopy, Computerized Axial Tomography, Angiography, Myelography, Magnetic resonance imaging, Ultrasonography. Basic principles of Nuclear Medicine, Diagnostic use of Radioisotopes In-vivo & In-vitro procedures, (Single isotope, Double isotope methods), Radio immunoassay counting system, General principles & procedures of organ scanning, Renal imaging, Cardiac imaging, Thyroid scanning, Blood volume determination by isotope method, Rectilinear scanners & Gamma scintillation camera, Positron emission Tomography (PET), Single Photon emission computer Tomography (SPECT), Radio pharmaceuticals & their Diagnostic applications.

Unit 3: Radiotherapy.

Concepts of teletherapy & Brachytherapy, Co-60 Therapy, Basic principles & scope of radio therapy, Benign & Malignant tumors, Tissue tolerance dose & Tumor lethal dose, Medical dosimetry, Dose fractionation, Palliative & Curative therapy, Treatment planning, Isodose distribution, Patient data, Correction & Setup, Field shaping, Skin dose and field separation, brachytherapy, Sources, Calibrations, Dose distribution implant dosimetry.

BPT/MJ/652: IPR, Biosafety & Bioethics

(Credits: 2 ; Workload : 30 hrs.)

Unit 1: Introduction to Intellectual Property, History, Agreements and Treaties

Types of IP: Patents, Criteria of patentability in US, UK, Europe and India, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, History of GATT & TRIPS Agreement; Paris Convention, Berne Convention, Rome Convention, Madrid Agreement; WIPO, Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments, TKDL.

Unit 2: Drafting of patent specification, Databases, PVP

Drafting a patent Specification: Provisional and complete; Types of patent applications: National & PCT filing procedure; Time frame and cost; Precautions while patenting- disclosure/non-disclosure; Prior art, international patent searches, Patent licensing and agreement, Patent infringement- meaning, scope, litigation, case studies

Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), PATENT Scope (WIPO), IPO, etc. Commercial potential of scientific inventions, rationale for IP protections, Plant variety protection in India, case studies

Unit 3: Biosafety, GM regulations in India, Bioethics

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary containment for Biohazards; Types of Biosafety Levels; Recommendations of Biosafety Levels for Specific Microorganisms, Infectious Agents and Infected Animals used; Biosafety guidelines- Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including; Cartagena Protocol. Bioethics- Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

BPP/MJ/653: Practical based on BPT/MJ/650

(Credits: 2 ; Workload : 60 hrs.)

1. To determine the incident UV flux using Actinometry system.
2. To determine the Dose rate of Gamma Source using

a) Fricke Dosimeter.
b) Methyl Orange Dosimeter.
c) Free Radical Dosimeter (Alanine and Glutamine.)
d) FBX Dosimeter.
e) Cerric Sulphate Dosimeter.

3. To determine the G value using Methyl Orange Dosimetry.
4. To determine the effect of UV and Gamma rays on E. Coli. and elucidate cell survival curve.
5. To demonstrate the effect of UV and Gamma rays on cell division.
6. To demonstrate the effect of Gamma rays on Enzymes, Proteins and DNA.
7. To demonstrate the effect of Gamma rays on cell membrane.
8. To determine the threshold Plateau and Operating Voltage for given GM tube.
9. To determine the Resolving time, Dead time and counter efficiency for given GM tube.
10. To determine the Absorption Coefficient of a given material for β- particles.
11. To determine the back scattering of a given material for β- particles.
12. To determine the X-ray output measurement,

a) As a function of current & voltage
b) Variation of exposure rate across the X-ray beam.
c) Decrease of output as a inverse square of distance.

13. To determine the HVL, HVT, TVT of a given material.
14. To determine the penumbra in good and bad geometry.
15. To use the personal dosimeter in radioprotection.
16. Radiation protection survey of X-ray diagnosis Unit, Cobalt therapy Unit, Brachy therapy Unit and other radiation facilities.
17. To measure the Central axis of Dose, Depth of Dose, Plotting at isodose curves.
18. To determine the value of LD50.
19. To determine the focal spot size of a Diagnostic X-ray Unit using a pinhole camera.
20. To determine the calibration of various personnel monitoring systems; film badges, thermo luminescent Dosimeters, Pocket Dosimeters.
21. To determine the surface Dose rate and Central axis depth dose of ophthalmic applicators

BPP/MJ/654: Practical based on BPT/MJ/651

(Credits: 2 ; Workload : 60 hrs.)

1. To record and analyze the Electrocardiogram and to draw the mean Electrical axis.
2. To measure the Evoked potentials.
3. To record and analyze Electroencephalographic (EEG) activity from the cortical areas of the brain.
4. To evaluate the auditory responses.
5. To assess the ventilatory functions using pulmonary function tests.
6. To study the effect of Ergography.
7. To study the effect of Electromyography.
8. To measure the Output of Gamma ray teletherapy units.
    a) Beam collimation and aliglment.
    b) Electron contamination of beam.
    c) Electron build up in the wall of Dosimeter.
9. To measure the central axis depth dose and plotting of isodose curves
For a teletherapy unit using ion chamber &/or film.
10. Treatment planning procedures for:
    a) A simple pair of two opposing fields.
    b) Arc and rotation fields.
    c) With tissue compensation.
    d) With Wedge fields.
11. Treatment planning procedures with in homogeneity corrections after localization of tumour.
12. Brachytherapy source: 1) Check for integrity of the source, 2) Calibration using an Isotope calibrator, 3) Plotting of Isodose curves using Ion chamber and/or film.
13. Brachytherapy treatment planning for 1) Manual after loading applicator, 2) Remote after loading applicator.
14. To prepare and use of surface moulds.
15. Thyroid uptake measurements: Resolution and Sensitivity of Collimators.
16. Techniques for organ Scanning (Bone, Liver, Brain, Whole Body).
17. Assignments on various aspects using signal acquisition systems. AD Instruments-LAB Tutor and other protocols

BPP/MJ/655: Practical based on BPT/MJ/652
(Credits: 2 ; Workload : 60 hrs.)

1. About 10-20 Case studies to be revealed and analysed emphasizing the procedural aspects of IPR, biosafety & bioethics.
2. About 10 practicing mock exercises to be performed.

BPP/MJ /656: Recombinant DNA(RDT) Techniques.
(Credits: 2 ; Workload : 60 hrs.)

1. Types of PCR, RT-PCR, site directed mutagenesis using PCR, Overlap extension PCR, Asymmetric PCR,Thermal Cycle Sequencing PCR, Nested PCR.
2. Analysis of PCR products, Advantage & Limitations of PCR.
3. Preparation of Competent cells of E. coli and construction of recombinant plasmid
4. Genetic Transformation of E. coli with a recombinant plasmid
5. Screening transformed cells for the presence of recombinant plasmid and gene
6. Blue and White selection for recombinants.
7. Separation of proteins by SDS-PAGE
8. Sandwich ELISA Technique
9. Demonstration of Western Blotting
10. Demonstration of Southern hybridization

BPT/DSE/657 -A : Genomics & Proteomics
(Credits: 2 ; Workload : 30 hrs.)

Unit 1 : Introduction to Genomics and Proteomics

Overview research areas and related journals in genomics and proteomics - Concepts of central dogma – Structure and organization of prokaryotic & eukaryotic genome, organization and structure of genome, genome size, sequence complexity, introns and exons. Genome structure in viruses, bacteria, eukaryotes. Changes and regulation of genome activity in prokaryote and eukaryote, Genetic maps-Linkage maps, Cytogenetics maps & Physical maps. Brief outlook of various genome projects and their outcomes - Human genome project, Genome mapping and sequencing mapping techniques – Genetic markers – RFLP, SSLP, STRs, VNTRs,Sequencing methods: chemical and enzymatic method, high throughput method. Automated sequencing methods – Whole genome shotgun sequencing method, NGS sequencing method .

Unit 2: Gene identification and Expression profiling

Gene annotation, traditional route of gene identification, detecting ORF, gene ontology. Overview of comparative genomics, global expression profiling- traditional approaches to expression profiling, analysis of RNA expression, application of genome analysis, application of functional genomics, gene knockdown, gene editing – Cripsr- Cas system, Sequence assembly and annotation, Assembly of contiguous DNA sequence- shotgun, directed shotgun and clone contig approach, Tools for sequence assembly, structural and functional genomics – Transcriptomes, Pharmacogenomics. Genome variation: variations in human genome, known examples of variants that cause disease, pharmacogenomics, ethical consequences of genomic variations. Expression data analysis: DNA / RNA microarrays, oligomicroarray, chip technology, Affymetrics protocol, data generation, spotted microarray technique, biomedical applications

Unit 3: Proteome analysis

Introduction to proteome: Proteome and technology, Importance of 2D Electrophoresis in proteomics - Protein identification in proteome projects - Primary and secondary attributes for protein identification, Detection and analysis of co- and post-translational modification, protein identification (2 D electrophoresis), mass spectroscopy based methods for protein identification, MALDI TOF, application of NMR, mining protein databases, application to human disease studies, Proteome databases: Protein sequence databases - SWISS-PROT and TrEMBL – Pattern and profile databases – PROSITE and BLOCKS - 2D PAGE databases – Structure databases - PDB- Metabolic databases – post translational modification databases – Application of proteomics to medicine, proteomics, toxicology and pharmaceuticals.

BPP/DSE/658 : Practical based on BPT/DSE/657 -A
(Credits: 2 ; Workload : 60 hrs.)

1. Approximately 20 Practical assignments designed/downloaded from Internet elucidating skills of computational methods in genome, transcriptome and proteome analysis the area of genomics and proteomics to be useful in research are to be performed. A through proficiency in gene, genome, transcriptome and proteome analysis through computational methods to be acquired.

2. Approximately 10 Practical assignments designed/downloaded from Internet to know well about the genome features of prokaryote and eukaryote and develop sequence analysis tools based on any genome and proteome feature.

BPT/DSE/657 -B: Cellular and Molecular Neurophysiology

(Credits: 2 ; Workload : 30 hrs.)

Unit 1: Neurophysiology and Biophysics

Basic concepts in neurobiology and biophysics, Historical perspectives and key discoveries, Neurons and Neural Networks Structure and function of neurons, Ion channels and membrane potentials, Synaptic transmission and neural circuits, Biophysical Techniques in Neuroscience, Electrophysiology (patch-clamp recording, voltage-clamp techniques), Imaging techniques (fluorescence microscopy, calcium imaging), Computational modelling of neural processes.

Unit 2: Molecular Neuro-biophysics

Neurotransmitters and Receptors, Neurotransmitter types (e.g., glutamate, GABA, acetylcholine), Receptor subtypes (ionotropic, metabotropic), Ligand-gated ion channels.
Neuronal Excitability and Action Potentials, Hodgkin-Huxley model, Voltage-gated ion channels (sodium, potassium), Propagation of action potentials, Synaptic Plasticity and Learning Long-term potentiation (LTP) and long-term depression (LTD) Role of calcium signalling, Molecular mechanisms underlying synaptic plasticity.

Unit 3: Neurodegenerative disorders

Neural Oscillations and Synchronization ,Brain rhythms (alpha, beta, gamma), Synchronization in neural networks, Role of oscillations in cognition and behaviour, Neuro- biophysics of Sensory Systems, Vision (photoreceptors, visual processing), Audition (hair cells, auditory pathways),Somatosensory systems (mechanoreceptors, touch), Neurological disorders and Therapeutics, Neurodegenerative diseases (Alzheimer's, Parkinson's), Drug targets and therapeutic interventions, Challenges in drug delivery to the brain.

BPP/DSE/658 : Practical based on BPT/DSE/657 -B

(Credits: 2 ; Workload : 60 hrs.)

1. Acquisition of data for various physiological parameters using various computational data acquisition system.
2. **Electrophysiology Lab:** Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration,
   pulse rate, heart sound, etc.)
3. To determine pain sensitivity in rat/mice using Tail-Flick Analgesia meter.
4. To learn the use of Stereotaxic instrument for neuroscience research.
5. Demonstration of basal metabolic rate.
6. Effect of various neurotransmitters on fish melanophores.
7. Pharmacological experiments on melanophores.

8. Study of Physiology models related to neurophysiology.
9. Studies of blood pressure in humans:

a) Effect of posture changes on blood pressure and heart rate.

b) Effect of vestibular stimulation on blood pressure and heart rate.

c) Valsalva maneuver.

10. Perimetry: visual field determination with different colours in perimeter in resting and stressful condition.
11. Audiometry: study of frequency threshold curve in humans.
12. Biofeedback: EMG biofeedback studies.
13. Study of galvanic skin response (GSR): Measurement of GSR in resting and different stressful condition.
14. Experimental of Chronobiology:

a. Recording of 24 hrs. body temperature of study circadian rhythm of body temperature.

b. Recording of heart rate to study circadian rthythm of resting heart rate.

15. Neuroimmnological studies: PMN assay, cytotoxic assay, PLN assay, phagocytotic assay in experimental animals in resting condition and after stress.
16. a) Patch-clamp recordings from neurons.

    b) Analysis of action potentials and synaptic currents.

17) Imaging Techniques Lab

    a) Fluorescence microscopy of neural structures.

    b) Calcium imaging in live neurons.

18) Computational Modeling Lab

    a) Simulating neural circuits using software tools.

    b) Parameter estimation and model validation.

ANNEXURE: -
Recommended Books and Journals.

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2. Barrow. C. (1974), Physical Chemistry For Life Sciences, McGraw-Hill.
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7. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west press.
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11. Dickerson R.E.& Geis I. (1972), Proteins: structure, function and evaluation, Benjamin.
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15. Hughes W. (1979), Aspects of Biophysics, John willey and sons.
16. Jain M.K. and Wanger R.C. (1980), Introduction to Biological Membranes, John willeyand sons.
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19. Pesce A.J., Rosen C.G and Pasty T.L., Fluorescence Spectroscopy: An introduction forBiology and Medicine, Marcel Dekkar.
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22. Quinn P.J. (1984), The Molecular biology of cell Membranes, Macmillan.
23. Saenge W. (1984), Principles of Nucleic acid structure, Springer-Verlag.
24. Schule G.E. and schirmer R.H. (1984), Principles of protein structure, Springer-Verlag.
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29. Stanford J.R. (1975), Foundation of Biophysics Academic press.
30. Stryer L. (1981), Biochemistry, W.A. Freeman and Co.
31. Szekely M. (1984), From DNA to protein, Macmillan.
32. Volkenstein M.V. (1977), Molecular Biophysics, Mir Publication.
33. Bach J. F. (1978), Immunology, John willey and sons.
34. Basar E. (1976), Biophysical and physiological system Analysis, Addition-Wesley.
35. Cameron J. R. and skofronick J.G. (1978), Medical Physics, John willey and sons.
36. Casarett A.P. (1968), Radiation Biology, Prentice-hall Inc.
37. Castellan A. and Querela I.F. (1979), Synchrotron Radiation, Applied to Biophysical and
38. Biochemical Research, Plenum Press.
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46. Knoll G.E.(1979), Radiation detection and measurement, John willey and sons.
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48. Moorse B.M., Panker R.P. and Pullman B.R. (1981), Physical aspects of medicalimaging, John willey and sons.
49. Banks S.M. (1983), Photosynthetic system: structure function and symmetry, John willeyand sons.
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147. Lachin, Biostatistical Method.
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Text Books for Genomics & Proteomics

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1. Greg Gibson, Spencer V. Muse, A primer of genome science, Sinauer associates Inc. Publishers, 2002.
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3. Pennington, Proteomics from protein sequence to function, 2nd edition, Viva Books Ltd, 2002.
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5. Principles of Genome Analysis and Genomics, 3rd Edition, Sandy B. Primrose, Richard Twyman ISBN: 978-1-405-10120-2 December 2002 Wiley-Blackwell.
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Reference Books for Cellular and Molecular Neurobiophysics

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3. The Human Nervous System- Basic Principles of Neurobiology by Charles R. Noback and Robert J. Demarest.
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Texts/References for IPR,Biosafety,Bioethics

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Important Links: http://www.w3.org/IPR/