Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Curriculum under Choice Based Credit &

Grading System

M.Sc. (BIOPHYSICS)

Semester-III & IV

Run at College level from the

Academic Year 2015-16

M.Sc. [BIOPHYSICS] COURSE

Preamble

The University Grants Commission (UGC) has stressed on speedy and substantive academic and administrative reforms in higher education for promotion of quality and excellence. The Action Plan proposed by UGC outlines the need to consider and adopt Semester System, Choice Based Credit System (CBCS), and Flexibility in Curriculum Development and Examination Reforms in terms of adopting Continuous Evaluation Pattern by reducing the weightage on the semester-end examination so that students enjoy a de-stressed learning environment. Further, UGC expects that institutions of higher learning draw a roadmap in time bound manner to accomplish the above.

Dr Babasaheb Ambedkar Marathwada University, Aurangabad 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.

The CBCS System

Dr Babasaheb Ambedkar Marathwada University, Aurangabad and affiliated colleges have adopted a credit-based system from the academic year 2015-16. This provides the flexibility to make the system more responsive to the changing needs of our students, the professionals and society. It gives greater freedom to students to determine their own pace of study. The credit-based system also facilitates the transfer of credits.

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 under faculty of Science, if candidate is

B.Sc.with Physics or Chemistry or Zoology or Biochemistry or Botany or Microbiology or Mathematics 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.**

0.885 : 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 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).

M.Sc. Biophysics Course structure:

The Choice Based Credit Grading System is adopted progressively from the academic year 2015-2016. Every student has to complete 100 Credits to obtain M.Sc. Biophysics degree. Out of 100 Credits 96 Credits should be earned from the concerned subject, includes theory, practical/ field work demonstration work, mini project and 04 Credits from Service Course/s

0.886 : Credits and Degrees

i) A candidate who has successfully completed all the core courses, Elective/ Specialized courses and, seminars and project prescribed and or optional service courses approved by the University for the programme with prescribed CGPA shall be eligible to receive the degree.

ii) One Credit shall mean one teaching period of one hour per week for one semester (of 15 weeks) for theory courses and two practical/ laboratory/field/demonstration hours/ week for one semester.

iii) Every student will have to complete at least 100 credits to obtain the masters degree (Post graduate degree) in the subjects having practicals /laboratory work/field work/ /demonstration work, out of which 96 credits should be from their respective subject and four credits from service courses. However the affiliated college or committee appointed by the university can design the curriculum of more credits and it will be compulsory for the students from that department to complete the credits in their subject accordingly.

R.1927 : Courses*(i) Core Course **:** A core course is a course that a student admitted to a particular P.G. programme must successfully complete to receive the degree. Normally no theory course shall have more than 4 credits.*

*(ii) Elective Course**:** Means an optional course from the basic subject or specialization.*

*(iii) Service course (SC)**:** The service courses will be offered in third and fourth semesters in different departments of the University. Student should complete at least one service course in any semester.*

(iv) Each Course shall include lectures / tutorials / laboratory or field work / Seminar / Practical training / Assignments / mid-term and term end examinations/ paper / Report writing or review of literature and any other innovative practice etc., to meet effective teaching and learning needs. .

*(v) Attendance**:** Students must have 75% of attendance in each Core and Elective course for appearing the examination. However student having 65% attendance with medical certificate may apply to the Principal for condonation of attendance.*

R.1928: Registration for Service Course:-

i) The student will register the service course of his interest after the start of semester in the concerned college department on official registration form. The teacher in-charge of the respective course will keep the record of the students registered. Maximum fifteen days period will be given from the date of admission for completion of registration procedure. The admission committee of the college shall follow a selection procedure after counseling to the students etc. to avoid overcrowding to particular course(s) at the expense of some other courses.

ii) No student shall be permitted to register for more than one service course in a semester.

iii) The University department shall decide the maximum number of students in each service course taking into account the teachers and Physical facilities available in the college.

iv) The college may make available to all students a listing of all the courses offered in every semester specifying the credits, the prerequisites, a brief description or list of topics the course intends to cover, the instructor who is giving the courses, the time and place of the classes for the course. This information shall be made available on the college website.

v) Normally no service course shall be offered unless a minimum of 10 students are registered.

vi) The student shall have to pay the prescribed fee of Rs.100/- only per course per semester/year for the registration as decided by the University

M.Sc. Biophysics course is covered in Four semesters.

Semester -1: 24 Credits including :

- Four Core Courses each of 03 Credits,
- One Foundation Course of 01 Credit,
- Three Lab Courses each of 03 Credits based on Core Courses
- One Lab Course of Credit 02 based on Fundamental Course.

Semester -2: 24 Credits including:

- Four Core Courses each of 03 Credits,
- One Skill Enhancement Course of 01 Credit,
- Three Lab Courses each of 03 Credits based on Core Courses
- One Lab Course of Credit 02 based on Skill Enhancement Course.

Semester -3 : 24 Credits including :

- Two Compulsory Core Courses each of 03 Credits,
- Two Elective Courses each of 03 Credits
- Three Lab Courses each of 03 Credits based on Core & Elective Courses
- One Mini Project of Credit 03 .

Semester – 4: 28 Credits including:

- Two Compulsory Core Courses each of 03 Credits,
- Two Elective Courses each of 03 Credits
- Four Lab Courses each of 03 Credits based on Core & Elective Courses
- One Service Course of Credit 04.

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

Total Credits for Semester -1: 24 (Theory : 08; Practical : 09 ; FC: 03)

(FC: Foundation Course; L-Lecture; P-Practical)

Course Code & Type		Course Title	Pattern (hrs.)		Credits	WL/wk Hrs.	Marks			Exam duration hrs.
			L	P			C.A	U.A	Total	
BPT - 101	C	Molecular Biophysics	3	0	03	03	20	80	100	3
BPT -102	C	Biophysical Chemistry	3	0	03	03	20	80	100	3
BPT - 103	C	Cellular Biophysics	3	0	03	03	20	80	100	3
BPT-104	C	Molecular Enzymology	3	0	03	03	20	80	100	3
BPT-105	FC	Biostatistics & Computer Fundamentals	3	0	01	03	20	80	100	3
BPP-111	LC	Lab Course -1 (Based on BPT-101 & 102)	0	6	03	06	10	40	50	6
BPP-112	LC	Lab Course -2 Based on BPT - 103)	0	6	03	06	10	40	50	6
BPP - 113	LC	Lab Course -3 (Based on BPT - 104)	0	6	03	06	10	40	50	6
BPP-114	FC	Lab Course -4 (Based on BPT- 105)	0	6	02	06	10	40	50	6
		Total	15	24	24	39	140	560	700	-

M.Sc. Biophysics First Year [Semester -2]

Total Credits for Semester -2 : 24 (Theory : 08 ; Practical : 09 ;SEC : 03)

(SEC: Skill Enhancement Course; L-Lecture; P-Practical)

Course Code & Type		Course Title	Pattern (hrs)		Credits	WL/wk Hrs.	Marks			Exam hrs.
			L	P			C.A	U.A	Total	
BPT - 201	C	Physiology & Biophysics	L	0	03	03	20	80	100	3
BPT -202	C	Membrane & Ion channel Biophysics	3	0	03	03	20	80	100	3
BPT - 203	C	Physicochemical Techniques	3	0	03	03	20	80	100	3
BPT- 204	C	Molecular Biology & Genetics	3	0	03	03	20	80	100	3
BPT-205	SEC	Research Methodology	3	0	01	03	20	80	100	3
BPP- 211	LC	Lab Course -5 (Based on BPT-201&202)	0	6	03	06	10	40	50	6
BPP-212	LC	Lab Course -6 (Based on BPT - 203)	0	6	03	06	10	40	50	6
BPP-213	LC	Lab Course -7 (Based on BPT- 204)	0	6	03	06	10	40	50	6
BPP-214	SEC	Science Communication Skills	0	6	02	06	10	40	50	6
		Total	15	24	24	39	140	560	700	-

M.Sc. Biophysics Second Year [Semester -3]

Total Credits for Semester - 3: 24 (Theory: 12; Practical: 09; Mini-project: 03)

(L-Lecture ; P-Practical; MP-Mini Project)

Course Code & Type		Course Title	Pattern (hrs)		Credits	WL/wk Hrs.	Marks			Exam hrs.
			L	P			C.A.	U.A	Total	
BPT - 301	C	Biophysical & Bio-analytical Techniques	3	0	**03**	03	20	80	100	3
BPT -302	C	Immunology & Immunotechniques	3	0	**03**	03	20	80	100	3
BPT - 303	E	Elective Group -A	3	0	**03**	03	20	80	100	3
BPT- 304	E	Elective Group-B	3	0	**03**	03	20	80	100	3
BPP –311	LC	Lab Course -8 (Based on BPT–301 & 302)	0	6	**03**	06	10	40	50	6
BPP-312	LC	Lab Course -9 (Based on BPT -303)	0	6	**03**	06	10	40	50	6
BPP-313	LC	Lab Course -10 (Based on BPT -304)	0	6	**03**	06	10	40	50	6
BPMP	MP	Mini Project	0	6	**03**	06	50	100	150	6
		Total	**12**	**24**	**24**	**36**	**160**	**540**	**700**	

Elective Group A :

1. Electrophysiology

2. Protein Engineering

3 Environmental Biophysics

Elective Group B :

1. Photo biophysics

2.Cellular and Molecular Neurophysiology

3. Recombinant DNA technology

M.Sc. Biophysics Second Year [Semester – 4]

Total Credits for Semester - 4 : 28 (Theory : 12 ; Practical : 12 ; SC : 04)

(L-Lecture ; P-Practical)

Course Code & Type		Course Title	Pattern (hrs)		Credits	WL/wk Hrs.	Marks			Exam hrs.
			L	P			C.A.	U.A.	Total	
BPT - 401	C	Bioinformatics & Structural Biology	3	0	**03**	03	20	80	100	3
BPT -402	C	Radiation Biophysics	3	0	**03**	03	20	80	100	3
BPT - 403	E	Elective Group - C	3	0	**03**	03	20	80	100	3
BPT- 404	E	Elective Group -D	3	0	**03**	03	20	80	100	3
BPP– 411	LC	Lab Course -11 (Based on BPT-401)	0	6	**03**	06	10	40	50	6
BPP-412	LC	Lab Course -12 (Based on BPT-402)	0	6	**03**	06	10	40	50	6
BPP-413	LC	Lab Course -13 (Based on BPT-403)	0	6	**03**	06	10	40	50	6
BPP - 414	LC	Lab Course -14 (Based on BPT-404)	0	6	**03**	06	10	40	50	6
BPSC-2	SC	Service Course*	To be completed in other dept.		**04***	**60 hrs/ sem.**	100	--	100	
		Total	**12**	**24**	**28**	**36**	**220**	**480**	**700**	

***Student should complete at least one Service Course in any semester (Either 3 or 4)**

Elective Group C

1. **Medical Biophysics**
2. **Genomics & Proteomics**
3. **Neurobiophysics**

Elective Group D

1. **Bioelectronics & Medical Instrumentation**
2. **IPR, Bio-safety & Bioethics**
3. **Molecular modeling &Drug Designing**

M.Sc. Biophysics Course workload and general Instructions:

1. Every Core Course will have workload of 45 periods, each of 60 minutes duration, distributed unit wise as indicated in this syllabus. **[3 periods/wk X 15 weeks= 45]**
2. Every Lab Course will have workload of 90 periods, each of 60 minutes duration. **[6 periods/wk X 15 weeks=90]**
3. The Foundation Course will have workload of 15 periods, each of 60 minutes duration. **[3 period/wk X 15 weeks =45]**
4. The Lab Course based on Foundation Course will have workload of 90 periods, each of 60 minutes duration **[6 periods/wk X 15 weeks=90]**
5. The Skill Enhancement Course will have workload of 15 periods, each of 60 minutes duration. **[3 period /wk X 15 weeks =45]**
6. The Lab Course based on Skill Enhancement Course will have workload of 60 periods, each of 60 minutes duration**[6 periods/wk X 15 weeks=90]**
7. In **Semester-3 One Mini-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. **[6 periods/wk X 15 weeks=90]**
8. In **Semester 3,two Elective Courses** from group A & B to be chosen and in **Semester 4 two Elective courses** from Group C & D to be chosen depending on faculty and facility available in the concern department
9. Every student is expected to complete **One Service Course** of **04 Credits** in **Semester -4** with an approval from the concerned department**. Three service courses of 4 credits each** are offered to the students of disciplines other than Biophysics. **[3 X 4 periods/wk X 15 weeks]**
10. 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.
11. The practical component in lab courses,fundamental courses, skill enhancement courses and mini-projects are performed in respective semesters.However the semester end examination of pratical components will be held at the end of respective academic year as per rules of university.
12. 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

R.1929 :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.

R.1930 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.

0.887: 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 Master.s 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.) Non appearance 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.

0.888 : 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:

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

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 –

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

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.

0.889 : Evaluation method :-
Each theory course will be of 100 Marks and be divided in to internal examination (Sessional) of 20 Marks and Semester end examination of 80 Marks. (20+80 = 100 Marks) Each Practical course will be of 50 marks. Research project if any, will be of 100 marks.

a. Internal Evaluation Method
There shall be two mid semester examinations, first based on 40 percent syllabus taught and second based on 60 percent syllabus taught. The setting of the question papers and the assessment will be done by the concerned teacher who has taught the syllabus. Average score obtained out of two mid semester examinations will be considered for the preparation of final sessional marks/grade.

b. Term end examination and evaluation
i. Semester end examination time table will be declared by the departmental committee and accordingly the concern course teacher will have to set question paper, conduct theory examination, conduct practical examination with external expert, evaluate, satisfy the objection / query of the student (if any) and submit the result to DC.
ii. The semester end examination theory question paper will have two parts (20+60 = 80 Marks)
Part A will carry short question of 2-3 marks (fill in the blanks/multiple choice questions/ match columns / state true or false / answer in one sentence) as ***compulsory questions*** and it should cover entire syllabus. (20 Marks)
Part B will carry 7 questions out of which there shall be at least one question from each Unit, student will have to answer any five questions out of 1 (60 marks)
iii. Semester end practical examinations will be of 50 marks each and students will examined by one external and one internal examiner. Project work and seminar if any,will be evaluated by the external examiners along with guide.
iv. At the end of each semester the university authorities shall assign grades to the students.
v. The university authorities shall prepare the copies of the result sheet in duplicate.
vi.The university authorities shall display the grade points and grades for the notice of students.

R.1931 Grade Card
The University shall issue at the beginning of each semester a grade card for the student, containing the grades obtained by the student in the previous semester and his Semester Grade Point Average (SGPA).
The grade card shall list:
(a) the title of the courses along with code taken by the student
(b) the credits associated with the course,
(c) the grade and grade points secured by the student,
(d) the total credits earned by the student in that semester.
(e) the SGPA of the student,
(f) the total credits earned by the students till that semester and
(g) the CGPA of the student (At the end of the IVth Semester) .

R.1932 Cumulative Grade Card
At the end of the IVth semester, the University shall issue Cumulative Grade Card to the Students showing details of Grades obtained by the student in each subject in all semesters along with CGPA and total credits earned.

M.Sc. Biophysics Second Year [Semester -3]
Total Credits for Semester - 3: 24 (Theory: 12; Practical: 09; Mini-project: 03)
(L-Lecture ; P-Practical; MP-Mini Project)

Course Code & Type		Course Title	Credits		WL/wk Hrs.	Exam hrs.	Marks		
			L	P			C.A.	U.A	Total
BPT - 301	CC	Biophysical & Bio-analytical Techniques	3	0	**03**	03	20	80	100
BPT -302	CC	Immunology & Immunotechniques	3	0	**03**	03	20	80	100
BPT - 303	EC	Elective Group -A	3	0	**03**	03	20	80	100
BPT- 304	EC	Elective Group-B	3	0	**03**	03	20	80	100
BPP –311	LC	Lab Course -8 (Based on BPT-301 & 302)	0	6	**03**	06	10	40	50
BPP-312	LC	Lab Course -9 (Based on BPT-303)	0	6	**03**	06	10	40	50
BPP-313	LC	Lab Course -10 (Based on BPT-304)	0	6	**03**	06	10	40	50
BPMP	MP	Mini Project	0	6	**03**	06	50	100	150
		Total	**12**	**24**	**24**	**36**	**160**	**540**	**700**

Elective Group A :[one from the following]

1. **Electrophysiology**
2. **Protein Engineering**
3. **Environmental Biophysics**

Elective Group B :[one from the following]

1. **Photobiophysics**
2. **Cellular and Molecular Neurophysiology**
3. **Recombinant DNA technology**

BPT-301: Biophysical & Bio-analytical Techniques

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs] [Credits: 3]

Unit 1: Fluorescence & Optical spectroscopy

Fluorescence spectroscopy: Principle, Instrument Design, Methods-fluorimetry, 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, fractin, fibrinogen. Fluorescence dye-Nucleic acid complexes.

Optical spectroscopy: Principle, Instrument Design, 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: NMR Spectroscopy

NMR Spectroscopy Fundamental principles of NMR, magnetic properties of nuclei: spin quantum number, restricted orientation of magnetic nuclei in applied field, chemical shifts concept, factors affecting chemical shift, reference standards; Proton magnetic spectra, their characteristics, presentation, terms used in describing spectra and their interpretation (number position and intensity of signal),NMR spectrometer, Spin-spin coupling, application of signal splitting and coupling constant data to interpretation of spectra,. Brief outline of principles of FT-NMR with reference to 13C-NMR: Spin-spin and spin-lattice relaxation phenomenon, free induction decay (FID), proton noise decoupling, signal averaging time domain and frequency domain signals, nuclear over Hauser enhancement; 13C-NMR spectra; their presentation, characteristics, interpretation, examples and applications. Introduction to 2-D NMR techniques- benefits of 2D NMR, practical details for the general 2D experiments (COSY, NOESY). Assignment problem in biopolymers, Ligand binding to macromolecules, chemical exchange, P-NMR spectroscopy, monitoring of cellular pH, metabolism, pH gradient in tumor cells etc. Fluidity gradient in lipids, chemical shift anisotropy of P resonance in membranes

Nuclear Quadrupole Resonance Spectroscopy: Consequence of nuclear spin greater than1/2. Prolate and oblate nuclear quadrupole charge distributions, the NQR isotopes, electric field gradients. Nuclear quadrupole coupling constants. Measurement techniques-SRO detection and pulse NQR. Application to purine and pyrimidine nucleic bases.

Unit 3: ESR Spectroscopy

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 labeled probes,spin-labelling: A reporter group technique, requirement of such a group,Nitrooxide 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 4: Mass Spectroscopy

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

Photoacoustic Spectroscopy-Basic principles, Techniques & Instrumentation involved, applications in biosciences and related disciplines

Unit 5: Diffraction Techniques

Crystals, Molecular crystal symmetry, Miller indices, reciprocal Lattice, Ewalds Construction, X ray diffraction by crystals, Bragg's Law & Bragg's diffraction equation, laue powder and rotation methods & Laue's equations, diffraction methods-Laue's method, Weissenberg diffraction camera and powder method, Calculating electron density and Patterson maps (Fourier transform and Structure factors, convolutions), phases, model building & evaluation, Interpretation of results, geometrical structure factor. Phase problem in interpretation of results. Crystallization of proteins, preparation of heavy metal derivatives, Patterson synthesis, isomorphous replacement methods, structure factors of centro-symmetric and non-centro-symmetric crystals. General remarks on Protein-structure determination from X-ray diffraction data, Neutron diffraction, Electron diffraction, Synchrotron diffraction, Application in Biomolecular structural studies

BPT-302: Immunology & Immunotechniques

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45 hrs] [Credits : 3]

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.

Concepts of antigen, Antigenic determinant, Antigenicity, Immunogen and Immunogenicity, Factors affecting Antigenicity, Hapten, Carrier effect, Cross reactivity, Adjuvtants, 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.

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.

Unit 4: - 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.

Unit 5: - Immunotechniques.

Double, Single, Radial immunoprecipitation, Immunodiffusion and measurement of immune complex, Immunoelectrophoresis, Immunofluorescence, Radioimmunoassay, ELISA, Hybridoma technology and monoclonal antibodies, Abenzyme technique.

BPT -303: Elective Group A: [one from the following]

A-1. Electrophysiology A-2. Protein Engineering A-3. Environmental Biophysics

BPT -303 : Elective A-1: Electrophysiology

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit 1: Overview of Electrophysiology

different electrical signals in human body. Potential of nerve – resting membrane potential–ionic basis. Nernst equation. Hodgkin-Huxley model. Goldman equation. Action potential- ionic basis, gating kinetics and physio-pharmacology of different ion channels. Voltage clamp studies, biphasic and compound action potential. Receptor potential- general transduction mechanism, stimulus–receptor relationship, adaptation of receptors.

Unit 2: Electrophysiology of Heart, Brain & Muscle

Electrocardiogram (ECG), source of ECG voltage – dipole theory, vector analysis of ECG , changes of ECG potential in different cardiac abnormalities myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; Brain Potentials, Electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep. abnormalities of EEG. Event related potential (evoked potential)- types, characteristics and significance; Electromyogram (EMG) – Motor Unit potential, physiological significance and analysis of EMG.

Unit 3: Electrophysiology of Visual & Auditory Sensory system

Ultrastructure of retina. Photoreceptor potential – genesis of potential in light and dark phase, recording of potential. Molecular mechanism of phototransduction process. Electroretinogram (ERG) – characteristics, physiological and clinical significance.The visual system: Retinal neural circuitry, visual pathway, primary visual cortex –topographic map, organization of infruts. Effect of striate cortex lesions in primated spatio temporal organization of retinal and other visual neurons. Chromatic properties of retinal, LGB and striatal cortical neurons. Binocular and stereoscopic perception

Ultrastructure of cochlea. Resting and stimulus related potentials – endocochlear potential, cochlear microphone potential, summating potential, auditory nerve potential.

The Auditory system:Sound transmission in auditory system. Organ of corti. Central auditory pathway. Descending auditory pathway. The primary and secondary auditory cortical

areas.Functions of auditory system – frequency analysis of sound by cochlea and central auditory pathway. Intensity coding of auditory system. Perception of sound in space. Cochlear potentials.

Unit 4: Electrophysiology of Olfactory & taste Sensory system

Structure of olfactory receptor. Olfactory receptor potential – characteristics and molecular mechanism of transduction.Olfactory system: Organization of receptors in olfactory epithelium. Olfactory receptor potential. Olfactory pathways – olfactory bulb, central olfactory connections. Codibng of olfactory informations. Anosmia and dysosmia.

Ultrastructure taste receptors – taste receptor potential – molecular mechanism of transduction.Taste system: Receptor organs – distribution, ultramicroscopic structure and innervations. Taste qualities. Receptor potential. Taste pathway. Sensory processing,. Abnormalities of taste.

Unit 5: Electrophysiology of Sensory systems

The Sensory system: Sensation and perception. Sensory receptor, coding of sensory modality, intensity, localization of sensation, central processing of somatic sensation – spinal cord, thalamus cerebral cortex. Somatosensory areas of cerebral cortex- topographic organization, columnar organization, effect of lesion of primary somato sensory area. Pain – CNS in modulation of pain.

BPT -303-A2 : Elective A-2: Protein Engineering

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit-1 Protein Architecture

Amino Acids And Their Characteristics:Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Primary, secondary, tertiary, quaternary structure, Bonds And Energies In Protein Makeup: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Primary structure: peptide mapping, peptide sequencing - automated Edman method & massspec.High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites Tertiary structure:Domains, folding, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes.Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis. Protein folding, molten globule structure, characterization of folding pathways; Post translation modification; Sequence and 3Dstructure analysis: Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

Unit-2 Characterization of proteins

Protein raw materials: cereals, legume, oil seeds and pseudo cereals. Muscle protein, Milk protein, Egg protein, Hemoglobin, Collagen, Keratin. Nutritive role of food proteins;Methods to determine structure of proteins- Protein structure determination, X-Ray analysis of protein, NMR and mass Spectroscopy, Absorption and Fluorescence, Circular Dichroism, FT Raman, FT-IR, MALDITOF. Protein characterization, 2 D Gel Electrophoresis; Structure and function prediction- Protein Bimolecular interaction, Drug protein interaction Thermal properties of proteins and application of DSC. Protein denaturation, aggregation and gelation. Flow properties of proteins and sensory properties of pertinacious foods..

Unit-3 Proteins Stability, Interactions & Modifications

Interaction with electromagnetic radiation (radio, micro, infrared, ultraviolet, X-ray) and elucidation of protein structure. ,denaturation and renaturation, Protein stability and Methods of measuring the

stability of a protein: Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UVCD; Fluorescence; UV absorbance; methods to alter primary structure of protein-Random mutation Site directed mutation, Catalytic activity; Protein modification- thermal, enzymatic, physical, pressure, solvents, interactions; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation

Unit 4 Structure-Function Relationship

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins:IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate assisted catalysis other commercial applications.

Unit 5 Protein Engineering

Protein engineering: definition, application; Features or characteristics of proteins that can be engineered (definition and Electives methods of study)–affinity and specificity Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, de-novo protein design.

BPT -303 : Elective A-3: Environmental Biophysics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit 1: Biophysical Ecology.

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.

Unit 2: Environmental radiation.

Nonionising radiation, sources consequences of UV absorption by living system, Diurnal radiation climate, Ozone umbrella & it's significance, Natural Radiation back ground of ionizing radiation- Radioactivity in ambient air, Cosmic radiations, Terrestrial radioactivity, Radiation from man made resources, Detection & measurement of radiation level, Consequences of ionizing radiation absorption by living system. Characteristics of microwave and radio frequency radiation sources, interactions with living system, biological effects, safe exposure limits and prevention of health hazards. Electric and magnetic field, Sources, measurement, biological effects at molecular, cellular and organism level. Protective standards and measures.

Unit 3: Sound pollution.

Physical aspects of transmission of sound in air and water, sound pollution, noise and its sources, types of noise, sound measurement, effect of noise on CNS, Sleep disorders, reproductive, cardiovascular and endocrine system, noise control measures,noise adaptation and audition elements.

Unit 4: Biophysics at Low and High temperature.

Coupling between temp, water and life, Aqueous solution at subzero temperatures, Biomolecules at sub optimal temperature, Single cell responses to chill and freezing, Freeze avoidance and freeze tolerance in living system, Cryopreservation and cryoprotectants, Thermophiles and Thermo resistance mechanism, Thermo stability of enzymes and other biomolecules, Heat hardening of plant cells.

Unit 5: Analytical methods in environmental studies.

Principle, instrumentation, method spectrum interpretation and application of mass spectrometry, Atomic absorption, Flame emission, Plasma emission, Spectrometry, X-ray fluorescence, PIXE, Neutron and proton activation analysis.

BPT -304 : Elective Group B : [one from the following]

B-1. Photo-biophysics B-2.Cellular and Molecular Neurophysiology
B-3. Recombinant DNA technology

BPT -304 : Elective B-1: Photo-biophysics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit 1: - Non-Ionizing Radiation physics

Different sources of Non Ionizing radiation-their physical; properties, Various types of optical radiations-UV, visible & IR sources, Lasers-Theory and mechanism, Measurement of fluence from optical sources, Optical properties of tissues, theory and experimental techniques, interaction of laser radiation with tissues, photo thermal,photochemical,photo ablation electromechanical effect, Radiofrequency & Microwave radiation, Production and properties, interaction mechanism of RF and microwaves with biological systems, Thermal and non-thermal effects on whole body, lens and cardiovascular systems, tissue characterization and Hyperthermia and other applications.Biomagnetism,Effects,applications.Electrical Impedance and Biological Impedance, Principle and theory of thermography, applications in biology & medicine

Unit 2: - Photophysics & Photochemistry.

Nature and measurement of light, Light sources Optical components and their calibration radiometry, Actinometry, UV radiation dosimetry with poly sulphonification, Molecular structure and excited states, Physical properties of excited molecules, Phophysical processes, fluorescence, Photophosphorescence, Internal conversion, Intersystem crossing, Photophysical spectra, Action spectra, 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

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

Unit 4 :-Circadian Rhythms and Extra retinal photoreception.

General failures of circulation rhythms, Entrainment to environmental cycles, Mechanisms of circadian rhythms, Circadian organization in multicellular organism including human, Concepts of extraratinal photoreception with reference to invertibrates, Vertibrates, Possible sites of extraretinal photoreception

Unit 5: - Photo-medicine.

Optical properties of skin, Acute and chronic effect of sunlight on skin, Photosensitivity, Phototoxicity, photoallergy and clinical implication, Beneficial effects of sun and artificial light energy, Photoprotection, Photoimmunology. Mediphotonics: Lasers in dermatology, oncology and cell biology, Laser Surgical Systems, Application of ultra fast pulsed lasers in medicine and biology, Lasers in blood flow measurement, Fiber optics in medicine, microscopy in medicine, birefringence, Fluorescence microscope, confocal microscope, Hazards of lasers and their safety measures.

BPT -304 : Elective B-2: Cellular and Molecular Neurophysiology

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit I : Neurons

Introduction to neurons; The Neuron Doctrine; Components of neurons; Classification of neurons; The Nissl and Golgi stains; Types of neurons; Cytology of neurons; Dendrites structure and function; Axons structure and functional aspects; Ultrastructure; Myelination and synapses. impregnation method;Structure and function of glial cells; Different types of glial cells: astrocytes, oligo dendrocytes and Schwann cells; Types of astrocytes – type I & II astrocytes, fibrous and protoplasmic astrocytes; Function of other glial cells: oligodendrocyte and microglial cells; Overview of glial and neuronal relationship in the CNS; Importance of astrocytes in glutamate metabolism and blood brain barrier; Microglial phenotypes; Glial –neuronal interplay in the CNS; Principles of fixation and staining of nervous tissue; Methods of tissue processing for microtomy, cryotomy and vibratomy;

Unit II : Biophysical basis of Neurophysiology

Electrical properties of excitable membranes: Basic electricity and electric circuits; Neurons as conductors of electricity; Equivalent circuit representation; Electrical properties of excitable membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations; Ion movement in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes; Membrane potential and role of sodium and potassium pumps

Unit III : Neural Signals

Neural Signals, Overview of Neurons, Synapses and Networks;Stimulus à Sensory Perception à Motor Action / Higher Brain Function;Chemical and Electrical Signaling Within a Circuit; Methods to Record Electrical Activity of a Neuron. Action potential; Non-gated ion channels and generation of action potential; Electrical properties of neurons, quantitative models of simulations; Hodgkin & Huxley's analysis of squid giant axon: Voltage-clamp experiments; Voltage gated channels; Biophysical, biochemical and molecular properties of voltage gated channels.

Unit IV : Synaptic transmission & Neurotransmission

Synaptic vesicles; Principles of synaptic transmission: Electrical and chemical synapses; Calcium hypothesis: Control of transmitter release; Synthesis and trafficking of neuronal proteins. Synaptic

transmission at nerve-muscle synapses; Synaptic transmission at central synapses; Ligand gated channels; Second messengers and synaptic transmission.
Transmission of nerve impulse – resting and action potentials – Polarization, depolarization and repolarization . Sodium/ potassium pump – Role of calcium. Chemical transmission

Unit V: Neurotransmitters & Neuromuscular Coordination

Neurotransmitters – types, synthesis and secretion of neurotransmitters, Receptors–adrenergic receptors and cholinergic receptors. Regulation of transmission. Enzymatic inactivation of neurotransmitters. Ach. Esterase – inhibitors – neurotoxins. Forces involved in ligand – receptor interaction; neuromuscular transmission, reflex action and reflex arc. Regulation of body temperature. Interaction between sense organs and neurons.

BPT -304 : Elective B-3: Recombinant DNA Technology

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit 1: Gene Cloning & Vectors

Concept of gene cloning, Recombinant (Chimeric DNA) DNA, Steps in gene cloning. Restriction Endonucleases and generation of DNA fragments for cloning, Vector, properties of good vector, Plasmids, pBR322, pUC18119, pGEM32, Bacteriophage vectors: λ phage vectors, Phagmid vectors, Phasmid vectors, Artificial Chromosome Vectors, BAC, Fosmid vectors, Shuttle vectors, YAC vfectors, Vectors for animals & plant[PET expression system]

Unit 2: DNA Sequencing & Genome Mapping

Concept of Gene Library, C-DNA library, Methods for DNA sequencing, Genetic maps-Linkage maps, Cytogenetics map & Physical map.Concept & Application of Genetic Markers-Naked eye polymorphism(NEP), Protein based markers, DNA markers, Application of molecular markers. Linkage mapping of DNA markers- Restriction Fragment Length olymorphism(RFLP),Random Amplified Polymorphic DNAs(RAPDs), Amplified Fragment Length Polymorphism(AFLP), Sequence Tagged Sites (STSs), Linkage Mapping of RFLP markers, Map Based Cloning. VNTRS(Variable Numbers of Tandem Repeats), minisatellite & microsatellite , Simple Sequence Repeats & ribosomal DNA.

Unit 3: Techniques in Recombinant DNA Technology

Agarose gel electrophoresis & purification of DNA fragments, Chemical synthesis of gene, Enzymatic synthesis of DNA.PCR: Denaturation, PCR primers, annealing, primer extension, Types of PCR, RT-PCR, site directed mutagenesis using PCR, Overlap extension PCR, Asymmetric PCR, Thermal Cycle Sequencing PCR, Nested PCR. Analysis of PCR products, Advantage & Limitations of PCR.Concept of blotting, blotting membranes, preparation & labeling of probes, Different types of blotting, Nucleic Acid blotting, Colony Hybridization, Dot-blot technique, Southern blotting, Northen blotting, Western blotting, Oligonucleotide Microarrays & DNA chips.

Unit 4: Transgenics

Transfection, Gene transfer methods in plant, Target cells for transformation,Vector based TI & Ri plasmid of Agrobacterium.Agrobacterium mediated transformationPhysical delivery methods, DNA mediated gene transfer(DMGT)Chemically Stimulated DNA uptake by protoplast, microinjection, macro injection, microprojectile & electroporation.Chemical methods of DNA transfer, use of polyethylene glycol, Calcium phosphate, DEAE Dextrose, Use of polycation DMSO etc.

Unit 5: Application of Genetic Engineering

In Agriculture- Agrobacterium mediated transformation, Transgenic Plants(disease resistance, protein production, herbicide resistance) animal as bioreactor. In Medicine- Stem Cell Therapy, gene therapy in cystic fibrosis DMD, SCID, RNAi as a tool of gene therapy in Industry-Production of recombinant therapeutic proteins, eg:-insulin, erythroprotein factor VIII & IX Hepatitis & surface antigen, recombinant vaccine.

BPP -311 : Lab Course-8 : Practicals based on BPT-301 & 302

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

Practicals based on Biophysical & Bio-analytical Techniques

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.

Practicals based on Immunology and Immune-techniques.

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.
9. To demonstrate Ag-Ab interaction by SRID (Single Radial Immuno Diffusion)
10. To demonstrate Ag-Ab interaction by Double diffusion.
11. To characterize Antigen- Antibody interaction by Immunoelectrophoresis.
12. To estimate Ag-Ab interaction quantitatively by Rocket Immunoelectrophoresis.
13. To demonstrate Ag-Ab interaction by Counter- Current Immunoelectrophoresis.
14. Electrophoretic characterization of Immunoglobulins by SDS – PAGE.
15. To study Antibody heterogeneity detected by isoelectric focusing.
16. To estimate the CH_{50} tube assay.
17. ELISA Demonstration.
18. Demonstration of RIA.

BPP - 312 : Lab.Course-9: Elective A-1: -Practicals based on Electrophysiology

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. Amphibian based experiments

1. Study of apparatus used for amphibian experiments.
2. Gastrocnemius muscle and Sciatic nerve preparation of frog.
3. Recording of simple muscle twitch (SMT).
4. To study the effect of temperature on SMT.
5. To determine conduction velocity of nerve impulse.
6. To study effect of load on SMT.
7. Effect of increase in strength of stimulus on skeletal muscle contraction.

8. Effect of two successive stimuli on SMT.
9. Effect of increasing frequency of stimulus on SMT.
10. Genesis of fatigue.
11. Recording of normal cardiogram.
12. To study the effect of temperature on normal cardiogram.
13. To study properties of Heart muscle—Auto rhythmicity and Conductivity.
14. To study the properties – Refractory Period and Extra Systole (ES) of Heart
15. Muscle.
16. To study All or None law and Staircase phenomenon.
17. Effect of Vagosympathetic Trunk and White Crescentic Line on heart muscle.
18. Effect of Vagal stimulation showing Vagal Escape.
19. To study the effect of drugs – Adrenaline and Acetylcholine.
20. To study the effect of drugs – Nicotine and Atropine.
21. Study of reflexes in Spinal and Decerebrate frog.
22. Capillary circulation in frog (Frog Web).
23. Perfusion of isolated heart of frog.
24. To demonstrate the phenomenon of reciprocal innervation in frog.
25. Oocyte Biophysics based electrophysiological experiments

2. Human Experiments

1. Phenomenon of human fatigue by Mosso's Ergograph and Hand Grip
2. Dynamometer.
3. Clinical examination and recording of Arterial Pulse.
4. Recording of Systemic Arterial BP and effect of posture and exercise.
5. Recording of 12 lead ECG
6. Plethysmography (Measurement of Blood Flow).
7. Stethography.
8. Vitalography.
9. Spirometry.
10. Measurement of BMR.
11. Cardiac Efficiency Tests.
12. Perimetry.
13. Auditory Function tests.
14. Reaction time (VRT & ART).
15. Electroencephalogram (EEG).
16. Autonomic Function Tests.
17. Neuro – electrodiagnostic tests.
18. Sensory and motor nerve conduction.
19. Visual Evoked Potential (VEP).
20. Auditory Evoked Potential (AEP).
21. Critical Fusion Frequency (CFF).
22. Cold Pressor Test (CPT).
23. Galvanic Skin Resistance.

3. Mammalian Experiments

1. Record of movements of isolated Rabbit Intestine and effects of drugs and ions.
2. Perfusion of mammalian heart by Langendorff's Method and effect of drugs and ions.
3. Acquisition of data for various physiological parameters using various computational data acquisition system Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.)

BPP - 312 :Lab.Course-9: Elective A-2:Practicals based on Protein Engineering

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

PART I: QUANTITATION OF PROTEINS[5 Assignments]

1 Protein Determination by UV Absorption
2 The Lowry Method for Protein Quantitation
3 The Bicinchoninic Acid (BCA) Assay for Protein Quantitation
4 The Bradford Method for Protein Quantitation
5 Ultrafast Protein Determinations Using Microwave Enhancement
6 The Nitric Acid Method for Protein Estimation in Biological Samples
7 Quantitation of Tryptophan in Proteins
8 Flow Cytometric Quantitation of Cellular Proteins
9 Kinetic Silver Staining of Proteins

PART II: ELECTROPHORESIS OF PROTEINS AND PEPTIDES AND DETECTION IN GELS [10 Assignments]

10 Nondenaturing Polyacrylamide Gel Electrophoresis of Proteins
11 SDS Polyacrylamide Gel Electrophoresis of Proteins
12 Gradient SDS Polyacrylamide Gel Electrophoresis of Proteins
13 SDS-Polyacrylamide Gel Electrophoresis of Peptides
14 Identification of Nucleic Acid Binding Proteins Using Nondenaturing Sodium Decyl Sulfate Polyacrylamide Gel Electrophoresis (SDecS-Page)
15 Cetyltrimethylammonium Bromide Discontinuous Gel Electrophoresis of Proteins: Mr-Based Separation of Proteins with Retained Native Activity
16 Acetic–Acid–Urea Polyacrylamide Gel Electrophoresis of Basic Proteins
17 Acid–Urea–Triton Polyacrylamide Gel Electrophoresis of Histones
18 Isoelectric Focusing of Proteins in Ultra-Thin Polyacrylamide Gels
19 Protein Solubility in Two-Dimensional Electrophoresis:Basic Principles and Issues
20 Preparation of Protein Samples from Mouse and Human Tissues for 2-D Electrophoresis
21 Radiolabeling of Eukaryotic Cells and Subsequent Preparation for 2-D Electrophoresis
22 Two-Dimensional Polyacrylamide Gel Electrophoresis Using Carrier Ampholyte pH Gradients in the First Dimension
23 Casting Immobilized pH Gradients (IPGs)
24 Nonequilibrium pH Gel Electrophoresis (NEPHGE)
25 Difference Gel Electrophoresis
26 Comparing 2-D Electrophoretic Gels Across Internet Databases
27 Immunoblotting of 2-D Electrophoresis Separated Proteins
28 Quantification of Radiolabeled Proteins in Polyacrylamide Gels
29 Quantification of Proteins on Polyacrylamide Gels
30 Rapid and Sensitive Staining of Unfixed Proteins in Polyacrylamide Gels with Nile Red
31 Zinc-Reverse Staining Technique
32 Protein Staining with Calconcarboxylic Acid in Polyacrylamide Gels
33 Detection of Proteins in Polyacrylamide Gels by Silver Staining
34 Background-Free Protein Detection in Polyacrylamide Gels and on Electroblots Using Transition Metal Chelate Stains
35 Detection of Proteins in Polyacrylamide Gels by Fluorescent Staining
36 Detection of Proteins and Sialoglycoproteins in Polyacrylamide Gels Using Eosin Y Stain
37 Electroelution of Proteins from Polyacrylamide Gels
38 Autoradiography and Fluorography of Acrylamide Gels

PART III: BLOTTING AND DETECTION METHODS[5 Assignments]

39 Protein Blotting by Electroblotting
40 Protein Blotting by the Semidry Method

41 Protein Blotting by the Capillary Method
42 Protein Blotting of Basic Proteins Resolved
on Acid-Urea-Trinton-Polyacrylamide Gels
43 Alkaline Phosphatase Labeling of IgG Antibody
44 □-Galactosidase Labeling of IgG Antibody
45 Horseradish Peroxidase Labeling of IgG Antibody
46 Digoxigenin (DIG) Labeling of IgG Antibody
47 Conjugation of Fluorochromes to Antibodies
48 Coupling of Antibodies with Biotin
49 Preparation of Avidin Conjugates
50 MDPF Staining of Proteins on Western Blots
51 Copper Iodide Staining of Proteins and Its Silver Enhancement
52 Detection of Proteins on Blots Using Direct Blue 71
53 Protein Staining and Immunodetection Using Immunogold
54 Detection of Polypeptides on Immunoblots Using Enzyme-Conjugated
or Radiolabeled Secondary Ligands
55 Utilization of Avidin- or Streptavidin-Biotin as a Highly Sensitive Method to Stain Total Proteins on Membranes
56 Detection of Protein on Western Blots Using Chemifluorescence
57 Quantification of Proteins on Western Blots using ECL
58 Reutilization of Western Blots After Chemiluminescent Detection or Autoradiography

PART IV: CHEMICAL MODIFICATION OF PROTEINS AND PEPTIDE PRODUCTION AND PURIFICATION [10Assignments]

59 Carboxymethylation of Cysteine Using Iodoacetamide/Iodoacetic Acid
60 Performic Acid Oxidation
61 Succinylation of Proteins
62 Pyridylethylation of Cysteine Residues
63 Side Chain Selective Chemical Modifications of Proteins
64 Nitration of Tyrosines
65 Ethoxyformylation of Histidine
66 Modification of Arginine Side Chains with p-Hydroxyphenylglyoxal
67 Amidation of Carboxyl Groups
68 Amidination of Lysine Side Chains
69 Modification of Tryptophan with 2-Hydroxy-5-Nitrobenzylbromide
70 Modification of Sulfhydryl Groups with DTNB
71 Chemical Cleavage of Proteins at Methionyl-X Peptide Bonds
72 Chemical Cleavage of Proteins at Tryptophanyl-X Peptide Bonds
73 Chemical Cleavage of Proteins at Aspartyl-X Peptide Bonds
74 Chemical Cleavage of Proteins at Cysteinyl-X Peptide Bonds
75 Chemical Cleavage of Proteins at Asparaginyl-Glycyl Peptide Bonds
76 Enzymatic Digestion of Proteins in Solution and in SDS Polyacrylamide Gels
77 Enzymatic Digestion of Membrane-Bound Proteins for Peptide Mapping and Internal Sequence Analysis
78 Reverse Phase HPLC Separation of Enzymatic Digests of Proteins

PART V: PROTEIN/PEPTIDE CHARACTERIZATION[10Assignments]

79 Peptide Mapping by Two-Dimensional Thin-Layer Electrophoresis–Thin-Layer Chromatography
80 Peptide Mapping by Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis
81 Peptide Mapping by High-Performance Liquid Chromatography
82 Production of Protein Hydrolysates Using Enzymes
83 Amino Acid Analysis by Precolumn Derivatization with 1-Fluoro-2,4-Dinitrophenyl--L-Alanine Amide (Marfey's Reagent)
84 Molecular Weight Estimation for Native Proteins Using High-Performance Size-

Exclusion Chromatography
85 Detection of Disulfide-Linked Peptides by HPLC
86 Detection of Disulfide-Linked Peptides by Mass Spectrometry
87 Diagonal Electrophoresis for Detecting Disulfide Bridges
88 Estimation of Disulfide Bonds Using Ellman's Reagent
89 Quantitation of Cysteine Residues and Disulfide Bonds by Electrophoresis
90 Analyzing Protein Phosphorylation
91 Mass Spectrometric Analysis of Protein Phosphorylation
92 Identification of Proteins Modified by Protein (D-Aspartyl/L-Isoaspartyl) Carboxyl Methyltransferase
93 Analysis of Protein Palmitoylation
94 Incorporation of Radiolabeled Prenyl Alcohols and Their Analogs into Mammalian Cell Proteins: A Useful Tool for Studying Protein Prenylation
95 The Metabolic Labeling and Analysis of Isoprenylated Proteins
96 2-D Phosphopeptide Mapping
97 Detection and Characterization of Protein Mutations by Mass Spectrometry
98 Peptide Sequencing by Nanoelectrospray Tandem Mass Spectrometry
99 Matrix-Assisted Laser Desorption/Ionization Mass Spectrometry for Protein Identification Using Peptide and Fragmention Masses
100 Protein Ladder Sequencing
101 Sequence Analysis with WinGene/WinPep
102 Isolation of Proteins Cross-linked to DNA by Cisplatin
103 Isolation of Proteins Cross-linked to DNA by Formaldehyde

PART VI : GLYCOPROTEINS [5 Assignments]

104 Detection of Glycoproteins in Gels and Blots
105 Staining of Glycoproteins/Proteoglycans in SDS-Gels
106 Identification of Glycoproteins on Nitrocellulose Membranes Using Lectin Blotting
107 A Lectin-Binding Assay for the Rapid Characterization of the Glycosylation of Purified Glycoproteins
108 Chemical Methods of Analysis of Glycoproteins
109 Monosaccharide Analysis by HPAEC
110 Monosaccharide Analysis by Gas Chromatography (GC)
111 Determination of Monosaccharide Linkage and Substitution Patterns by GC-MS Methylation Analysis
112 Sialic Acid Analysis by HPAEC-PAD
113 Chemical Release of O-Linked Oligosaccharide Chains
114 O-Linked Oligosaccharide Profiling by HPLC
115 O-Linked Oligosaccharide Profiling by HPAEC-PAD
116 Release of N-Linked Oligosaccharide Chains by Hydrazinolysis
117 Enzymatic Release of O- and N-Linked Oligosaccharide Chains
118 N-Linked Oligosaccharide Profiling by HPLC on Porous Graphitized Carbon (PGC)
119 N-Linked Oligosaccharide Profiling by HPAEC-PAD
120 HPAEC-PAD Analysis of Monosaccharides Released by Exoglycosidase Digestion Using the CarboPac MA1 Column
121 Microassay Analyses of Protein Glycosylation
122 Polyacrylamide Gel Electrophoresis of Fluorophore-Labeled Carbohydrates from Glycoproteins
123 HPLC Analysis of Fluorescently Labeled Glycans
124 Glycoprofiling Purified Glycoproteins Using Surface Plasmon Resonance
125 Sequencing Heparan Sulfate Saccharides
126 Analysis of Glycoprotein Heterogeneity by Capillary Electrophoresis and Mass Spectrometry
127 Affinity Chromatography of Oligosaccharides and Glycopeptides with Immobilized

Lectins

PART VII : ANTIBODY TECHNIQUES[10Assignments]

128 Antibody Production
129 Production of Antibodies Using Proteins in Gel Bands
130 Raising Highly Specific Polyclonal Antibodies Using Biocompatible Support-Bound Antigens
131 Production of Antisera Using Peptide Conjugates
132 The Chloramine T Method for Radiolabeling Protein
133 The Lactoperoxidase Method for Radiolabeling Protein
134 The Bolton and Hunter Method for Radiolabeling Protein
135 Preparation of 125I Labeled Peptides and Proteins with High Specific Activity Using IODO-GEN
136 Purification and Assessment of Quality of Radioiodinated Protein
137 Purification of IgG by Precipitation with Sodium Sulfate or Ammonium Sulfate
138 Purification of IgG Using Caprylic Acid
139 Purification of IgG Using DEAE-Sepharose Chromatography
140 Purification of IgG Using Ion-Exchange HPLC
141 Purification of IgG by Precipitation with Polyethylene Glycol (PEG)
142 Purification of IgG Using Protein A or Protein G
143 Analysis and Purification of IgG Using Size-Exclusion High Performance Liquid Chromatography (SE-HPLC)
144 Purification of IgG Using Affinity Chromatography on Antigen-Ligand Columns
145 Purification of IgG Using Thiophilic Chromatography
146 Analysis of IgG Fractions by Electrophoresis
147 Purification of Immunoglobulin Y (IgY) from Chicken Eggs
148 Affinity Purification of Immunoglobulins Using Protein A Mimetic (PAM)
149 Detection of Serological Cross-Reactions by Western Cross-Blotting
150 Bacterial Expression, Purification, and Characterization of Single-Chain Antibodies
151 Enzymatic Digestion of Monoclonal Antibodies
152 How to Make Bispecific Antibodies
153 Phage Display: Biopanning on Purified Proteins and Proteins Expressed in Whole Cell Membranes
154 Screening of Phage Displayed Antibody Libraries
155 Antigen Measurements Using ELISA
156 Enhanced Chemiluminescence Immunoassay
157 Immunoprecipitation

PART VIII: MONOCLONAL ANTIBODIES[10Assignments]

158 Immunogen Preparation and Immunization Procedures for Rats and Mice
159 Hybridoma Production
160 Screening Hybridoma Culture Supernatants Using Solid-Phase Radiobinding Assay
161 Screening Hybridoma Culture Supernatants Using ELISA
162 Growth and Purification of Murine Monoclonal Antibodies
163 Affinity Purification Techniques for Monoclonal Antibodies
164 A Rapid Method for Generating Large Numbers of High-Affinity Monoclonal Antibodies from a Single Mouse.

BPP- 312: Lab.Course-9: Elective A-3:-Practicals based on Environmental Biophysics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

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

BPP-313:Lab.Course-10:Elective B-1:Practicals based on Photobiophysics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. To study the Photo reactivation process in E. Coli
2. To study the effect of visible light intensity and time of irradiation on photo reactivation process.
3. To study the Photoacoustic Spectra of Oat Seedlings.
4. To study the Action Spectrum for Bacterial killing.
5. To study the Photo Inactivation of Enzymes.
6. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
7. To study the photomorphogenisis using seedlings.
8. To isolate chloroplast from spinach leaves.
9. To study bioluminescence of live fire flies by correlating light intensity with time.
10. To study chemiluminescence in a chemical transformation.
11. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
12. To study the spectrophotometric assay of Hill reaction and estimation of chlorophyll.
13. To demonstrate Hill reaction using Oxygen Electrode.
14. To study the effect of Inhibitors and Light Intensity on Hill reaction.
15. Effect of Lasers on Biomolecules and Cellular Systems.
16. To study the characteristics of Fluorescence spectra of Auto fluorescent and induced fluorescent substances.

BPP-313:Lab.Course-10: Elective B-2: -Practicals based on Cellular & Molecular Neurophysiology

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

Part A

1. Study of the nerve cell: staining of neurons by crestyl violet and Nissl fast violet stain in the paraffin section of the spinal cord and cerebellum.
2. Study of central nervous system architecture by hematoxylin van Giessen method and Mallory's phosphotungstic acid hematoxylin method.
3. Experimental neuroanatomical studies:
   a) Nauta – Laidlaw method / Marchi's method
   b) Fink – heimer procedure.
   c) Cupric silver method.
   d) Rapid Golgi cox method / Bulchawosky method.
4. Tracing nerve tract horseradish peroxidase techniques.
5. Vital staining of nerve fibre by Methylene blue method.
6. Measurement of neurotransmitters:
   a) Spectroflurometric method for measuring acetylcholine, epinephrine, nonepinephrine, dopamine, serotonin in micro dissected brain regions of rats.
   b) HPLC method for measuring neurotransmitter.
7. Electrocardiographic study in humans in resting and stress condition.
8. Electromyographic study in humans in different stages of sleep and awakefulness.
9. Electroencephalographic study in humans: Recording of EEG in humans in different stages of sleep and awakefulness.
10. Evoked potentials study in humans: Brainstem evoked potential and auditory evoked potential in humans.

Part B Neurochemistry

1. Neurotoxicological studies using animal models
2. Study of developing rat nervous system
3. Normative and under exposure to toxic agents
4. Study of pathological tissue from different pathological conditions
5. Study of permanent slides
6. Visits to neurology and neurosurgery clinics
7. Histopathological methods for analysis of pathological tissues
8. Study of neurodegenerative models, e.g., nerve crush models

Part C

1. Acquisition of data for various physiological parameters using various computational data acquisition system
2. 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

Part D

1. 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.

2. Perimetry: visual field determination with different colours in perimeter in resting and

stressful condition.

3. Audiometry: study of frequency threshold curve in humans.
4. Biofeedback: EMG biofeedback studies.
5. Study of galvanic skin response (GSR): Measurement of GSR in resting and different stressful condition.
6. 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.
7. Neuroimmnological studies: PMN assay, cytotoxic assay, PLN assay,phagocytotic assay in experimental animals in resting condition and after stress.
8. Training programme / Laboratory Visit: Students will submit a report on the basis of their visit /training in some advanced national laboratories such as NBRC. New Delhi: NIMHANS & NCBS Bangalore;, AIIMS, New Delhi etc. as a part of their practical syllabus.

BPP-313:Lab.Course-10:Elective B-3: Practicals based on Recombinant DNA Technology

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1 Isolation and estimation of DNA, RNA and protein
Isolation and purification of plasmid DNA- i. Mini preparation, ii. Purification by LMP agarose, iii. Purification using DE81 cellulose.

2 Preparation and transformation of competent E.coli,Restriction enzyme analysis-restriction mapping

3 Agarose gel electrophoresis and PAGE of DNA and RNA – Southern blotting – RFLP analysis

4 Gene cloning-cloning a DNA fragment in Blue script vector. Blue White selection of transformed colonies

5 Characterization of transformants:
i. Complementation, ii. Insertional inactivation, iii. Screening by hybridization.

6 Isolation of DNA from bacteriophage
Isolation, estimation and restriction analysis of phage DNA., Preparation of helper phage and its titration.,UV survival curve,Dark repair of UV mutation.

7 Extraction, Purification and analysis of RNA
i Isolation of total RNA, ii. Isolation of cytoplasmic RNA,iii. Electrophoresis of RNA on denaturing gels

8 DNA sequencing, mutagenesis and engineering genes PCR and RAPD

BPMP: Mini Project:

[Total Marks: 150] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

The mini-project will be allotted by the concerned departmental committee

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M.Sc. Biophysics Second Year [Semester – 4]

Total Credits for Semester-4:28(Theory: 12;Practical:12;SC:04)

(L-Lecture ; P-Practical)

Course Code & Type		Course Title	Credits		WL/wk Hrs.	Marks			
			L	P		C.A.	U.A.	Total	Exam hrs.
BPT - 401	CC	Bioinformatics & Structural Biology	3	0	03	20	80	100	3
BPT -402	CC	Radiation Biophysics	3	0	03	20	80	100	3
BPT - 403	EC	Elective Group- C	3	0	03	20	80	100	3
BPT- 404	EC	Elective Group-D	3	0	03	20	80	100	3
BPP– 411	LC	Lab Course -11 Based on BPT-401)	0	6	03	10	40	50	6
BPP-412	LC	Lab Course -12 (Based on BPT-402)	0	6	03	10	40	50	6
BPP-413	LC	Lab Course -13 (Based on BPT-403)	0	6	03	10	40	50	6
BPP - 414	LC	Lab Course -14 (Based on BPT-404)	0	6	03	10	40	50	6
BPSC	SC	Service Course*	04*		60 hrs/ sem.	100	--	100	
		Total	12	28	36	220	480	700	

***Student should complete at least one Service Course in any semester (Either 3 or 4)**

Elective Group C

1. Medical Biophysics
2. Genomics & Proteomics
3. Neurobiophysics

Elective Group D

1. Bioelectronics & Medical Instrumentation
2. IPR, Bio-safety & Bioethics
3. Molecular Modeling & Drug Designing

BPT-401: Bioinformatics & Structural Biology

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45 hrs][Credits 3]

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.

Unit 2: Biological databases.

Sequence databases, Protein sequence databases, Structural databases, PDBs, Motif databases, Protein motif database, Genome databases, Proteome databases etc.

Unit 3: Genomics and Proteomics.

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 micro array 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.

Unit 4: Bioinformatics tools.

Pair wise Alignment, Alignment algorithms, sequence analysis tools, BLAST (Basic Logical Alignment Search Tool) FASTA, Multiple Alignment, Sequence analysis using EMBOSS, DNA micro array technique.

Unit 5: Molecular Modeling.

Introduction to computer graphics, Visualization of bimolecular structures, Concepts in molecular modeling, Energy minimization, Dynamic stimulation & conformational analysis, Applications of molecular modeling packages, structural similarity & overlaps, structural prediction & molecular docking, Applications of protein modeling.

BPT-402: Radiation Biophysics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credit 3]

Unit 1: Radiological Physics.

Atomic structure models, Constituents of atomic nuclei, Isotope, Radioactivity, laws of Radioactivity, Alfa, Beta, Gamma rays, Properties of Electromagnetic radiation, Particle accelerate absorbed cyclotrons & synchrotrons, Radiation Units- Units of radioactivity, exposure & dose, Dose equivalent Unit, Particle flux & fluence, X & Gamma ray interaction with matter, Photoelectric & Compton effect, Ion pair production, dependence on atomic weight, Interactions, absorption & scattering of electron, Heavy charged particles & Neutrons, attenuation coefficient-linear, mass, electronic & atomic, HVL, Mean free path, Absorption edges, LET.

Unit 2: Radiochemistry & Radiobiology.

Radiolysis of water, Production of free radicals & their interactions, Competition kinetics, Kinetic constants studies of transient species, Pulse radiolysis, Diffusion kinetics & Physicochemical effects, Role of scavengers, G-value, Direct and Indirect action, Oxygen and temperature effect, OER, Action of radiation on living system – Viruses, Prokaryotic & Eukaryotic cells, Thetical models, Cellular radiation action, Radio sensitisation and protection, Target theory, Single hit & 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, Type & Energy of radiation, Temperature, Anoxia age, 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 and Measurement.

Principles of radiation detection and measurement, General requirements of Dosimeters, Radiation sources, Telegamma 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, Thermoluminiscent 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.

Unit 4: Radiation safety measures

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.

Unit 5: Applications of Radioactivity

Radioisotopes in biology, Agriculture, Plant breeding, Soil plant relationship & plant physiology, Medicine, (Therapy & diagnosis), Radioimmunoassay, Radio tracer techniques with illustrative examples,

BPT -403 : Elective Group C : [one from the following]

C-1. Medical Biophysics C-2. Genomics & Proteomics C-3 Neurobiophysics

BPT -403: Elective C-1: Medical Biophysics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

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, Trouble shooting & Maintenance, Other electrophysiological recordings, EMG, ERG, EOG & their applications.

Unit 2: Medical-Imaging Techniques.

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.

Unit 3: Nuclear Medicine.

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 4: Radiotherapy.

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

Unit 5: Biomechanics and Ergonomics.

Physical forces exemplified in man, Human musculo- skeletal system, Integrity of Joints, Articular surfaces, Mechanical properties of bones, Degrees of freedom of movements at various joints, Axes & planes, Center of gravity, Base support, Segmental Weights & Lengths, Posture alignment of body segments, Locomotion, Basic determinants of gaits, Gait cycle and Swing phases, Time sequence, Neural control of gaits, Prostheses & Orthoses, Ergonomics, Muscle mechanics, Load velocity relation, Length tension relation, Entire State, Role of elastic components in muscle contraction, Ergonomic problems of computer users.

BPT -403 : Elective C-2: Genomics & Proteomics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit I Overview

Research areas and related journals in genomics and proteomics - Concepts of central dogma – Structure and organization of prokaryotic & eukaryotic genome – Changes and regulation of genome activity in prokaryote and eukaryote - Brief outlook of various genome projects and their outcomes - Human genome project

Unit II Genome mapping and sequencing

Mapping techniques – Genetic markers – RFLP, SSLP, STRs, VNTRs – Physical markers – EST, STS, FISH, SNP - Radiation hybrids – Mapping resources - Sequencing methods: chemical and enzymatic method - High throughput method –Automated sequencing methods – Whole genome shotgun sequencing method

Unit III Sequence assembly and annotation

Assembly of contiguous DNA sequence - shotgun, directed shotgun and clone contig approach - Genomic DNA library – cDNA library – Primer walking, Chromosome walking, Chromosome jumping – Tools for sequence assembly - Structural and functional genomics - Transcriptome and Microarray approach — Comparative genomics - Population genomics – Pharmacogenomics

Unit IV Proteomics

Introduction to proteome – Proteome and technology – Information and the proteome – Importance of 2D Electrophoresis in proteomics - Protein identification in proteome projects - Primary and secondary attributes for protein identification –Cross species protein identification – Detection and analysis of co- and post-translational modification.

Unit V 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

BPT -403 : Elective C-3: Neurobiophysics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit I-Neuroanatomy:

Central nervous system – components; Peripheral nervous system – Autonomous nervous system– Sympathetic and parasympathetic. Morphology of the brain and spinal cord. Development and growth of nervous system. Principles of cellular organization in the nervous system and population of cells. Structure and function of the nervous tissue. Types of neurons Functional groups of neurons, neuron circuits and neuroglia cells. CSF. Synaptic cleft and neuromuscular junction. Spinal cord, internal structures, spinal nerves, cytoarchitectural lamination, dorsal root afferents, spinal tracts, Brain and its gross anatomy: cerebral hemispheres, basal ganglia, brain stem. Pons. Thalamus, hypothalamus, cerebellum, medulla, corpus striatum and related nuclei, hippocampai formation, mygdala and olfactory pathways, cerebral, cerebellar and cerebrospinal tracts, meninges.

Unit II-Electrophysiology:

Origin of membrane potential, Role of Na/K pump and leak channel, recording of membrane potential, Nerve action potential: initiation and propagation. Role of Voltage gated channels in conductance of ion during action potential, Synapses, physiology of chemical, Synapses, neurotransmitters, excitatory and inhibitory postsynaptic potentials, synaptic summation and facilitation. Electrical characteristic of skeletal muscles electromyography and electroencephalography ;Somatic Sensation- Sensory receptors and their basic mechanism of action. Tactile and position sensation pathway for transmission to CNS. Somatic sensory cortex. Characteristics of transmission, pain, Headache and Thermal sensation. Special Senses: Photochemistry of vision, colour vision, neurophysiology of vision. The sense of hearing.

Unit III- Motor Mechanisms:

Cortical and Brain Stem Control of Motor function, control of posture and movement, reticular formation and support of the body against gravity, vestibular system and maintenance of equilibrium structure and function basal nuclei. Concept of pyramidal and extrapyramidal system, motor functions of cerebellum, Sensory control of motor functions. Basal ganlia and its function.

Unit IV- Cerebral Cortex and Intellectual Functions of Brain

Functional organization of the cerebral cortex, functions of specific cortical areas, learning conditioned reflexes, thoughts, consciousness and memory, consolidation of memory, intercortical transfer of learning, drugs that facilitate learning functions of neocortex, aphasia and allied disorders, cerebral dominance, frontal and temporal lobe in higher functions.

Unit V-Neurophysiologic basis of behavior & Neural Centers regulation

Neurophysiologic basis of behavior: Limbic system and hypothalamus, regulation of biologic rhythms, sexual behavior, fear and range, motivation, mechanism of sleep, Wakefulness and self stimulation.

Tools in electrophysiological studies of the brain in animals; Animal activity monitoring; Different types of mazes and their application in studies on behavior, learning and memory and cognitive aspects of animals; Rotarod; Grip strength meter; Pain sensitivity testing with the help of tail-flick instrument and paw test..

Neural Centers regulating visceral functions: Medulla oblongata in control of respiration heart rate and blood pressure, medullar, autonomic reflexes, hypothalamus and its relation to autonomic functions, Autonomic nervous system, basic characteristics of sympathetic and parasympathetic function, Chemical transmission of autonomic nerve endings, the autonomic reflexes.

BPT -404-(D1-D4) : Elective Group D : [one from the following]

D-1 Bioelectronics & Medical Instrumentation D-2 IPR, Bio-safety & Bioethics
D- 3. Molecular Modeling & Drug Designing

BPT -404 : Elective D-1: Bioelectronics & Medical Instrumentation

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit 1: Basic Electronics.

P-N Junction, Transistor characteristics, Transistor as Amplifier, Cascade Amplifiers, DC coupling, Field effect Transistors, Light sensitive semiconductor devices, Oscillators -Phase shift, Wein Bridge, Relaxation Oscillators, Operational Amplifiers, Circuits and characteristics of OP-Amplifiers in different configuration, Concept of Digital Electronics, Binary number system, Binary Arithmetic, Analog to Digital conversion, Digital to Analog conversion, Counters, Shift Resistors, Memory, Introduction to Microprocessor, CRO- Design Working and Applications**.**

Unit 2: Bioelectric Signal Monitoring and Recording.

Origin and Characteristics of Bioelectric signals & recording, Electrodes-types Design and properties and Utility, Skin contact impedance of Electrodes, noise suppression techniques, recording system, Medical Display systems, Patient Monitoring systems, Biomedical Telemetry, Computer Applications in medical field, Patient Safety**.**

Unit 3: Physiological Transducers.

Transducers and Measurement of Physiological event, Transducers- properties and the principle of Transducers, Resistive Transducers, Thermo resistors, Thermistors, Metallic strain gauges, Potentiometric Transducers magneto resistive transducers, piezoelectric transducers and their Biomedical applications, Inductive Transducers, Signal inducers, Mutual inducers, Capacitive Transducers, Biological capacitors, Signal Conditioners for Transducers, Transducer Amplifiers**.**

Unit 4: Diagnostic Equipments.

Principle, Working of Blood flow Meters, Pulmonary function analyzers, Blood gas analyzer, Oximeters, Audiometer.

Unit 5: Therapeutics Equipments.

Cardiac pace makers, Defibrillators, Hemodialysis machines, Short wave and Micro wave Diathermy, Ultrasonic Therapy, Pain relief through electrical stimulation, Surgical Diathermy, Laser, principle of operation, Types, Laser tissue interaction, Biomedical applications in surgery and therapy.

BPT -404 : Elective D-2: IPR, Biosafety & Bioethics

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit I : Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Unit II :Agreements and Treaties

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit III : Basics of Patents and Concept of Prior Art

Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENT Scope(WIPO), IPO, etc.)

Unit IV: Patent filing procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting–disclosure/non-disclosure; Financial assistance for patenting-introduction to existing schemes, Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

Unit V :Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; 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; Cartegana Protocol. Bioethics-Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

BPT -404: Elective D-3: Molecular Modeling & Drug Designing

[Total Marks: 100] [Exam Duration: 3 hrs] [Total Workload: 45hrs][Credits : 3]

Unit I Quantum mechanics and concepts in molecular modeling:

Concepts of Molecular Modeling, Coordinate System: Cartesian and Internal, Surfaces, Potential Energy Surfaces, introduction to quantum mechanics,postulates,Schrodinger wave equation, hydrogen molecule, Born-Oppenheimer approximation ,Molecular Graphics and Structure visualization, Applications of Molecular Graphics in Molecular Modeling.

UNIT II: Force Fields,Molecular mechanics &Energy Minimization

Force Fields. Molecular mechanics and Quantum mechanics, Empirical force field models ,thermodynamics properties using a force field, Features of Molecular mechanics force fields. Bond Stretching. Angle Bending. Torsion terms ,Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. and Local and Global energy minima. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Energy Minimization and Related Methods for Exploring the Energy Surface, Energy minimization by Systematic search, derived and non derived energy minimization method, 1st and 2nd order minimization methods, simplex – sequential univariate method, steepest descent method,conjugate gradient method, Newton-Raphson method, Applications of energy minimization,

Unit IV Molecular Dynamics & Monte Carlo Simulation

Introduction,Using single Model,time steps,Multiple steps,Setting up MD, energy conservation in MD Simulation Examples – Monte Carlo – Random number generation .

Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials. Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method,

Methods and simulations, Monte Carlo Simulation of Molecules , Models Used in Monte Carlo Simulations of Polymers. Molecular Modeling software: BIOSUITE , Conformational Search Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors. GROMACS and CNS. Difference between Molecular dynamics and Monte Carlo method

UNIT V: Structure Prediction and Drug Design

Sequence Alignment. Constructing and Evaluating a Comparative Model,Introduction to Comparative Modeling. Homology modeling:Comparative modeling of proteins, comparison of 3D structure, Homology- steps in homology modeling, tools, databases, side chain modeling, loop modeling. Protein Structure Prediction, Predicting Protein Structures by 'Threading',Modeling Drug – Receptor Interaction-Molecular Recognition by Receptor and Ligand Design, Ligand-Receptor Interaction, Binding site properties, Ligand Binding Prediction, The phramacophore concept, Binding Energy, Aqueous and Nonaqueous Solvent models.

Drug design: General approach to discovery of new drugs, lead discovery, lead modification, physiochemical principles of drug action, drug stereo chemistry, drug action, Structure based De Novo Ligand design, Chemo informatics – QSAR,3D database search,computer aided drug design,molecular modeling in drug design – Molecular Docking, AUTODOCK and HEX., structure based drug design, pharmacophores, QSAR

BPP-411:Lab Course-12: Practicals based on BPT-401- Bioinformatics & Computational Biology

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

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-412 : Lab Course-13: Practicals based on BPT-402 Radiation Biophysics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

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 LD_{50}.
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.
22. Modification of Radio sensitivity of Cell and Molecular system.

BPP-413 : Lab Course-14:Elective C-1: -Practicals based on Medical Biophysics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

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.
    d)
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 inhomogenity 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-413 : Lab Course-14:Elective C-2: -Practicals based on Genomics & Proteomics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. Approximately 45 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 15 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.

BPP-413 : Lab Course-14:Elective C-3: -Practicals based on Neurobiophysics

Part A

1. Experimental electrical stimulation in animals (rat/cat): Study of electrical stimulation of different portion of brain, by electrical stimulation and observation of changes in muscle tone, behaviour, heart. rate, respiration, blood pressure. Evaluation of electrolytic lesion.
2. Experimental chemical stimulation of brain: Microinjection of acetyl choline, epinephrine, nor-epinephrine, serotonin, histamine, kainic acid in different regions of brain and cerebral ventricles and study of changes in physiological parameters.
3. EEG and ECoG in experimental animals:Recording of spontaneous electrical activity of surface and deeper parts of brain of experimental animals in acute and chronic condition. Effect of stimulant and depressive drugs on ECoG.
4. Evoked potential study in experimental animals Recording of auditory and visual evoked potential in rats.
5. Study of experimental epilepsy rat.
6. Behavioural study in experimental animals:
   a) Exploratory behaviour in open fieid
   b) Exploratory behaviour in hole board
   c) Light dark transition test.
   d) Active social interaction test.
   e) pento barbital sleeping time
   f) Maze tests
7. Locomor movements in rats: Recording of locomotor movements in rats by Kymograph at rest and after injection of stimulant drug.
8. Study of neuroendocrine functions:
   a) Effect of stress on estrous cycle, ovary, adrenal, thyroid, pineal.
   b) Effect of lesion of different neural structure of endocrine function.
9. Studies of blood pressure and heart rate in experimental animals:
   a) Effect of bilateral carotid occlusion on blood pressure and heart rate in cats.
   b) Effect of stimulation of medullary pressure area on heart rate and blood Pressure

Part B

1. Steriotaxic technique lesioning of a specific brain area.
2. EEG recording of normal human subject in different states by multichannel recorder (BIOPAC).
3. Assessment of autonomic status by orthostatic tests and 15:30 ratio and E:I ratio.
4. Determination of Vo2 max by Queen's college test.
5. Determination of hearing threshold by audiometer.
6. Estimation of physiological active substance by HPLC.
7. ECG recording and interpretation
8. Determination of percentage of body fat and desired body weight
9. Estimation of Acid phosphates from rat testis.
10. Measurement of hormone by ELISA techniques

Part B Behaviour Biology

1. Automated exploratory behaviour recording using activity monitor
2. Assessment of neuromuscular function/performance using Grip Strength Meter
3. Studies on locomotory behaviour in rats
4. Studies on learning behaviour using T-maze
5. Studies on locomotory development like: pivoting, traversing, homing, etc.
6. Exploratory behavior of young and old rats

7. Maternal behaviour in rats and mice
8. Chemoreception in butterflies and houseflies
9. Avoidance behaviour in cockroach
10. Behaviour patterns in honeybee
11. Geotropism and phototropism
12. Nesting behavour in birds
13. Study of museum specimens for adaptations

BPP-414 : Lab Course-16 : Elective D-1:Practicals based on Bioelectronics and Medical Instrumentation

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. Introduction to Electrical & Electronic Components.
2. To study the different waveforms and their characteristics.
3. LDR, LED & photodiode characteristics.
4. Temperature sensors and their characteristics.
5. Operational Amplifier, Buffer, Adder& Sub tractors.
6. Frequency response of AC Amplifier using OP Amplifier.
7. Instrumentation Amplifier with Transducer Bridge.
8. Measurement of Pressure, Movement, Force, Frequency & Time using different transducers.
9. Principle of measurement of pH.
10. Principle of measurement of resistance/conductivity.
11. To study the Micro voltmeter.
12. To study the timer.
13. To study the Electronic pulse detector.
14. To study the Binary up/down counter.
15. To study the diode laser characteristics.

BPP-414 : Lab Course-16 : Elective D-2: -Practicals based on IPR, Biosafety & Bioethics

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. About 25-30 Case studies to be revealed and analyzed emphasizing the procedural aspects of IPR, biosafety & bioethics.
2. About 15-20 practicing mock exercises to be performed

BPP-414 : Lab Course-16 : Elective D-2: -Practicals based on Molecular Modeling and Drug Designing

[Total Marks: 50] [Exam Duration: 6 hrs] [Total Workload: 90hrs] [Credits: 3]

1. Model building of Biomolecules using CHEM SHETCH
2. Structural Analysis of Protein/Nucleic Acids
3. Conformational parameters for oligosaccharides/ polypetides
4. Homology modeling using SWISS-PDB
5. Energy minimization for protein/ carbohydrates – Schrödinger software
6. Molecular Dynamics for Protein/carbohydrates - Schrödinger software
   QSAR/STRUCTURE BASED DRUG DESIGN
7. Docking and binding site analysis - Schrodinger software
8. Combinatorial Screening of small molecules database – GOLD, ZINC

9. CORINA and SMILES for target molecule
10. Quantitative structure activity relationship and QSAR equation - Schrödinger software
11. Hydrogen bond interaction for Protein-Lead complex - Schrödinger software
12. Structure based inhibitor design - Molecular mechanics and Molecular dynamics calculation for Protein ligand (inhibitor) complex - Schrödinger software
13. Molecular Modeling and drug designing practical assignments using conventional latest software/freeware

BPSC: List of Service Courses :

BPSC-1 : Service Course: Bio- analytical Techniques

[Total Marks: 100] [Total Workload: 60hrs] [Credits: 4]

Unit 1 : Optical Techniques:[15 hrs.]

Microscopy : Basic principle in optics , Light & Electron Microscope- Principle ,Types, Instrument design ,Applications.
Polarimetry : Principle ,Types, Instrument design ,Applications.
Refractometry: Principle , Types, Instrument design ,Applications.

Unit 2 : Spectroscopic Techniques : [15 hrs.]

Basic principles of Spetroscopy , Colorimetry, Spectrophotometry, Fluorimetry ,IR Spectra, NMR &ESR Spectra, Atomic absorption & Flame Photometry: Principle , Instrument design and Applications.

Unit 3: Hydrodynamic Techniques: [15 hrs.]

Analytical and Preparative Centrifugation, Viscometry, Chromatography, Electrophoresis ,pH meter- Principle , Instrument design , Applications.

Unit 4: Immunotechniques : [15 hrs.]

Concept of Antigen, Antibody , Ag-Ab Interaction , Immuno-diffusion, Immunoelectrophoresis - Principle ,Types, Instrument design ,Applications.

BPSC- 2 : Service Course : Biophysics of Radiation

[Total Marks: 100] [Total Workload: 60hrs] [Credits: 4]

Unit 1 : Physicochemical aspects of Radiation:[15 hrs]

Basic Concepts of Radiation Science, Natural radiation background, Radioactivity phenomenon , Ionizing and Non-ionizing Radiations, Physical characteristics and interaction of radiation , Radiolysis of water ,free radical diffusion kinetics , photo- physical processes, quantum photo physical principles

Unit2 : Radiobiology: [15 hrs]

Consequences of radiation exposure in living systems, target theory , molecular and cellular effects of radiation ,somatic and genetic effects, LD_{50}, Radiation Syndrome, Radio tracer technique, radioisotopic applications in biology,medicine & agriculture

Unit 3 : Radiation measurements: [15 hrs]

Basic principle of radiation detection and measurements, Radiation units, Sources of radiations, Physical and Chemical dosimeters.

Unit 4 : Radiation Safety Measures : [15 hrs]

Natural and man made radiation exposures, radiation Hazards, Principles of radiation protection, dose equivalent units, radiation protection measures in different establishment, transportation and disposal of radioactive substances, Administrative and legislative aspect of radiation protection.

BPSC-3: Service Course: Biophysics in Medicine

[Total Marks: 100] [Total Workload: 60hrs] [Credits: 4]

Unit 1: Physiological Biophysics [15 hrs]

Biophysical Principles of Human Physiology, Structure and functions of heart, lungs,brain and kidney ,human sense organs.

Unit 2: Haematology and Hemodynamics [15 hrs]

Blood as a tissue- composition & function, Biophysical properties of plasma, blood viscosity, Blood clotting , Blood groups ,blood rheology, blood flow and dyanamic of circulation ,Blood analytical techniques, blood pressure &its measurements, pulse rate &its recording .

Unit 3: Electrophysiology [15 hrs]

Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG),Electro occulogram (EOG), - Principle , Instrument design , Clinical utility.

Unit 4: Medical imaging [15 hrs]

x-ray imaging, CT Scan , PET Scan , Angiography, MRI, Ultrasonography -- Principle , Instrument design , Applications.

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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, Wm.c.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 press.
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.
172. A.R.Leach, Molecular Modelling Principles and Application, Longman, 2001.
173 J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons,1997.
174 Satya Prakash Gupta, QSAR and Molecular Modeling,Springer-Anamaya Publishers, 2008.

175 Allan Hinchkliffe, Molecular Modeling for Beginners, Wiley Publisher, 2003
176 N. Claude Cohen, Guidebook on Molecular Modeling in Drug Design, Academic Press, 2006
177. R.K.Prasad, Quantum chemistry , Halsted Press, 2002 .

Text Books for Genomics & Proteomics

1. T.A. Brown, Genomes, 2nd edition, BIOS Scientific Publishers Ltd, 2002.
2. Marc R. Wilkins, Keith L. Williams, Ron D. Appel and Denis F. Hochstrasser Proteome Research: New Frontiers in Functional Genomics, Springer, 1997.

Reference books for Genomics & Proteomics

1. Greg Gibson, Spencer V. Muse, A primer of genome science, Sinauer associates Inc.Publishers, 2002.
2. David W. Mount, Bioinformatics: sequence and genome analysis, 2nd edition, CBS publishers, 2004.
3. Pennington, Proteomics from protein sequence to function, 2nd edition, Viva Books Ltd, 2002.

Reference Books for Neurubiophysics

1. Core Text Book of Neuroanatomy by Carpenter, MB
2. Test Book of Medical Physiology by AF Guyton
3. The Human Nervous System- Basic Principles of Neurobiology by Charles R. Noback and Robert J. Demarest.
4. Physiology by Ganong.
5. Principle of neuro science by Kandel,Shwartz
6. John A. Kierrnan, Barr's the Human Nervous System, 7th Edition, Lippincott-Raven, 1998.
7. Richard S. Snell, Clinical Neuroanatomy for the Medical Students, 5th Edition, Lippincott-Williams & Wilkins, 2001.
8. Susan Standring (Editor-in-Chief), Gray's Neuroanatomy: The Anatomical Basis of Clinical Practice, 39th Edition,Elsevier, 2005.
9. M.J.T. Fitzgerald, Clinical Neuroanatomy & Related Neuroscience, 4th Edition, CRC Press, 2000.
10. Water, J. Hendelman, Atlas of Functional Neuroanatomy, 2nd Edition, CRC Press, 2006.
11. Sanes, Development of the Nervous System, 2nd Edition, Academic Press, 2006.
12. Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.
13. Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.
14. Guilbert, Developmental Biology, 7th Edition, Sinaur Publication, 2006.
15. Siegel et al., Basic Neurochemistry, 6th Edition, Lippincott -Williams-Wilkins, 1999
16. Kandel et al., Principles of Neural science, 4 Edition, McGraw-Hill Medical, 2000.
17. Zegmond, Fundamentals of Neuroscience, 1st Edition, Academic Press, 1999
18 Bear: Neuroscience: Exploring the Brain, 2nd edition, Lippincott Williams & Wilkins, 2001

Texts/References for IPR,Biosafety,Bioethics

1.BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2.Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

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

http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

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 ……..

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The use of internet surfing for exploring the Latest Information should be compulsory to enrich the knowledge.

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