

**B.Sc. (Honors) Biophysics**  
**Under the Framework of Honors School System**  
**Choice Based Credit System**  
**Session 2019-20**

**PANJAB UNIVERSITY, CHANDIGARH**  
**OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR**  
**CHOICE BASED CREDIT SYSTEM B.Sc. (HONORS) BIOPHYSICS**  
**UNDER THE FRAMEWORK OF HONORS SCHOOL SYSTEM**  
**(SEMESTER SYSTEM) EXAMINATION, 2018-2019**

**OUTLINES OF TESTS**

**OBJECTIVE OF THE COURSE**

The course intends to teach the fundamental concepts of Biophysics and its applications. The syllabus pertaining to B.Sc. (Honors) Biophysics (3 Year course i.e. 6 Semesters) in the subject of Biophysics under Honors School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honors Biophysics.

**Semester I**

**CORE COURSES**

**Theory Papers:**

Core Course-1 (BPH-C1):	Biomolecules	100 Marks (4 credits)
Core Course-2 (BPH-C2):	Cell Biology	100 Marks (4 credits)

**Practicals:**

Core Course-1 Practical (BPH-C1 Lab):	Biomolecules	50 Marks (2 credits)
Core Course-2 Practical (BPH-C2 Lab):	Cell Biology	50 Marks (2 credits)

**GENERIC ELECTIVES**

**Theory Papers:**

Each student shall opt for two generic electives offered by the **other Departments** of Panjab University as:

Generic Elective -1 (GE1)	100 Marks (4 credits)
Generic Elective -2 (GE2)	100 Marks (4 credits)

**Practicals:**

Generic Elective -1 Practical (GE1 Lab)	50 Marks (2 credits)
Generic Elective -2 Practical (GE2 Lab)	50 Marks (2 credits)

**ABILITY ENHANCEMENT COMPULSORY COURSE**

**Theory Papers:**

BPH-AECC1: English	50 Marks (2 credits)
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**Generic Electives offered by Department of Biophysics in Semester I (For students of other departments)**

1. BPH-C-GE1: Human Physiology and Anatomy

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**Semester II**

**CORE COURSES**

**Theory Papers:**

Core Course-3 (BPH-C3):	General Microbiology	100 Marks (4 credits)
Core Course-4 (BPH-C4):	Molecular Biology	100 Marks (4 credits)

**Practicals:**

Core Course-1 Practical (BPH-C3 Lab):	General Microbiology	50 Marks (2 credits)
Core Course-2 Practical (BPH-C4 Lab):	Molecular Biology	50 Marks (2 credits)

**GENERIC ELECTIVES**

**Theory Papers:**

Each student shall opt for two generic electives offered by the **other Departments** of Panjab University as:

Generic Elective -3 (GE3)	100 Marks (4 credits)
Generic Elective -4 (GE4)	100 Marks (4 credits)

**Practicals:**

Generic Elective -3 Practical (GE3 Lab)	50 Marks (2 credits)
Generic Elective -4 Practical (GE4 Lab)	50 Marks (2 credits)

## ABILITY ENHANCEMENT COMPULSORY COURSE

### Theory Papers:

BPH-AECC2: Environmental Science 50 Marks (2 credits)

### Generic Electives offered by Department of Biophysics in Semester I (For students of other departments)

1. BPH-C-GE2: Radiation Biophysics and Biomedical Instrumentation

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### Semester III

#### CORE COURSES

### Theory Papers:

Core Course-5 (BPH-C5): Physics of Human Body 100 Marks (4 credits)

Core Course-6 (BPH-C6): Physicochemical Techniques 100 Marks (4 credits)

Core Course-7 (BPH-C7) Human Physiology and Anatomy I 100 Marks (4 credits)

### Practicals:

Core Course-5 (BPH-C5 Lab): Physics of Human Body 50 Marks (2 credits)

Core Course-6 (BPH-C6 Lab): Physicochemical Techniques 50 Marks (2 credits)

Core Course-7 (BPH-C7 Lab): Human Physiology and Anatomy I 50 Marks (2 credits)

#### GENERIC ELECTIVES

### Theory Papers:

Each student shall opt for one generic elective offered by the **other Departments** of Panjab University as:

Generic Elective -5 (GE5) 100 Marks (4 credits)

### Practicals:

Generic Elective -5 Practical (GE5 Lab) 50 Marks (2 credits)

## SKILL ENHANCEMENT COMPULSORY COURSE

Each student shall opt for one Skill enhancement compulsory course:

**Papers:**

BPH-SEC1: Biophysics: Industrial and Clinical Applications 50 Marks (2 credits)

BPH-SEC2: Human Genetics and its Applications 50 Marks (2 credits)

**Generic Electives offered by Department of Biophysics in Semester III (For students of other departments)**

2. BPH-C-GE3: Bioinformatics and Computational Biology

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**Semester IV**

**CORE COURSES**

**Theory Papers:**

Core Course-8 (BPH-C8): Human Physiology and Anatomy II 100 Marks (4 credits)

Core Course-9 (BPH-C9): Biophysical Chemistry 100 Marks (4 credits)

Core Course-10 (BPH-C10) Radiation and Biomedical Instrumentation 100 Marks (4 credits)

**Practicals:**

Core Course-8 (BPH-C8 Lab): Human Physiology and Anatomy II 50 Marks (2 credits)

Core Course-9 (BPH-C9 Lab): Biophysical Chemistry 50 Marks (2 credits)

Core Course-10 (BPH-C10 Lab): Radiation and Biomedical Instrumentation 50 Marks (2 credits)

**GENERIC ELECTIVES**

**Theory Papers:**

Each student shall opt for one generic electives offered by the **other Departments** of Panjab University as:

Generic Elective -6 (GE6) 100 Marks (4 credits)

**Practicals:**

Generic Elective -6 Practical (GE6 Lab) 50 Marks (2 credits)

**SKILL ENHANCEMENT COMPULSORY COURSE**

Each student shall opt for one Skill enhancement compulsory course:

**Papers:**

BPH-SEC3: Sports Medicine	50 Marks (2 credits)
BPH-SEC4: Soft Skills Development	50 Marks (2 credits)

**Generic Electives offered by Department of Biophysics in Semester III (For students of other departments)**

1. BPH-C-GE4: Biophysical Techniques

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**Semester V**

**CORE COURSES**

**Theory Papers:**

Core Course-11 (BPH-C11):	Radiation Biophysics	100 Marks (4 credits)
Core Course-12 (BPH-C12):	Bioinformatics and Computational Biology	100Marks (4 credits)

**Practicals:**

Core Course-11 (BPH-C11):	Radiation Biophysics	50 Marks (2 credits)
Core Course-12 (BPH-C12):	Bioinformatics and Computational Biology	50 Marks (2 credits)

**DISCIPLINE SPECIFIC ELECTIVES**

**Theory Papers:**

Each student shall opt for two Discipline Specific Elective courses:

Discipline Specific Elective course-1 (BPH-DSE1):		
	Cytology and Cell Physiology	100 Marks (4 credits)
Discipline Specific Elective course-2 (BPH-DSE2):		
	Biomedical Imaging	100 Marks (4 credits)
Discipline Specific Elective course-3 (BPH-DSE3):		
	Advanced Microscopy	100 Marks (4 credits)
Discipline Specific Elective course-4 (BPH-DSE4)		
	Biomaterials	100 Marks (4 credits)
Discipline Specific Elective course-5 (BPH-DSE5):		
	NeuroBiophysics	100 Marks (4 credits)

Discipline Specific Elective course-6 (BPH-DSE6):		
	Gene Organization and regulation	100 Marks (4 credits)
Discipline Specific Elective course-7 (BPH-DSE7):		
	Immunology	100 Marks (4 credits)
Discipline Specific Elective course-8 (BPH-DSE8)		
	Cell and Tissue culture Techniques	100 Marks (4 credits)

**Practicals:**

Discipline Specific Elective course-1 (BPH-DSE1):		
	Cytology and Cell Physiology	50 Marks (2 credits)
Discipline Specific Elective course-2 (BPH-DSE2):		
	Biomedical Imaging	50 Marks (2 credits)
Discipline Specific Elective course-3 (BPH-DSE3):		
	Advanced Microscopy	50 Marks (2 credits)
Discipline Specific Elective course-4 (BPH-DSE4)		
	Biomaterials	50 Marks (2 credits)
Discipline Specific Elective course-5 (BPH-DSE5):		
	NeuroBiophysics	50 Marks (2 credits)
Discipline Specific Elective course-6 (BPH-DSE6):		
	Gene Organization and regulation	50 Marks (2 credits)
Discipline Specific Elective course-7 (BPH-DSE7):		
	Immunology	50 Marks (2 credits)
Discipline Specific Elective course-8 (BPH-DSE8)		
	Cell and Tissue culture Techniques	50 Marks (2 credits)

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**Semester VI**  
**CORE COURSES**

**Theory Papers:**

Core Course-13 (BPH-C13):	Gene and Protein Engineering	100 Marks (4 credits)
Core Course-14 (BPH-C14):	Molecular Biophysics	100 Marks (4 credits)

**Practical Papers:**

Core Course-13 (BPH-C13):	Gene and Protein Engineering	50 Marks (2 credits)
Core Course-14 (BPH-C14):	Molecular Biophysics	50 Marks (2 credits)

**DISCIPLINE SPECIFIC ELECTIVES**

**Theory Papers:**

Each student shall opt for two Discipline Specific Elective courses:

Discipline Specific Elective course-1 (BPH-DSE1):		
	Cytology and Cell Physiology	100 Marks (4 credits)
Discipline Specific Elective course-2 (BPH-DSE2):		
	Biomedical Imaging	100 Marks (4 credits)
Discipline Specific Elective course-3 (BPH-DSE3):		
	Advanced Microscopy	100 Marks (4 credits)
Discipline Specific Elective course-4 (BPH-DSE4)		
	Biomaterials	100 Marks (4 credits)
Discipline Specific Elective course-5 (BPH-DSE5):		
	NeuroBiophysics	100 Marks (4 credits)
Discipline Specific Elective course-6 (BPH-DSE6):		
	Gene Organization and regulation	100 Marks (4 credits)
Discipline Specific Elective course-7 (BPH-DSE7):		
	Immunology	100 Marks (4 credits)
Discipline Specific Elective course-8 (BPH-DSE8)		
	Cell and Tissue culture Techniques	100 Marks (4 credits)

**Practical Papers:**

Discipline Specific Elective course-1 (BPH-DSE1):



Cytology and Cell Physiology	50 Marks (2 credits)
Discipline Specific Elective course-2 (BPH-DSE2):	
Biomedical Imaging	50 Marks (2 credits)
Discipline Specific Elective course-3 (BPH-DSE3):	
Advanced Microscopy	50 Marks (2 credits)
Discipline Specific Elective course-4 (BPH-DSE4)	
Biomaterials	50 Marks (2 credits)
Discipline Specific Elective course-5 (BPH-DSE5):	
NeuroBiophysics	50 Marks (2 credits)
Discipline Specific Elective course-6 (BPH-DSE6):	
Gene Organization and regulation	50 Marks (2 credits)
Discipline Specific Elective course-7 (BPH-DSE7):	
Immunology	50 Marks (2 credits)
Discipline Specific Elective course-8 (BPH-DSE8)	
Cell and Tissue culture Techniques	50 Marks (2 credits)

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### **EVALUATION**

1. There shall be one Mid Term Examination of 20% Marks (20 marks) in each semester.
2. End-semester examination will be of 80% of total marks (80 marks).
3. Each practical examination shall be of 3 hours duration.

#### **Pattern of end-semester question paper**

- (i) Nine questions in all will be set with equal weightage (16 marks). The candidate will be asked to attempt five questions.
- (ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
- (iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.
- (iv) Students will attempt one question from each unit and the compulsory question.

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## **PREAMBLE**

The Department of Biophysics at Panjab University was established in the year 1964 with a vision to strengthen the field of Basic Medical Sciences of Panjab University. It originated with Electro-Physiology, Radiation Biophysics and Electron Microscopy. Apart from the traditional areas in Biophysics such as Cell and Molecular Biophysics, Radiation Biophysics, Membrane Biophysics and Neuro-Biophysics, the Department had put in efforts in recent times to move into new emerging areas such as Molecular Modelling, Bioinformatics, Molecular Imaging, Translational research in Cancer, Molecular Medicine and Nuclear Medicine. Advances in these areas have paved a way for the designing and development of drugs and medical technologies for the welfare of mankind.

It is the only department in India, which offers both undergraduate and postgraduate courses in the discipline of Biophysics (Honors School). The department also offers excellent research opportunities leading to the award of Ph.D. degree. The courses being offered to three years B.Sc. (Honors School) and two years M.Sc. (Honors School) students in biophysics are planned in a way so as to provide a broad base in the subject and can be accepted in the diverse fields of biomedical sciences. The department is also actively involved in collaborations with other departments of various Universities/Institutes for multidisciplinary research.

World over, the alumni from this department have been appropriately employed and most of them have occupied coveted positions in the academia, industry, medical institutions, national laboratories and prestigious research institutions of India as well as abroad. In the last few years, around fifty alumni have been awarded doctoral as well as post doctoral fellowships in USA & Europe and even some have been able to secure professional positions in academia as well as in industry.

The department has been selected by UGC for Special Assistance Program (SAP) DSA-Phase-I based on its accomplishments in research and education. Moreover, the Department of Science and Technology (DST), Government of India also has accorded it with the status of "DST-FIST Supported Department" and PURSE grant. The department is also looking forward for a Public-Private Partnership Programme such as DBT-BIRAC, which supports research scheme to facilitate academia and industry collaboration.

## COURSE STRUCTURE

SEMESTER I		SEMESTER II	
<b>C1</b>	<b>BPH-C1: Biomolecules</b>	<b>C3</b>	<b>BPH-C3: General Microbiology</b>
<b>C2</b>	<b>BPH-C2: Cell Biology</b>	<b>C4</b>	<b>BPH-C4: Molecular Biology</b>
<b>AECC1</b>	<b>BPH-AECC1: English</b>	<b>AECC2</b>	<b>BPH-AECC2: Environmental Science</b>
<b>GE1*</b>		<b>GE3*</b>	
<b>GE2*</b>		<b>GE4*</b>	

SEMESTER III		SEMESTER IV	
<b>C5</b>	<b>BPH-C5: Physics of the Human Body</b>	<b>C8</b>	<b>BPH-C8: Human Physiology and Anatomy II</b>
<b>C6</b>	<b>BPH-C6: Physicochemical Techniques</b>	<b>C9</b>	<b>BPH-C9: Biophysical Chemistry</b>
<b>C7</b>	<b>BPH-C7: Human Physiology and Anatomy I</b>	<b>C10</b>	<b>BPH-C10: Radiation and Biomedical Instrumentation</b>
<b>SEC1</b>		<b>SEC2</b>	
<b>GE5*</b>		<b>GE6*</b>	

SEMESTER V		SEMESTER VI	
<b>C11</b>	<b>BPH-C11: Radiation Biophysics</b>	<b>C13</b>	<b>BPH-C13: Gene and Protein Engineering</b>
<b>C12</b>	<b>BPH-C12: Bioinformatics and Computational Biology</b>	<b>C14</b>	<b>BPH-C14: Molecular Biophysics</b>
<b>DSE1</b>		<b>DSE3</b>	
<b>DSE2</b>		<b>DSE4</b>	

**C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective**

**\*: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.**

**\*\*SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)**

1. BPH-SEC1: Biophysics: Industrial and Clinical Applications
2. BPH-SEC2: Human Genetics and its Applications
3. BPH-SEC3: Sports Medicine
4. BPH-SEC4: Soft Skills Development

**\*\*DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in semesters 5-6)**

1. BPH-DSE1: Cytology and Cell Physiology
2. BPH-DSE2: Biomedical Imaging
3. BPH-DSE3: Advanced Microscopy
4. BPH-DSE4: Biomaterials
5. BPH-DSE5: NeuroBiophysics
6. BPH-DSE6: Gene Organization and regulation
7. BPH-DSE7: Immunology
8. BPH-DSE8 : Cell and Tissue culture Techniques

**\*\*GENERIC ELECTIVE SUBJECTS (Offered by Biophysics Department) *for students of other departments***

1. BPH-C-GE1: Human Physiology and Anatomy
2. BPH-C-GE2: Radiation and Biomedical Instrumentation
3. BPH-C-GE3: Bioinformatics and Computational Biology
4. BPH-C-GE4: Biophysical Techniques

**\*\*Courses under these will be offered only if a minimum of 10 students opt for the same.**

**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester I**

## **BPH-C2: Cell Biology**

### **THEORY**

**Total Lectures: 60**

**Credits : 4**

*Objective: Cell Biology deals with every detail of a cell including structure, function (cell physiology) and chemistry.. It studies cell structure, cell composition, cell organelles and the interaction of cells with other cells and the larger environment in which they exist. The subject shall also provide an understanding of the survival strategies of organisms. The module on radiation biology will help to explore and gain insight into radiation-induced biological responses at molecular, cellular and tissue levels.*

#### **UNIT 1: The organization of Cell-I:**

**15 hrs**

*Introduction to Cell:* Discovery of Cell, Shape & Size of cell, General organization of prokaryotic and eukaryotic cells

*Structure, organization and functions of various organelles:*

*Plasma Membranes:* Theories regarding molecular architecture of plasma membranes. Chemical composition of biological membranes, structural specialization of the cell surface and basics of transport across the membranes.

*Nucleus:* Nuclear envelope- its structure, pore complex, nucleo-cytoplasmic interaction, nucleolus-structure and functions.

*Mitochondria:* Structure, role in cellular metabolism, biogenesis of mitochondrial RNA and DNA, intra-mitochondrial protein synthesis. Functions of mitochondria.

#### **UNIT 2: The organization of Cell-II:**

**15 hrs**

*Endoplasmic Reticulum:* Morphological organization of ER, role of ER in cellular differentiation, protein synthesis, intracellular transport. Non granular ER- occurrence, morphology and roles in cellular metabolism.

*Ribosomes-*nature of association with ER, distribution, macromolecular organization, origin and functions, protein synthesis

*Golgi complex:* Morphology, chemical composition, role in cell secretion and acrosome formation, relationship with other cell organelles, polysaccharide synthesis, protein sorting and export from the Golgi apparatus.

*Lysosomes:* Cytological and biochemical characterization of lysosomes, lysosome formation, lysosomal polymorphism in relation to cytolysis, role in cell aging, cell autophagy and phagocytosis.

*Peroxisomes:* Peroxisome assembly, biochemical characterization of peroxisomes, functions of peroxisomes, physiological role of peroxisomes.

### **UNIT 3: Tools and Techniques in Cell Biology**

**15 hrs**

Microscopy: Light microscopy, Phase contrast microscopy, Dark field microscopy, polarizing microscopy, confocal microscopy, Electron Microscopy, Flow cytometry & cell sorting, specimen preparation for light and electron microscopy, Microtomes and Embedding, shadow casting, Negative & Positive staining, Freeze drying and freeze substitution, Chemical basis of staining.

Cell Fractionation: Centrifugation- types of centrifuges, principle and different types of centrifuges, differential or gradient centrifugation.

### **UNIT 4: Introduction to radiation biology**

**15 hrs**

Introduction – Nuclear structure, stability of nuclide, Nuclear reactions. General properties of radiations, Radioactivity: Units of measurement of radioactivity; Curie, Becquerel and Rutherford, Roentgen, Rad, REM. Ionizing and non-ionizing radiation and their effects on biomolecules.

## **BPH-C2: Cell Biology**

### **PRACTICALS**

**Total Lectures : 30**

**Credits : 2**

1. To dissect animal and perform tissue fixation for histological processing
2. To perform dehydration and embedding of fixed tissue.
3. To carry out sectioning, stretching and slide preparation of a given sample.
4. To perform H&E staining of a given slide and differentiate between cell's nucleus and cytoplasm.
5. To demonstrate the principle and working of phase contrast microscope.
6. To demonstrate the principle and working of polarization microscope.
7. To measure the dimensions of different tissues, human hair, seminiferous tubule etc under light microscope using micrometry.

## SUGGESTED READING

1. Cell and Molecular Biology by E.D.P. De Robertis and E.M.F. De Robertis Jr. Publisher: Lea & Febiger; 8 Sub edition (June 1, 1987). ISBN-10: 0812110129, ISBN-13: 978-0812110128.
2. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
3. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.
4. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

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### Generic Electives

#### Offered by Department of Biophysics for Semester I

#### (For students of other departments)

1. BPH-C-GE1: Human Physiology and Anatomy

## **BPH-C-GE1 HUMAN PHYSIOLOGY AND ANATOMY**

### **THEORY**

**Total Lectures: 60**

**Credits : 4**

*Objective: Physiology deals with the understanding of functions and activities of living matter (as organs, tissues, or cells) and of the physical and chemical phenomena involved. This course will explore the functions associated with the major systems of human body particularly heart, blood circulation and urinary system. This course also includes the study of microscopic structures of tissues and organs.*

#### **UNIT 1: Microscopic anatomy of tissues in human body**

**15 hrs**

**Epithelial tissue:** Epithelial Tissue-electron-microscopic structure and various structural modifications

**Connective Tissue:** Basic composition of connective tissue. *Cartilage and bone:* Different types of cartilage and their structure, Macroscopic and microscopic structure of bone. Blood and its formed elements.



**Muscular tissue:** Skeleton muscle-histological organization, cytology of the muscle fibre, physiological properties and contractile mechanisms, Neuromuscular junction and molecular mechanism of muscle contraction, Smooth muscle-fine structure, cell to cell relations in smooth muscle, cardiac muscle-histological organization

**Nervous Tissue:** Neurons, distribution, forms and varieties of neurons, Synapse and the relationships of neurons, Nerve impulse, Mechanism of myelinations, Neuroglia

**UNIT 2: Blood circulation and Heart:**

**15 hrs**

The heart as a pump, cardiac cycle, cardiac contractility, rhythmic excitation of the heart, normal electro-cardiogram (ECG.), various method of recording ECG, vectoral analysis of ECG, Cardiac arrhythmias, cardiac pacemaker.

**UNIT 3: The Digestive system**

**15 hrs**

**Microscopic anatomy of digestive system:** Histological organization of esophagus, stomach, small and large intestine, liver, ultrastructure-details of hepatocytes and Kupffer cells. Bile canaliculi and sinusoids, Pancreas; Exocrine and endocrine tissue.

**Physiology of digestive system:** Movement of food and absorption, secretory function of alimentary canal, digestion and absorption in gut, liver and biliary system, gastro- intestinal disorders.

**UNIT 4: The Urinary system**

**15 hrs**

**Microscopic anatomy of urinary system:** Structural organization of Kidney, Submicroscopic structure of nephron including renal corpuscle, proximal convoluted tubule, loop of Henle, distal convoluted tubule. Cellular architect of glomerular filtration slits and Juxta glomerular complex.

**Physiology of Urinary system:** Urine formation, glomerular filtration, determinants of glomerular filtration rate, tubular function-reabsorption and secretion; regulation of urine concentration; regulation of ECF composition, ureter, urethra, urinary bladder, micturition.

**BPH-C-GE1: HUMAN PHYSIOLOGY AND ANATOMY  
PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. To evaluate total leukocyte count (TLC) in a given blood sample using heamocytometer.
2. To evaluate red blood cell count in a given blood sample using heamocytometer
3. To estimate glomerular filtration rate by measurement of creatinine clearance.
4. To evaluate bleeding time and clotting time in mouse and demonstrate effects of anti-coagulants
5. Extraction of muscular tissue from leg of cockroach leg and visualization under microscope.
6. Identification of histological features of various organs and tissues: kidney, urinary bladder, ureter, cardiac muscle, skeletal muscle, smooth muscle.
7. Preparation of serum from rat blood.
8. To perform tissue fixation for histological processing

**SUGGESTED READING**

1. Textbook of Medical Physiology (1956) 12<sup>th</sup> Edition Guyton, Arthur C.; Hall, John E. ; (Publisher)- Philadelphia:Saunders, Elsevier; ISBN-978-1-4160-4574-8/978-81-312-2703-9
2. Human Physiology An Integrated Approach (2007) 5<sup>th</sup> Edition Sliverthorn, Dee Unglaub; (Publisher) San Francisco: Pearson, ISBN-978-0-321-55980-7.
3. Histology (1988) Lesson, Thomas S.; Lesson, C. Roland and Paparo, Anthony A; (Publisher)- Philadelphia: W.B. Saunders; ISBN-978-0-721-62386-3.

**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester II**

**Generic Electives**

**Offered by Department of Biophysics for Semester II**

**(For students of other departments)**

1. BPH-C-GE2: Radiation and Biomedical Instrumentation

**BPH-C-GE2: RADIATION AND BIOMEDICAL INSTRUMENTATION  
THEORY**

**Total Lectures: 60**

**Credits: 4**

**Objectives:** *This paper is for the exposure of the students to the radiations, electronics and measurement of radiation and bio-potential signals.*

*Ionizing and non-ionizing radiation plays a important role for the diagnosis and therapy in medical sciences. The students are given exposure to the basic aspects of the ionizing radiations, units for the radiation exposure and their detection and measurements.*

*Electronic and bio-potential signal recording enable the students to learn the basic principles and circuits of amplifiers, control circuits, Electrodes and transducers used in biomedical recording systems like ECG, EEG, EMG, for diagnosis and therapy. The various topics covered in the course shall enable students to critically analyze and improve existing technologies and develop the next generation of devices.*

**Unit I: Basic Radiation Biophysics**

**15 Hrs**

Isotopes, Isobars, Isotones, Isomers, stability of nuclide, binding energy forces, radioisotopes, laws of radioactivity decay, Interaction of radiation with matter: Excitation and ionization, Photo electric effect, Compton effect, pair production, annihilation radiation, Radiation energy loss (Bremsstrahlung) and characteristic radiation. Range of  $\beta$  particles in air and tissues, half value thickness, linear and mass absorption coefficients, and linear energy transfer. General properties of alpha, beta and gamma radiations, decay process , parent-daughter relationship, metastable state and isomeric transistion, modes of beta decay, electron capture processes, internal conversion, Auger effect, positron emission,

Specific activity and carrier- free activity.

## **Unit II: Concepts of Radiation Measurement**

**15Hrs**

*Radiation units:* Units of measurement of radioactivity. curie, bacquerel and rutherford. Units of exposure, Roentgen, units of measurement of dose, roentgen equivalent physical, radiation absorbed dose Gray, relative biological effectiveness, roentgen equivalent man, Sievert, Dose equivalent, quality and modifying factors. Radiation dosimetry for external radioactive source and internally deposited radioactive source.

*Radiation detection and measurement:* Introduction to radioactivity measuring devices. Theory of ionization chambers, operational voltage, Gas multiplication, proportional counter, principle and working of GM counter, concept of dead time and recovery time, detection efficiency.

## **Unit III: Essential Electronics of Biomedical Instrumentation**

**15Hrs**

Measuring Devices: circuit, components and working of Digital multimeter and Oscilloscope.

Amplifiers: Hybrid parameters values of Common base, Common Emitter and Common collector transistors. Single stage common emitter amplifier, D.C. or Differential amplifier, Feedback fundamentals in amplifier. Operational amplifiers: Properties of Op AMP, Circuits employing Op AMP, amplification and measurement of Transducer signal, application of Op AMP to voltage and current control, to mathematical operations and switching circuits.

## **Unit IV: Electrodes and Biomedical Recorders**

**15 Hrs**

*Biomedical recorders:* Electrocardiography, Block diagram of electrocardiograph; The ECG leads, effects of artifacts on ECG recording, vector cardiography. Electroencephalography; Block diagram of EEG, Electrode locations, the normal EEG, clinical value of the EEG. Electromyography; Block diagram of EMG, clinical value of EMG. Electroretinography: Superconducting quantum interference device (SQUID).

*Electrodes,* Electrode- electrolyte interface. Charge distribution and potential at an electrode-electrolyte interphase, electrode potential, chloride silver electrode, potential of silver-silver chloride electrode, electrode impedance, electrode capacitance and resistance, current density consideration, impedance of chloride silver electrodes on subject, platinum electrode, electrodes for measuring bioelectric events, plate and disc types of electrodes, conducting-adhesive electrode, electrodes for exposed tissue, hypodermic needle electrodes.

**BPH-C-GE2: Radiation and Biomedical Instrumentation**

**PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. To measure the impedance of an electrode electrolyte interface and interpret the results using Warburg's model.
2. Setup the circuits of an operational amplifier (OPAMP) in the inverting and non-inverting configuration selecting different sets of the input and feedback impedances and measure the voltage gain. Verify the voltage gain with theoretical value.
3. Setup circuits of an operational amplifier (OPAMP) as an adder and as an integrator and verify the same experimentally and justify the results obtained.
4. Plot the G.M. plateau and find the operating voltage of the Geiger-Muller Counter. Discuss the obtained response in the light of theory.
5. Find the HVL of aluminum for the  $\beta$ -rays of given energy, emitted from a radioisotope using a Geiger Muller Counter.
6. Understand the working of the analog and the digital multimeters, in terms of Analog to digital signal converter, different controls available on the front panel and recording of a.c. from the mains and a step down transformer.
7. Measure given resistance, capacitance, output of a battery eliminator, a.c. output voltage from a step down transformer and check the working of a PN junction diode with the help of a digital multimeter.
8. Understand the functioning of an Oscilloscope, in terms of the controls available on its front panel, and the electronic circuit/principle for each control. Record the time for the signal sweep and verify the same in terms of Time./Div on the X scale.
9. Use an oscilloscope for the measurement of
  - a. Given a.c. voltage.
  - b. Output of a battery eliminator
  - c. Frequency of the given a. c. signal.
  - d. Record the electrical noise in the laboratory
10. Record the 12 Lead ECG of a subject. Analyse it for the QRS voltage and frequency. Compare the experimental values with that of a healthy adult.

11. Analyze a given ECG response, for the axis deviation. Comment on the outcome of the axis deviation observation.
12. Record the blood pressure of a subject. Comments on the observations.

### **SUGGESTED READING**

1. Intermediate Physics for Medicine and biology, Russel K Hobbie, John Willy & Sons, 2<sup>nd</sup> edition, 1988
2. Introductory Physics of Nuclear Medicine by Ramesh Chandra Lea & Febiger, 1992.
3. Radiation Dosimetry by Frank Herbert Attix, Wiley –Interscience Publication, John Wiley, 1986.
4. Handbook of Biomedical instrumentation, R.S.Khanpur, Tata Mc Graw Hill Publishing Company, 1st print – 1987 and 13<sup>th</sup> print -1998.
5. Principles of applied biomedical instrumentation, 3<sup>rd</sup> ed. by Geddes, L.A. and Baker, L.E., A Wiley Interscience Publication, 1989.
6. Principles of Electronic Instrumentation, A. James Diefenderfer, Saunders college Publishing, 1979.
7. Introduction to Biomedical Equipment Technology, by Joseph J. Carr and John M. Brown, Pearson Education, Inc., 2001.
8. Biomedical Instrumentation and Measurements, L Cromwell, F.J. Weibell & E.A. Pleifter, Prentice-Hall of India, 1998.
9. Medical Instrumentation, Application and Design. 3<sup>rd</sup> edition, John G. Webster, Editor 2001.

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**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester III**



### Semester III

#### BPH-C5: Physics of the Human Body

#### THEORY

**Total Lectures: 60**

**Credits : 4**

**OBJECTVES:** This course introduces the Physical Aspects of the Human Body . Human Body being a machine, works in coordination with various parts(organs). The course deals in a numerical or quantitative viewpoint explaining the concepts on a Macro level. To rise up Macro level, the assumptions of the microphysics (atoms form molecules that form cells that form organs) , and the basics of the anatomy & human physiology should be clear. This course covers the mechanics of human motion, fluid dynamics of blood flow through the mechanisms for speaking and hearing and the optical imaging system

#### **UNIT I: Terminology**

**15 hrs**

The Standard Human, and Scaling : Anatomical Terminology ,Motion in the Human Machine, The Standard Human , Scaling Relationships ; Allometric Rules , Scaling in the Senses Statics of the Body; Review of Forces, torques , and Equilibrium , Statics: Motion in One Plane and Levers , Statics in the Body ;The Lower Arm , Hip Problem, Statics of Other Synovial Joints , Lower Back Problems , Multisegment Modeling , The Sense of Touch , Diversion into the Units of Force and Pressure ; Force, Pressure

**Motion** : Kinematics and Musculature , Standing ; Stability, Forces on the Feet, Walking ; Kinematics, Muscular Action, Friction , Energetics , Review of Harmonic Motion, Pendulums, Moments Of Inertia, Ballistic (or Pendulum) Model Of Walking , Inverted Pendulum Model , Running ; Kinematics , Muscular Action , Jumping ; Vertical Jump , Pole Vault Throwing a Ball , Collisions of Human Body , Sustained Acceleration , Physics of Sports

**Mechanical Properties Of the Body** : Material Components of the Body ,Bone ,Ligaments and Tendons , Cartilage , Elastic Properties ; Basic Stress-Strain Relationships Other Stress-Strain Relations , Bone Shortening , Time-Independent Deviations in Hookean Materials , Static Equilibrium of Deformable Bodies ; Bending Of a Beam (or Bone) , Viscoelasticity in Bone , Bone Fractures  
Common Sports Injuries

**UNIT II**

**15 hrs**

**Muscles:** Skeletal Muscles In the Body , Types of Muscular Activity, The Structure of Muscles , Passive Muscles , Activating Muscles: Macroscopic View , Mechanical Model of the Active State of Muscles , The Effect Of Exercise , Muscle Fatigue , Coordination of Muscles , Active/Tetanized Muscles: Microscopic View , Total Muscle Tension , Everyday Proof Of the Limited Range Of Useful Muscle Length , Hill Force-Velocity Curve , The Sliding Filament Model : Nanoscopic View

**Fluid Pressure, Fluid Flow in the Body and Motion in Fluids :** Characteristic Pressures in The Body, Definitions and Units ,Measuring Pressure , Basic Physics of Pressure and Flow Of Fluids , Law of Laplace , Fluids in Motion ; Equation of Continuity ,Bernoulli's Equation , Interaction among The Flow Parameters, Viscous Flow and Poiseuille's Law , Diffusion , Motion Humans in Fluids , Swimming , Human Flight

**UNIT III**

**15 hrs**

**Cardiovascular System :** Overview of the Circulatory System ;Circulation ,Cardiac Cycle, Physics of Circulation System ,Properties of Blood ; Blood Pressure and Flow in Vessels , Capillaries and Osmotic Pressure , Work Done and Metabolic Needs of the Heart , Modeling the Circulatory System , Model of Heart and Overall Flow in the Circulatory System , The Arterial Pulse, Windkessel Model.

**UNIT IV**

**15 hrs**

**Sound, Speech , and Hearing :** The Physics of Sound Waves , The Speed and Properties of Sound Waves , Intensity of Sound Waves ,What happens when Sound Travels from one Medium to Another , Speech Production ; Types of Sounds ,Hearing , Other Vibrations of the Body ,Cardiac and Other Sources of Sounds.

**Light, Eyes, and Vision :** Structure of the Eye , Focusing and Imaging with Lenses , Image Formation, Scientific Basis of Imaging ,Combination of Lenses or Refractive Surfaces , Imaging and Detection by the Eye ,Transmission of Light In the Eye , The Eye as a Compound Lens , Accommodation , Field of View and Binocular Vision , Imperfect Human Vision , Correction of Vision by Eyeglasses, Contact Lenses , Other Means ,Types of Vision Impairment

**BPH-C5: Physics of the Human Body  
PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. To get accustomed to Sections of human body
2. To study skeletal system of human body including anatomical details
3. To measure the body parameter for a group of seven or more only female or Male candidate in a class and compare it with standard human parameters given in the book (Chapter 1., Physics of Human Body, Irving P. Herman, Publishers Springer, 2016).
4. To measure the Blood pressure using sphygmomanometer through manual and digital machines.
5. To verify the relationship between the weight of an object and the volume displaced by it.
6. To understand the morphology of human heart.
7. To solve numerical Exercises related to Statics and dynamics of Human Body. (Please note this part can form about 70% of the total experiments, as this helps the student to understand the Human body quantitatively, and helps to apply in the field of sports, Physiotherapy, Robotics etc.)

**SUGGESTED READING**

1. Physics of the Human Body by Irving P. Herman , Springer , ISSN 1618-7210
2. Biophysics by Hoppe, Lohman, Markl and Ziegler Springer; 2., völlig Neubearb. Aufl. Ed. 1982.
3. Intermediate Physics in Biology and Medicine by Hobbie, R.K., 3rd ed. 2001

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**BPH-C6: Physicochemical Techniques**

**THEORY**

**Total Lectures: 60**

**Credits: 4**

*Objectives: This course offers an understanding of the core biophysical biochemical processes of macromolecular separation and characterization. This includes the principles and applications of chromatography, viscosity, velocity sedimentation and ultracentrifugation. It also includes the*

*concepts and methodology of electrophoresis and different immunochemical techniques such as ELISA, RIA and immunoelectrophoresis.*

**UNIT I: Chromatography**

15 Hrs

Theory, operations and applications of Partition, Adsorption, Gel permeation, Ion exchange and Affinity chromatography, Chromatography on paper, thinlayer and column. Gas- liquid and high performance liquid chromatography techniques: hydrophobic interaction chromatography, covalent chromatography, Special techniques in the chromatography of Nucleic acids and of proteins that bind nucleic acids: DNA-cellulose chromatography, Hydroxyapatite chromatography.

**UNIT II: Hydrodynamic methods**

15Hrs

**Sedimentation:** Theory of velocity Sedimentation, preparative and analytical ultracentrifugation, factors affecting sedimentation velocity, sedimentation coefficient. Zonal centrifugation through pre-formed density gradient. Determination of molecular weight by sedimentation diffusion, sedimentation equilibrium (Archibald's method).

**Viscosity:** Theory and measurement of viscosity, Viscometers- Ostwald capillary, Ubbelohde capillary, examples of use of viscometry.

**UNIT III: Electrophoresis**

15Hrs

Theory and types of electrophoresis, operations and application of Electrophoresis. Zone electrophoresis, paper, cellulose acetate strip and gel electrophoresis. Sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE). Disc electrophoresis in polyacrylamide gels. Agarose gel electrophoresis. Electrophoretic transfer-Southern, Northern and Western.

**UNIT IV: Immunochemical methods**

15Hrs

Definitions in immunochemistry, The immunological system, Preparation of antibody, Antigen-antibody reaction, Immune reactions useful in bioassay- precipitin reaction, Immunodiffusion, complement fixation assay, Agglutination, Radioimmunoassay (RIA)- theory, operation and applications. Preparation of labelled antigen, Immunoradiometric assays (IRMA). Examples of immunological procedures used in bioassays, Enzyme-linked immunosorbent assay (ELISA). Fluorescent immunoassay. Protein-A immunoassay. Immunological technique for localizing

substances in cells, tissue and molecules—Fluorescent antibody and Ferritin conjugated antibody. Immunoelectrophoresis.

### **BPH-C6: Physicochemical Techniques**

#### **PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. Separation of the components of Sudan black B dye by Radial chromatography using different solvent systems and calculations of the Rf of the separated components.
2. Separation of the components of Sudan black B dye by paper chromatography.
3. Separation of the components of Sudan black B dye by thin layer chromatography using silica gel.
4. Separation of the components of Sudan black B dye by column chromatography.
5. Separation of amino acids by using ascending paper chromatography.
6. Demonstration of the Ouchterlony's double diffusion technique on glass slides.
7. To extract protein from a biological sample and separate them using SDS-PAGE
8. Demonstration of differential and density gradient centrifugation.

#### **SUGGESTED READING:**

1. Physical Biochemistry: applications to biochemistry and molecular biology by Friefelder, David; (Publisher)- New York: W.H. Freeman; {Edition-2nd(year -1982)}; *1st year of publication- 1935*
2. Biochemical Technique: theory and practice by Robyt, John F. and White, Bernard, J; (Publisher)- Monterey: Brooks/ Cole Pub.; *1st year of publication-1987*
3. Tools of Biochemistry by Cooper, Terrance G; (Publisher)- New York:Wiley-Interscience; *1st year of publication- 1942*
4. Physical Biochemistry: Principles and Applications by D. Sheehan Wiley, 2000

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**Semester III**  
**BPH-C7: HUMAN PHYSIOLOGY AND ANATOMY PART-I**  
**THEORY**

**Total Lectures: 60**

**Credits : 4**

*Objective: Physiology deals with the understanding of functions and activities of living matter (as organs, tissues, or cells) and of the physical and chemical phenomena involved. This course will explore the functions associated with the major systems of human body particularly heart, blood circulation and urinary system. This course also includes the study of microscopic structures of tissues and organs.*

**UNIT 1: Microscopic anatomy of tissues in human body**

**15 hrs**

**Epithelial tissue:** Epithelial Tissue-electron-microscopic structure and various structural modifications  
**Connective Tissue:** Basic composition of connective tissue. *Cartilage and bone:* Different types of cartilage and their structure, Macroscopic and microscopic structure of bone. Blood and its formed elements.

**Muscular tissue:** Skeleton muscle-histological organization, cytology of the muscle fibre, physiological properties and contractile mechanisms, Neuromuscular junction and molecular mechanism of muscle contraction, Smooth muscle-fine structure, cell to cell relations in smooth muscle, cardiac muscle-histological organization

**Nervous Tissue:** Neurons, distribution, forms and varieties of neurons, Synapse and the relationships of neurons, Nerve impulse, Mechanism of myelinations, Neuroglia

**UNIT 2: Blood circulation and Heart:**

**15 hrs**

The heart as a pump, cardiac cycle, cardiac contractility, rhythmic excitation of the heart, normal electro-cardiogram (ECG.), various method of recording ECG, vectoral analysis of ECG, Cardiac arrhythmias, cardiac pacemaker.

**UNIT 3: The Circulation**

**15 hrs**

Biophysics of Blood flow, blood pressure, Haemodynamics, Capillary dynamics and exchange of fluids between the blood and interstitial fluids, lymphatic system and edema. Diffusion through placental membrane. Pulmonary circulation, intrinsic regulation of the circulation, regulation of mean arterial pressure and hypertension, measurement of blood pressure and pressure transducer, cardiac output and venous return and their regulation, circulatory shock and its physiology, cardiac failure, heart sounds, coronary circulation, blood flow through specific area of body.

**UNIT 4: The Urinary system**

**15 hrs**

**Physiology of Urinary system:** Urine formation, glomerular filtration, determinants of glomerular filtration rate, tubular function-reabsorption and secretion; regulation of urine concentration; regulation of ECF composition, ureter, urethra, urinary bladder, micturition

**Microscopic anatomy of urinary system:** Structural organization of Kidney, Submicroscopic structure of nephron including renal corpuscle, proximal convoluted tubule, loop of Henle, distal convoluted tubule. Cellular architect of glomerular filtration slits and Juxta glomerular complex.

**BPH-C7: HUMAN PHYSIOLOGY AND ANATOMY PART-I  
PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. To evaluate total leukocyte count (TLC) in a given blood sample using hemocytometer.
2. To evaluate red blood cell count in a given blood sample using hemocytometer
3. To estimate glomerular filtration rate by measurement of creatinine clearance.
4. To evaluate bleeding time and clotting time in mouse and demonstrate effects of anti-coagulants
5. Extraction of muscular tissue from leg of cockroach leg and visualization under microscope.
6. Identification of histological features of various organs and tissues: kidney, urinary bladder, ureter, cardiac muscle, skeletal muscle, smooth muscle.
7. Preparation of serum from rat blood.
8. To perform tissue fixation for histological processing

**SUGGESTED READING**

1. Textbook of Medical Physiology (1956) 12<sup>th</sup> Edition Guyton, Arthur C.; Hall, John E. ; (Publisher)- Philadelphia:Saunders, Elsevier; ISBN-978-1-4160-4574-8/978-81-312-2703-9
2. Human Physiology An Integrated Approach (2007) 5<sup>th</sup> Edition Sliverthorn, Dee Unglaub; (Publisher) San Francisco: Pearson, ISBN-978-0-321-55980-7.
3. Histology (1988) Lesson, Thomas S.; Lesson, C. Roland and Paparo, Anthony A; (Publisher)- Philadelphia: W.B. Saunders; ISBN-978-0-721-62386-3.
4. Text book of Histology (1997) 2<sup>nd</sup> Edition Bloom, William & Fawcett, Don Wayne; (Publisher)- Philadelphia: W.B: Saunders; ISBN: 978-0412046919.

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**BPH-SEC1: Biophysics: Industrial and Clinical Applications**

**Total Lectures: 30**

**Credit: 2**

*Objective: There is a need for the skilled human resource and Industry, Hospitals and corporate sector and research trained in interdisciplinary science such as Biophysics. The course is designed in such a manner that it will introduce about the instrumentation used in Tertiary Hospitals, Pharmaceutical and related industry. Course is student centric, where the students carry field work, meet industrialist and other corporate employers, search relevant information from internet and develop broader outlook about employability beyond academia. Students after introductory classes will be divided into teams/Group of five to seven members, who will work as a team for the collection of data. To develop teamwork spirit all the members of a given team will get same marks. Comparison will be between the different teams based on the quality of documentation prepared by each team and the judgement of the faculty.*

**UNIT I: Hospitals**

**10 Hrs**

Physical biochemical & other principles of following instrumentation used in diagnostic and therapy in hospitals. Manufacturing of these instruments. Economic assessment for the installation, skilled human resource (manpower) requirement and the patient load for such instruments. Comparison between the developed economies (such as U.S.A., Europe, Australia) and the developing economies for Hospital services. Data collection of the instrumentation available in the hospitals and diagnostic centres in and around Chandigarh. Feedback about the manpower requirement from the hospitals.

Major instruments used in diagnosis/therapy in Hospital for systematic evaluation: Magnetic Resonance Imaging, Computer Aided Tomography, X-ray imaging, Fluoroscopy/Mammography, ultrasound, ECG, EEG, EMG.

Instrumentation in clinical Medicine: Haematological parameters and enzyme estimations, immunoassays (ELISA) and radio immune assay (RIA), .

**UNIT II: Pharmaceuticals and Biotechnology Industry**

**20 Hrs**

Case study about the pharmaceutical and Biotechnological industry in Baddi and Mohali and other industrial hubs in North India. Manufacturing process for drug and biotechnological products. Data collection about major pharmaceuticals manufactures (multinational companies) in India and its comparison with global presence. Case study (about two to five examples) about some IPR held by



pharmaceutical and Biotechnological industry. Economy of drug manufacturing and consumption, employability of biophysicists (Graduate & post graduate) in Pharmaceutical and Biotechnological industry.

**Development of Pharmacognosis in India:** Case studies about the biophysicists already working in the Pharmacognosis corporate sector such Parexal India Ltd. (Formally Quantum Solutions), Tata Consultancy Services, Spectra force etc..

References: The direct documentation on these topics is not available, therefore students will be encouraged to collect information from the internet by consulting the websites of the instrument manufacturers, pharmaceutical industry and the corporate sectors. Besides student

### **BPH-SEC2: Human Genetics and its Applications**

**Total Lectures: 30**

**Credits : 2**

*Objective: This syllabus introduces the fundamentals of genetics, focusing basic Mendelian genetics and the concept of gene mapping. The course provides overview of techniques involved in human genomics and proteomics, further, introducing genetic disorders and application of these techniques in diagnosis.*

#### **Unit 1: Over view of genomics and proteomics**

**15 Hrs**

Mendel's Laws of Inheritance and Genetic Linkage: Dominance, Recessiveness, and Segregation, Independent Assortment, Genetic Linkage and gene mapping

Polymerase chain reaction (PCR), DNA microarray and its analysis

Proteomics: Techniques for proteomics-2D gel electrophoresis, Differential in Gel electrophoresis (DIGE), Protein sequence databases and data analysis

#### **Unit 2: Molecular diagnostics and genetic disorders**

**15 Hrs**

PCR based diagnosis of various bacterial infections like tuberculosis, typhus, syphilis.

DNA fingerprinting as a forensic technique

Genetic disorders: Mendelian disorders, mutations, autosomal disorders, sex-chromosomal related disorders and their diagnosis.

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### **Generic Electives**

**Offered by Department of Biophysics for Semester III**

**(For students of other departments)**

1. BPH-C-GE3: Bioinformatics and Computational Biology

**BPH-C-GE3: Bioinformatics and Computational Biology**

**THEORY**

**Total Lectures : 60**

**Credits: 4**

*Objective:* The field of Bioinformatics is the science of designing and creating databases, softwares, computational and statistical tools for research in life sciences. Today, the quantity of biological data accumulated by laboratories is daunting. As a result, the data can no longer be dealt with ‘manually’ and **bioinformatics** has become an essential ally. Computational Biology refers to the hypothesis based investigation of a biological problem with the primary goal of discovery and advancement of knowledge. The course contents have been carefully designed to introduce the undergraduate students to this upcoming field.

**UNIT 1: Computer Fundamentals and Bioinformatics**

**15 hrs**

**Introduction to Bioinformatics:** Overview, History and need of bioinformatics technology.

**Computer Fundamentals:** Block Structure of a computer, characteristics of computers, classification of computers- digital and analogue computers, Input, output and Memory.

**Languages, Flowcharts and Operating Systems:** Machine level languages, assembly level languages, high level languages. Computer algorithms and flowcharts. Operating Systems- DOS, windows 98/XP/VISTA, UNIX/LINUX, Mac OS, VMS.

**Modern Computers:** Workstations, parallel processing computers, supercomputers. Internet and Related Programmes: WWW, HTML, HTTP, telnet, FTP, computer domain.

**UNIT 2: Biological Databases**

**15 hrs**

**Introduction:** Types of Databases (with examples) - primary, secondary and composite databases, Public and proprietary databases.

**Sequence databases:** Nucleotide Sequence databases: GenBank, EMBL, DDBJ, Protein sequence database- Uniprot, SWISSPROT/TrEMBL, PIR.

**Molecular Structure Databases:** Protein Data Bank (PDB), SCOP, CATH. Understanding the structure of each database and using it on the web.

**Introduction to sequence file data formats:** FASTA, Genbank flatfile. Sequence Retrieval: Entrez and SRS.

### **UNIT 3: Sequence Alignment and Analysis**

**15 hrs**

**Sequence analysis:** Introduction to sequence alignment and its applications. Notion of homology: Orthologues, Paralogues, Analogues. Identity, homology and similarity with reference to evolutionary relationships.

**Pair wise sequence alignment:** Concept of global and local alignment, Dot Plot, Algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods), Substitution matrices- PAM and BLOSSUM.

**Multiple sequence alignment:** Basic concepts and applications. Consensus sequence, Motifs, BLOCKS, Profiles.

**Tools for Similarity Search:** BLAST: concepts & algorithm, applications and significance, Salient features of various BLAST versions: BLASTp, BLASTn, BLASTx, tBLASTn, tBLASTx, PSI and PHI BLAST. FASTA & its algorithm. ClustalW, Toffee; Position specific scoring matrices.

### **UNIT 4: Structural Bioinformatics**

**15 hrs**

**Protein Structure Prediction:** Concepts and strategies of protein structure prediction, methods of secondary structure prediction and methods of protein tertiary structure prediction.

**Introduction to Molecular Modelling:** Molecular Mechanics and Molecular Dynamics concepts, potential energy functions, potential energy surface, energy minimization, local and global minima, saddle point, grid search. Molecular modelling packages.

**Drug Design:** Introduction to Molecular docking, Computer Aided Drug Design and Drug Discovery:

**Basic Structure visualization and Building tools:** RasMol, Swiss PDB Viewer.

## **BPH-C-GE3: Bioinformatics and Computational Biology**

### **PRACTICALS**

**Total Lectures : 30**

**Credits : 2**

1. Introduction to basic Linux commands.
2. Building amino acids and Peptides
3. An overview of proteins and amino acids using RasMol.
4. Peptide bonds; Ramachandran plots; peptides and secondary structure
5. Using the PDB database and understanding PDB file format
6. Sequence Alignment using BLAST.
7. Sequence Alignment using ClustalW.

**SUGGESTED READING**

1. Bioinformatics Basics: Applications in Biological Science and Medicine 2005) 2<sup>nd</sup> Edition, Lukas K. Buehler, Hooman H. Rashidi, Taylor and Francis, ISBN 9780849312830.
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Springer Harbor Lab Press, 2001.
3. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press, 2008.
4. Introduction to Bioinformatics by T.K. Attwood, D.J. Parry-Smith, PHI-2000.
5. An introduction to protein informatics by Karl-Heinz Zimmermann, Springer.
6. Molecular Modelling: Principles and Applications by Andrew R. Leach, Addison Wesley Longman.

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**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester IV**

**Semester IV**  
**BPH-C8 HUMAN PHYSIOLOGY AND ANATOMY PART-II**  
**THEORY**

**Total lectures: 60**

**Credits: 4**

**Objective:** Physiology deals with the understanding of functions and activities of living matter (as organs, tissues or cells) and of the physical and chemical phenomena involved. This course will explore the functions associated with the major systems of human body particularly the respiratory system and the digestive system. Temperature regulation and the study of microscopic structures of tissues and organs.

**UNIT 1: Reproductive System**

**15 Hrs**

Male Reproductive System: Testis, seminiferous tubules, spermatogenesis, spermiogenesis and interstitial cells, epididymis, vas deferens.

Female Reproductive System: Ovary, oviduct, follicles, ovulation and corpus luteum. Uterus-endometrium and myometrium, endometrial changes during menstruation and pregnancy. Placenta.

Endocrine System: Microscopic structure, functional aspect of Pituitary gland, hypothalamus, thyroid gland, parathyroid gland, adrenal gland and pineal gland.

**UNIT 2: Digestion**

**15 Hrs**

Histological organization of stomach, small and large intestine and liver, movement of food and absorption, secretory function of alimentary canal, digestion and absorption in gut, liver and biliary system, gastro- intestinal disorders.

**UNIT 3: Respiratory System**

**15 Hrs**

Respiratory structure of lungs, pulmonary ventilation, physical principle of gaseous exchange, transport of oxygen and carbon dioxide in blood and body fluids, regulation of respiration.

**UNIT 4: Temperature Regulation**

**15 Hrs**

Body temperature and Homeostasis.

Physiology of deep sea diving, high altitude and space physiology: Effect of high pressure and decompression on diver, hyperbaric oxygen therapy, effect of low oxygen pressure during space flight.

**BPH- C8: HUMAN PHYSIOLOGY AND ANATOMY PART- II**  
**PRACTICALS**

**Total lectures: 30**

**Credits: 2**

1. To determine surface tension of Bronchoalveolar lavage fluid (BALF) and compare with the given set of standard solutions.
2. To demonstrate the inflammatory response elicited by carrageenan as a function of time by Paw edema test.
3. To demonstrate blood pressure measurement using Auscultatory method and to demonstrate the change after exercise.
4. To evaluate the reproductive potential of male mouse in terms of sperm concentration and sperm motility, and to observe the changes in both the parameters after heat shock to testis (42°C).
5. Identification of histological features of various organs viz, lungs, stomach, intestine, liver, testis and ovaries.
6. To evaluate the various lung capacities and peripheral oxygen saturation using respirometer and oxymeter respectively and to demonstrate the changes after exercise.

**SUGGESTED READING:**

1. Textbook of medical physiology (1956) 12<sup>th</sup> edition Guyton, Arthur C.; Hall, John E.; (PUBLISHER)- Philadelphia: Saunders, Elsevier; ISBN-978-1-4160-4574-8/978-81-312-2703-9
2. Human Physiology an integrated approach (2007) 5<sup>th</sup> edition Sliverthorn, Dee Unglaub; (publisher) San Francisco: Pearson, ISBN-978-0-321-55980-7.
3. Histology (1988) Lesson, Thomas S, Lesson C, Roland and Paparo, Anthony A. (Publisher)- Philadelphia: W. B. Saunders; ISBN- 978-0-721-62386-3.

4. Text book of histology (1997) 2<sup>nd</sup> edition, Bloom, William and Fawcett, Don wayne; (publisher) Philadelphia: W. B. Saunders; ISBN- 978-0412046919.

## Semester IV

### BPH-C9: Biophysical Chemistry

#### THEORY

**Total Lectures: 60**

**Credits : 4**

*Objective: This course provides an introduction to the biophysical aspects of bio-macromolecules primarily proteins and nucleic acids. It highlights the physical and chemical properties of amino acids, proteins, nucleotides and nucleic acids. The course also provides insights on metabolic pathways and cellular energetics.*

#### **UNIT 1: Amino Acids and Proteins**

**15 hrs**

**Amino Acids:** Structure and classification of amino acids, ionization- pK, Values, chemistry of peptide bond, non-ribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids.

**Peptide and Protein conformational analysis:** Configuration and Conformation, Definition of a peptide, peptide unit, peptide group, bond length, cis and trans conformation, Ramachandran Plot, primary structure, secondary structure –helices, beta sheets, random coil, turns- reverse turn and beta bends, Fibrous Proteins- alpha keratin and collagen triple helix, tertiary and quaternary structures (with examples).

#### **UNIT 2: Protein structure and Stability**

**15 hrs**

**Molecular Interactions in Proteins:** Types of intra and inter-molecular forces that stabilize proteins and their characteristics – hydrophobic effect, electrostatic interactions, disulfide bonds, ion-dipole, dipole-dipole, dipole-induced dipole and dispersion (London) forces, hydrogen bond (intra-molecular and inter-molecular), effect of inter/intra- molecular forces on structure of different biomolecules. Protein denaturation and renaturation.

**Protein Folding Pathways** - molten globule, folding funnel. Diseases caused by protein misfolding.



**Tools and Techniques:** Protein purification, Protein Sequencing, Edman Degradation, Peptide Syntheses: Solution and solid phase peptide synthesis.

**UNIT 3: Cellular energetic and metabolic pathways**

**15 hrs**

**Metabolism:** Overview of metabolism, catabolism, anabolism, bioenergetics and thermodynamic considerations – Gibbs free energy, enthalpy, entropy, Characteristics of metabolic pathways, types of reactions and control of metabolic flux, High energy compounds, Electron Carriers

**Overview of major metabolic pathways:** Glycolysis, Krebs's cycle, oxidative phosphorylation, Urea cycle, ATP synthesis.

**Metabolic Pathways Databases:** EcoCyc, MetaCyc, BioCyc, KEGG, Reactome, BRENDA

**UNIT 4: Nucleic Acids**

**15 hrs**

**Nucleotide structure and properties:** Introduction to DNA, RNA, bases, sugars, phosphates. Structure of nucleoside, nucleotide, polynucleotide and their nomenclature. Tautomerisation and Ionization. Chargaff's rule. Stereochemistry- nucleoside torsion angles, ribose puckering.

**DNA structure:** Different types of DNA and their structure, DNA polymorphism –A, B and Z forms, DNA motifs, repeats and their significance, function and stability. DNA supercoiling, denaturation and renaturation of DNA, thermal denaturation and  $T_m$  value.

**RNA structure:** structure and properties, different forms of RNA, structure and properties of tRNA.

**BPH-C9: Biophysical Chemistry**

**PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. Introduction to Primary and Secondary Solutions.
2. Preparation of buffers – phosphate buffer, acetate buffer
3. Study the  $pK_1$  and  $pK_2$  of Glycine.
4. Study the isoelectric point of Casein.
5. Separation of albumins and globulins from serum sample
6. Study the absorption spectra of dyes

7. Study thermal effect or effect of high urea on the enzymatic activity of potato catalase enzyme.
8. To study cellular respiration-aerobic and anerobic in yeast.

### SUGGESTED READING

1. Biophysical Chemistry (I & III) (2004) Cantor, Charles, R., and Schimmel, Paul, R., San Francisco: W.H. Freeman & Co. **ISBN-10:** 0716711885/**ISBN-13:** 978-0716711889.
2. Proteins: Structure and Molecular Properties (1993) 2<sup>nd</sup> Edition Creighton, Thomas E; (Publisher)- New York: W.H. Freeman; **ISBN-10:** 071677030X/**ISBN-13:** 978-0716770305.
3. Biochemistry (2010) 4<sup>th</sup> Edition Voet, Donald; Voet, Judith G.; (Publisher) - Hoboken: John Wiley; **ISBN-10:** 0470917458/**ISBN-13:** 978-0470917459.
4. Physical Chemistry-principles and applications in Biological Sciences, (2001) 4<sup>th</sup> Edition Tinoco, Ignacio and others; (Publisher)- Upper Saddle River: Prentice- Hall; **ISBN-10:** 013095943X/**ISBN-13:** 978-0130959430.
5. Principles of Physical Biochemistry (2005) 2<sup>nd</sup> Edition Van Holde, Kensal Edward; Johnson, W.Curtis & Shing Ho, P.S.; (Publisher)- Upper Saddle River: Pearson Education; ISBN 0-13-046427-9.

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### **BPH-C10: Radiation and Biomedical Instrumentation**

#### **THEORY**

**Total Lectures: 60**

**Credits : 4**

**Objectives:** *This paper is for the exposure of the students to the radiations, electronics and measurement of radiation and biopotential signals.*

*Ionizing and non-ionizing radiation plays a important role for the diagnosis and therapy in medical sciences. The students are given exposure to the basic aspects of the ionising radiations, units for the radiation exposure and their detection and measurements.*

*Electronic and biopotential signal recording enable the students to learn the basic principles and circuits of amplifiers, oscillators, control circuits, Electrodes and transducers used in biomedical recording systems like ECG, EEG, EMG, for diagnosis and therapy. The various topics covered in the*

course shall enable students to critically analyze and improve existing technologies and develop the next generation of devices.

### **Unit I: Basic Radiation Biophysics**

**15 Hrs**

Isotopes, Isobars, Isotones, Isomers, stability of nuclide, binding energy forces, radioisotopes, laws of radioactivity decay, Interaction of radiation with matter: Excitation and ionization, Photo electric effect, Compton effect, pair production, annihilation radiation, Radiation energy loss (Bremsstrahlung) and characteristic radiation. Range of  $\beta$  particles in air and tissues, half value thickness, linear and mass absorption coefficients, backscatter and self absorption, specific ionization and linear energy transfer. General properties of alpha, beta and gamma radiations, decay process, parent-daughter relationship, metastable state and isomeric transition, modes of beta decay, electron capture processes, internal conversion, Auger effect, positron emission, Specific activity and carrier-free activity.

*Radiation units:* Units of measurement of radioactivity. curie, becquerel and rutherford. Units of exposure, Roentgen, units of measurement of dose, roentgen equivalent physical, radiation absorbed dose Gray, relative biological effectiveness, roentgen equivalent man, Sievert, Dose equivalent, quality and modifying factors. Radiation dosimetry for external radioactive source and internally deposited radioactive source.

### **Unit II: Radiation Detection and Measurement**

**15Hrs**

Introduction to radioactivity measuring devices. Theory of ionization chambers, operational voltage, Gas multiplication, proportional counter, principle and working of GM counter, concept of dead time and recovery time, detection efficiency.

Detectors: Properties of a scintillation NaI(Tl) detector: Intrinsic efficiency, geometric efficiency, Resolving time, High voltage power supply, Energy resolution, FWHM. Scintillation counters: scintillator, Preamplifier, Voltage amplifier, Pulse-Height Analyzer, low level discriminators, Multi-channel analyzer Scaler, Rate meter & gamma spectrum, response to monochromatic gamma rays, response to gamma rays of two energies, Compton valley, plateau characteristics, x ray peaks, back scatter peak, Iodine Escape Peak, Annihilation peak, coincidence peak & summation of peaks, bismuth germanate detectors, barium fluoride detector, orthosilicate detectors (LSO), Basic components, Intrinsic efficiency, Geometric efficiency, well type counters, principles and working of liquid scintillation counters. primary solute, secondary solute (Wavelength shifter) Quenching -Internal standard method, external standard method.

**Unit III: Essential Electronics of Biomedical Instrumentation**

**15Hrs**

Measuring Devices: circuit, components and working of Digital multimeter and Oscilloscope.

Design of DC power supply from ac source using rectifier, filter and zener diode as voltage regulator.

Amplifiers: Thevenin's and Norton's equivalent circuit theorems. Hybrid parameters equivalent circuit of Common base, Common Emitter and Common collector transistors. Cascade amplifier, D.C. or Differential amplifier, Feedback fundamentals in amplifier, Amplifier coupling methods. Operational amplifiers: Properties of Op AMP, Circuits employing Op AMP, amplification and measurement of Transducer signal, application of Op AMP to voltage and current control, to mathematical operations and switching circuits.

*Oscillators*: Phase shift, Wein bridge; relaxation oscillators, feedback oscillators, Colpitts and Hartley oscillators.

Transducers: Resistive transducers; Thermoresistors, thermistors. Metallic strain gauges, Potentiometric transducers, magneto-resistive transducer, and their biomedical applications. Inductive transducer; Single and mutual inductance based transducers and their biomedical applications, Capacitive transducer; capacitive transducers and their biomedical applications.

**Unit IV: Electrodes and Biomedical Recorders**

**15 Hrs**

*Biomedical recorders*: Electrocardiography, Block diagram of electrocardiograph; The ECG leads, effects of artifacts on ECG recording, vector cardiography. Electroencephalography; Block diagram of EEG, Electrode locations, the normal EEG, clinical value of the EEG. Electromyography; Block diagram of EMG, clinical value of EMG. Electroretinography: Superconducting quantum interference device (SQUID).

*Electrodes*, Electrode- electrolyte interface. Charge distribution and potential at an electrode-electrolyte interphase, electrode potential, chloride silver electrode, potential of silver-silver chloride electrode, electrode impedance, electrode capacitance and resistance, current density consideration, impedance of chloride silver electrodes on subject, platinum electrode, electrodes for measuring bioelectric events, plate and disc types of electrodes, conducting-adhesive electrode, electrodes for exposed tissue, hypodermic needle electrodes.

## **PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. Establish the circuit for the common base NPN/PNP transistor with appropriate voltages and verify that the collector current is close to the emitter current.
2. Establish the circuit for the common emitter NPN/PNP transistor with appropriate voltages. Draw the input characteristics. Draw the output characteristics. From the output characteristics select the operating point so that maximum voltage gain without distortion of the input signal, can be obtained.
3. Setup the circuit for the astable multivibrator. Measure its oscillation frequency and compare it with the theoretical frequency. Do the experiments for three sets of components.
4. Setup circuits for the Hartley and Colpitt Oscillators. Measure the oscillation frequency of the same and compare it with the calculated value. Do the experiment for two set of components. Do the experiment for two set of components, in the feedback loop.
5. Setup circuits for the Wein Bridge and the RC Phase shift Oscillators. Measure the oscillation frequency of the same and compare it with the calculated value. Do the experiment for two set of components, in the feedback loop.
6. Setup the circuits of an operational amplifier (OPAMP) in the inverting and non-inverting configuration selecting different sets of the input and feedback impedances and measure the voltage gain. Verify the voltage gain with theoretical value.
7. Setup circuits of an operational amplifier (OPAMP) as an adder and as an integrator and verify the same experimentally and justify the results obtained.
8. Setup the circuit for the series LCR network. Determine the resonance frequency and compare it with the calculated one, for the chosen L, C, and R. Repeat the experiment for a different set of L, C, and R values. Justify the results obtained.
9. Setup the circuit for the parallel LCR network. Determine the resonance frequency and compare it with the calculated one, for the chosen L, C, and R. Repeat the experiment for a different set of L, C, and R values. Justify the results obtained.

10. Plot the G.M. plateau and find the operating voltage of the Geiger-Muller Counter. Discuss the obtained response in the light of theory.
11. Find the HVL of aluminum for the  $\beta$ -rays of given energy, emitted from a radioisotope using a Geiger Muller Counter.
12. Understand the working of a analog and a digital multimeter, in terms of Analog to digital signal converter, different controls available on the front panel and recording of a.c. from the mains and a step down transformer.
13. Measure given resistance, capacitance, output of a battery eliminator, a.c. output voltage from a step down transformer and check the working of a PN junction diode with the help of a digital multimeter.
14. Understand the functioning of an Oscilloscope, in terms of the controls available on its front panel, and the electronic circuit/principle for each control. Record the time for the signal sweep and verify the same in terms of Time./Div on the X scale.
15. Record the 12 Lead ECG of a subject. Analyse it for the QRS voltage and frequency. Compare the experimental values with that of an healthy adult.
16. Analyse a given ECG response, for the axis deviation. Comment on the outcome of the axis deviation observation.
17. Record the blood pressure of a subject. Comments on the observations.
18. Use an oscilloscope for the measurement of
  - e. Given a.c. voltage.
  - f. Output of a battery eliminator
  - g. Frequency of the given a. c. signal.

### **SUGGESTED READING**

1. Intermediate Physics for Medicine and biology, Russel K Hobbie, John Willy & Sons, 2<sup>nd</sup> edition, 1988
2. Introductory Physics of Nuclear Medicine by Ramesh Chandra Lea & Febiger, 1992.
3. Radiation Dosimetry by Frank Herbert Attix, Wiley –Interscience Publication, John Wiley, 1986.

4. Handbook of Biomedical instrumentation, R.S.Khanpur, Tata Mc Graw Hill Publishing Company, 1st print – 1987 and 13<sup>th</sup> print -1998.
5. Principles of applied biomedical instrumentation, 3<sup>rd</sup> ed. by Geddes, L.A. and Baker, L.E., A Wiley Interscience Publication, 1989.
6. Principles of Electronic Instrumentation, A. James Diefenderfer, Saunders college Publishing, 1979.
7. Introduction to Biomedical Equipment Technology, by Joseph J. Carr and John M. Brown, Pearson Education, Inc., 2001.
8. Biomedical Instrumentation and Measurements, L Cromwell, F.J. Weibell & E.A. Pleifter, Prentice-Hall of India, 1998.
9. Medical Instrumentation, Application and Design. 3<sup>rd</sup> edition, John G. Webster, Editor 2001.

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### **BPH-SEC3: SPORTS MEDICINE**

**Total Lectures: 30**

**Credits: 2**

#### **UNIT I:**

##### **APPLIED GENERAL CLINICAL ANATOMY**

Anatomy of Nerve Injuries, anatomical angles and stiff joints, anatomical disturbances in various bone pathologies, anatomy of certain diseases- headache, sciatica, dislocation, hernias, low back pain, lesions of inter-vertebral discs, abscesses of the spine.

##### **BLOOD AND CARDIOVASCULAR SYSTEM**

Various components of blood, viscosity correlation, oxy-hemoglobin dissociation curves, inter-relationship between pressure flow and resistance, pressure volume curves, physical characteristics of systemic circulation, oxygen demand theory, nervous control of blood circulation, hypertension, cardiac output and its regulation, coronary blood flow, ischemic heart disease, physiological basis of shock.

#### **UNIT II:**

##### **NEUROMUSCULAR SYSTEM**

Basic physics of membrane potential, recording of membrane potential and action potential with electromyogram, mechanism of muscle contraction, neural control of movement.

## RESPIRATORY SYSTEM

Mechanics of respiration, pulmonary volumes, composition of alveolar air, transport of oxygen and carbon dioxide, regulation of respiration, respiratory abnormalities, regulation of body temperature.

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### BPH-SEC4: Soft Skills Development

**Total Lectures: 30**

**Credits: 2**

*Objective: The focus of the course is to develop a wide variety of soft skills starting from communication, to working in different environments, learning creative and critical decision making, developing awareness of how to work with and negotiate with people. The key areas addressed are conversation skills, group skills, persuasion skills, presentation skills and critical and creative thinking.*

#### **UNIT I: Communication skills and Technical Writing**

**15 Hrs**

Creativity in writing, critical thinking and problem solving. Resume and CV writing, application writing.

IT skills: Basic of excel spreadsheet, Power point presentation/Scientific presentations and oral presentations.

Use of web information, Library Research, online resources, medical data acquisition and database systems, Information Analysis. Ethics and copyright issues.

Presentation and interaction: Multimedia presentation: Understanding the basics, Communication styles, speaking in groups and discussions.

Communication skills: Visual, nonverbal and aural communication. General gesture, speed, loudness, clarity of thought, appropriate vocabulary and facial expressions.

Time management, Team work and Leadership

#### **UNIT II: Research Methodology and Intellectual Property Rights**

**15 Hrs**

Research objectives, approaches and significance. Types of research: pure and applied. Research ethics, Animal Ethics, biosafety, Literature survey, research design, data collection techniques, interpretation and presentation.



Preparation of scientific and technical report, scientific posters.

Introduction to Intellectual Property, Types of IP- Patents, trademarks, copyright. Relevance of IP in Biotechnology.

Basics of Patents, types of Patent Applications and Patent Filing

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### Generic Electives

#### Offered by Department of Biophysics for Semester IV

#### (For students of other departments)

### BPH-C-GE4: Biophysical Techniques

#### THEORY

Total Lectures: 60

Credits : 4

*Objectives: This course offers an understanding of the core biophysical techniques for macromolecular separation and characterization. This includes the principles and applications of chromatography and electrophoresis. It also includes the concepts and methodology of various spectroscopic techniques.*

#### UNIT I

15 Hrs

**Chromatography:** Theory, operations and applications of Partition, Adsorption, Gel permeation, Ion exchange and Affinity chromatography, Chromatography on paper, thin layer and column. Gas- liquid and high performance liquid chromatography techniques: hydrophobic interaction chromatography, covalent chromatography, Special techniques in the chromatography of Nucleic acids and of proteins that bind nucleic acids: DNA-cellulose chromatography, Hydroxyapatite chromatography.

#### UNIT II:

15Hrs

#### **Hydrodynamic methods**

**Sedimentation:** Theory of velocity Sedimentation, preparative and analytical ultracentrifugation, factors affecting sedimentation velocity, sedimentation coefficient. Zonal centrifugation through pre-formed density gradient. Examples of the use of Zonal Centrifugation in the preparative

ultracentrifugation. Determination of molecular weight by sedimentation diffusion, sedimentation equilibrium (Archibald's method).

**Viscosity:** Theory and measurement of viscosity, Viscometers- Ostwald capillary, Ubbelonde capillary, examples of use of viscometry.

### UNIT III

15 Hrs

**Electrophoresis:** Theory and types of electrophoresis, operations and application of Electrophoresis. Zone electrophoresis, paper, cellulose acetate strip and gel electrophoresis. Sodium dodecyl sulphate-polyacrylamide gel Electrophoresis (SDS-PAGE). Disc electrophoresis in polyacrylamide gels. Agarose gel electrophoresis. Electrophoretic transfer- Southern, Northern and Western.

### UNIT IV:

15 Hrs.

**Immunochemical methods:** Definitions in immunochemistry, The immunological system, Preparation of antibody, Antigen-antibody reaction, Immune reactions useful in bioassay- precipitin reaction, Immunodiffusion, complement fixation assay, Agglutination, Radioimmunoassay (RIA)- theory, operation and applications. Preparation of labelled antigen, Immunoradiometric assays (IRMA). Examples of immunological procedures used in bioassays, Enzyme-linked immunosorbent assay (ELISA). Fluorescent immunoassay. Protein-A immunoassay. Immunological technique for localizing

## BPH-C-GE4: BIOPHYSICAL TECHNIQUES

### PRACTICAL

Total Lectures: 30

Credits: 2

1. Separation of the components of Sudan black B dye by Radial chromatography using different solvent systems and calculations of the Rf of the separated components.
2. Separation of the components of Sudan black B dye by paper chromatography.
3. Separation of the components of Sudan black B dye by thin layer chromatography using silica gel.
4. Separation of the components of Sudan black B dye by column chromatography.
5. Separation of amino acids by using ascending paper chromatography.
6. Demonstration of the Ouchterlony's double diffusion technique on glass slides.
7. To extract protein from a biological sample and separate them using SDS-PAGE
8. Demonstration of differential and density gradient centrifugation.

**SUGGESTED READING:**

5. Physical Biochemistry: applications to biochemistry and molecular biology by Friefelder, David; (Publisher)- New York: W.H. Freeman; {Edition-2nd(year -1982)}; *1st year of publication- 1935*
6. Biochemical Technique: theory and practice by Robyt, John F. and White, Bernard, J; (Publisher)- Monterey: Brooks/ Cole Pub.; *1st year of publication-1987*
7. Tools of Biochemistry by Cooper, Terrance G; (Publisher)- New York:Wiley-Interscience; *1st year of publication- 1942*
8. Physical Biochemistry: Principles and Applications by D. Sheehan Wiley, 2000

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**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester V**

## BPH-C11: RADIATION BIOPHYSICS THEORY

**Objectives:** Students shall learn how the problem of measuring radiation doses is currently handled in terms of physical concepts, such as energy absorption, and empirical constructs, such as quality factors and equivalent dose rates. Further, the course also introduces the concepts of Nuclear medicine i.e. speciality of medicine and medical imaging that uses radionuclides and relies on the process of radioactive decay in the diagnosis and treatment of disease. Course provides in depth knowledge about the radiopharmaceuticals in biomedical imaging and their applications in diagnosis and treatment of various diseases. It also familiarizes the students with the various organ imaging devices and radiation carcinogenesis. While studying Radiation biophysics and nuclear medicine the concept of radiation protection cannot be ignored. So, this course also provides a basic guide to the exposure limits, limits for whole body counting, acute radiation syndrome, maximum permissible doses (ICRP Recommendations), radioactive decontamination and waste disposal.

**Total Lectures: 60**

**Credits: 4**

### Unit I

**15 Hrs**

*Nuclear Medicine:* Biomedical applications of  $^{131}\text{I}$ , Thyroid radioactive uptake measurements: Tracer dose, use of carrier, standard and phantom, shielding and collimation, factors effecting thyroidal radioactive iodine uptake, PBI-131, thyroid stimulation test, thyroid suppression tests perchlorate discharge test, T3 charcoal uptake test external counting of the liver.  $^{125}\text{I}$  -applications, Radio immunoassay of T3, T4, TSH and other hormones, treatment of hyperthyroidism.

*Radiation dosimetry:* radiation dose rates, cumulative radiation dose, radiation dose in SI units, effective dose, pocket dosimeter, contamination monitor and survey monitor, film badge, Thermo-Luminescent Dosimeter (TLD).

*Radiation Chemistry:* Direct and Indirect effects, Energy transfer, concept of 'G' Value. Free radical formation due to radiation interaction, radiation chemistry of water, Reactions in aqueous inorganic and organic molecules in solutions. Radiation effects on simple chemical system and on molecules in solutions and biological systems. Reactions with DNA

### Unit II

**15 Hrs**

*Radiation Molecular Biology:* Radiation effects on proteins, enzymes, nucleic acids, lipids and carbohydrates. Radiation effects on transcription and translation.

*Radiation Effects on Cell and major organ systems:* Effects on cell structure, membranes. Energy metabolism, synthetic processes, enzymes and cell organelles. Radiation effects on chromosomes. Radiation effects on cell division. Radiation effects on blood, digestive systems, respiratory and urinary systems. Acute whole body exposures, Late effects of radiation in fetus.

*Theories and Models for cell Survival:* Lea's target theory model, Biological survival curves, Exponential survival curve, Threshold type survival curve, single hit model, target size. Multi target theory.

### Unit III

**15 Hrs**

*Radionuclides/Radiopharmaceuticals :*  $^{51}\text{Cr}$ - labeling of red blood cells, spleen uptake, red cell survival

studies, blood volume, labeling with proteins and their turnover studies,  $^{32}\text{P}$ - treatment of polycythemia vera and leukemia, application in molecular biology,  $^{14}\text{C}$ - breath test, detection of bacteria in blood/Urine cultures, Radio-respirometry. Uptake and turnover of  $^{14}\text{C}$  labeled amino acids. Uptake of  $^3\text{H}$  thymidine by DNA . Design of a radio-pharmaceutical nuclide purity, radio-chemical purity, uses of radio pharmaceuticals,  $^{99\text{m}}\text{Tc}$  – applications.

*Cell Sensitivity and Modification of the Radiation Response:* Criteria of sensitivity, factors influencing sensitivity: Role of water, temperature and radiation damage. Oxygen effect, oxygen, thiols and modification of radiation response. Radiation sensitizer, halogenated pyrimidines, hyperbaric oxygen, oxygen supply to tumors, hypoxic cell sensitizers. Radioprotectors- Mechanism of action, development of effective compounds, amifostine as radioprotectors, radio-protectors and chemotherapy

#### Unit IV

15 Hrs

*Stochastic Effects:* Radiation Carcinogenesis: Stochastic versus and Nonstochastic, effects. Radiation carcinogenesis in man and experimental animals.

*Radiation protection:* Basics for exposure limits, limits for whole body counting. Acute radiation syndrome , chronic exposures, cosmic radiation, terrestrial radiation, medical and other exposures, Maximum permissible doses(ICRP Recommendations), basics for exposure limits for occupational exposure, accidental exposures, dose constraints for pregnant women, Dos and Don'ts for radiation workers, ALARP programme, precautions, regulations, cautions signs and labels , receiving and monitoring radioactive packages. Radioactive decontamination and waste disposal: Radioactive decontamination of labs, clothes, hands, glassware, gloves, metals, plastic, paints and bricks. Management of internal contamination/exposure. Radioactive waste disposal of solids, liquids and gaseous effluents, decay by storage, release into sewerage system, transfer to authorized persons, radioactive spills, management of sealed sources, release of patients administered with radiopharmaceutical/radioisotope.

### BPH-C11: RADIATION BIOPHYSICS PRACTICAL

Total Lectures: 30

Credits: 2

1. To measure the Half Value Layer of different elemental materials using Beta and Gamma and determine absorption coefficients of elemental materials.
2. To study the factors producing the back ground counts.
3. To determine the dead time/ resolving time of G.M. counter.
4. To determine the efficiency of G.M. counter and find out the strength/ radioactivity of unknown radioactive source.
5. To determine the absorption coefficients of different biological tissues with beta and gamma radioactive sources of different energies.
6. To study the absorption of radiations by different solvents and determine the counting errors arising from different geometries of samples.
7. To determine the back scatter arising out of different elemental materials using different radioisotopes with different energies.
8. To find out the energy spectrum of radioisotope  $^{137}\text{Cs}$  and determine FWHM and percent resolution by using Gamma Ray Counter.

9. To identify unknown radioisotope on the basis of its principal energy by using scintillation counter.
10. To determine the half life of a given radionuclide using scintillation counter.
11. To find out the biodistribution of a given radionuclide.
  
12. To find out % uptake of carrier-free radiodine-131 in the thyroid and determine effective and biological half lives.
13. To demonstrate the influence of carrier on the uptake of  $^{131}\text{I}$ .
14. To perform perchlorate discharge test to asses organification defect.
15. To determine thyroid clearance rate by using radioiodine-131.
16. To assess thyroid function by performing PBI-131 test.
17. To find out the volume of a given unknown liquid by using isotope dilution technique
18. To determine the turnover of  $^{14}\text{C}$  glucose in liver slices using radiorespirometric technique.
19. To demonstrate that tritium labeled thiamidine is incorporated in DNA
20. To study in vivo incorporation of  $^{14}\text{C}$  uracil in RNA.
21. To determine the in-vitro uptake of  $^{14}\text{C}$  labeled amino acids in the given organ slices.
22. To find out the bio-distribution of  $^{51}\text{Cr}$  in a given animal.
23. To label the red blood cells using  $^{51}\text{Cr}$  and to determine the efficiency of labeling.
24. To find out the average life span of red blood cells by using  $^{51}\text{Cr}$  radionuclide
25. To determine the blood volume of a given animal using  $^{51}\text{Cr}$  labeled red blood cells.
26. To measure the blood volume of a given animal using  $^{99}\text{Tc}$  labeled red blood cells.
27. To prove that spleen is the storehouse of worn out red blood cells by using  $^{51}\text{Cr}$  labeled red blood cells.
28. To determine the half lives of radioactive isotopes.
29. To study the back scatter of beta particle.

## **SUGGESTED READING**

1. Cellular Radiobiology by Alper, T., Cambridge University Press, 1979.
2. Radiation Biology by Cassarett, A.P., Prentice Hall, 1968.
3. Elements of Radiobiology –Selman, J. Charles C Thomas 1983.
4. Radiation Biophysics – 2<sup>nd</sup> edition by Andrew, H.L., Prentice Hall, 1961,1974.
5. Radiation Dosimetry by Frank Herbert Attix, Wiley –Interscience Publication, John Wiley, 1986.
6. Fundamental Physics of Radiology - by Meredith, W.J. and Massay, J.B J. Wright; 3rd ed. 1977.
7. Radiotracer Methodology in the Biological, Environmental and Physical Science by Wang, C.H., Wills, D.L. and Loveland, W.O., 1975.
8. Textbook of Nuclear Medicine by Michael A.Wilson, Lippincott- Raver Publishers, 1997.

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## **BPH-C12: Bioinformatics and Computational Biology**

### **THEORY**

**Total Lectures : 60**

**Credits : 4**

*Objective:* The field of Bioinformatics is the science of designing and creating databases, softwares, computational and statistical tools for research in life sciences. Today, the quantity of biological data accumulated by laboratories is daunting. As a result, the data can no longer be dealt with ‘manually’ and **bioinformatics** has become an essential ally. Computational Biology refers to the hypothesis based investigation of a biological problem with the primary goal of discovery and advancement of knowledge. The course contents have been carefully designed to introduce the undergraduate students to this upcoming field.

#### **UNIT 1: Computer Fundamentals and Bioinformatics**

**15 hrs**

**Introduction to Bioinformatics:** Overview, History and need of bioinformatics technology.

**Computer Fundamentals:** Block Structure of a computer, characteristics of computers, classification of computers- digital and analogue computers, Input, output and Memory.

**Languages, Flowcharts and Operating Systems:** Machine level languages, assembly level languages, high level languages. Computer algorithms and flowcharts. Operating Systems- DOS, windows 98/XP/VISTA, UNIX/LINUX, Mac OS, VMS.

**Modern Computers:** Workstations, parallel processing computers, supercomputers. Internet and Related Programmes: WWW, HTML, HTTP, telnet, FTP, computer domain.

#### **UNIT 2: Biological Databases**

**15 hrs**

**Introduction:** Types of Databases (with examples) - primary, secondary and composite databases, Public and proprietary databases.

**Sequence databases:** Nucleotide Sequence databases: GenBank, EMBL, DDBJ, Protein sequence database- Uniprot, SWISSPROT/TrEMBL, PIR.

**Molecular Structure Databases:** Protein Data Bank (PDB), SCOP, CATH. Understanding the structure of each database and using it on the web.

**Introduction to sequence file data formats:** FASTA, Genbank flatfile. Sequence Retrieval: Entrez and SRS.



**UNIT 3: Sequence Alignment and Analysis**

**15 Hrs**

**Sequence analysis:** Introduction to sequence alignment and its applications. Notion of homology: Orthologues, Paralogues, Analogues. Identity, homology and similarity with reference to evolutionary relationships.

**Pair wise sequence alignment:** Concept of global and local alignment, Dot Plot, Algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods), Substitution matrices- PAM and BLOSSUM.

**Multiple sequence alignment:** Basic concepts and applications. Consensus sequence, Motifs, BLOCKS, Profiles.

**Tools for Similarity Search:** BLAST: concepts & algorithm, applications and significance, Salient features of various BLAST versions: BLASTp, BLASTn, BLASTx, tBLASTn, tBLASTx, PSI and PHI BLAST. FASTA & its algorithm. ClustalW, Toffee; Position specific scoring matrices.

**UNIT 4: Structural Bioinformatics**

**15 hrs**

**Protein Structure Prediction:** Concepts and strategies of protein structure prediction, methods of secondary structure prediction and methods of protein tertiary structure prediction.

**Introduction to Molecular Modelling:** Molecular Mechanics and Molecular Dynamics concepts, potential energy functions, potential energy surface, energy minimization, local and global minima, saddle point, grid search. Molecular modelling packages.

**Drug Design:** Introduction to Molecular docking, Computer Aided Drug Design and Drug Discovery:

**Basic Structure visualization and Building tools:** RasMol, Swiss PDB Viewer.

**BPH-C12: Bioinformatics and Computational Biology**

**PRACTICALS**

**Total Lectures : 60**

**Credits: 2**

1. Introduction to basic Linux commands.
2. Building amino acids and Peptides
3. An overview of proteins and amino acids using RasMol.
4. Peptide bonds; Ramachandran plots; peptides and secondary structure
5. Using the PDB database and understanding PDB file format

6. Sequence Alignment using BLAST.
7. Sequence Alignment using ClustalW.

### **SUGGESTED READING**

1. Bioinformatics Basics: Applications in Biological Science and Medicine 2005) 2<sup>nd</sup> Edition, Lukas K. Buehler, Hooman H. Rashidi, Taylor and Francis, ISBN 9780849312830.
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Lab Press, 2001.
3. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press, 2008.
4. Introduction to Bioinformatics by T.K. Attwood, D.J. Parry-Smith, PHI-2000.
5. An introduction to protein informatics by Karl-Heinz Zimmermann, Springer.
6. Molecular Modelling: Principles and Applications by Andrew R. Leach, Addison Wesley Longman

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**B.Sc. (Honors)**  
**Biophysics**  
**Syllabus-Semester VI**

**Semester 6th**  
**BPH-C13: Gene and Protein Engineering**  
**THEORY**

**Total Lectures : 60**

**Credits : 4**

*Objective: The course lays a foundation for understanding the basic concepts of gene and protein manipulation introducing desirable functions. It also enhances the knowledge towards various cloning techniques, gene engineering tools, modern human welfare and gene therapy.*

**UNIT1: Tools of genetic engineering (15hrs)**

Exonucleases, endonucleases, Restriction endonucleases, Types of Restriction endonucleases, Nomenclature, Recognition Sequences, cleavage patterns, Frequency of Recognition Sites, Modifications of cuts ends, Example of some enzymes; DNA ligases, Reverse transcriptase, DNA polymerase, T4 polynucleotide kinase, Terminal transferases, use of linkers and adaptors.

**UNIT 2: Cloning methods and DNA analysis (15hrs)**

Strategy of recombinant DNA technology, Gene library; Genomic library; cDNA Library- isolation of mRNA, reverse transcription, Transfer of recombinant DNA into Bacterial cells, Transformation, transfection and selection of recombinants, Blotting techniques, Western blotting technique (protein blotting or electroblotting techniques), Northern and Southern blots.

**UNIT 3: Genetic engineering: applications for human welfare (15hrs)**

Gene therapy, types of gene therapy, somatic cell gene therapy, germ line gene therapy, methods of gene therapy, augmentation gene therapy, genes for vaccines, DNA vaccines, Diagnosis of diseases: genes associated with genetic diseases

**Methods of gene transfer in plants and animals:** chemical/ physical and viral mediated gene transfer. Gene transfer mechanism in microbe's transformation, transduction, conjugation, and Recombination.

**UNIT 4: Transcriptome and Proteome (15hrs)**

General Account. Protein sequence analysis by mass spectroscopy. DNA and protein microarrays- application of DNA chips Advantages and disadvantages of DNA and protein microarrays

**Protein engineering approaches:** Types of mutations, Molecular mechanism of mutations, directed mutagenesis procedures: oligonucleotide directed mutagenesis, random mutagenesis, adding disulphide bonds, increasing enzyme activity,

**BPH-C13: Gene and Protein Engineering  
PRACTICALS**

**Total Lectures : 60**

**Credits : 2**

1. To perform extraction of nucleic acids from a given animal tissue
  - a. Genomic DNA extraction
  - b. RNA extraction
2. To carry out extraction of total protein(s) from a given animal tissue
3. Estimation of DNA content in a given tissue extract by colorimetric technique
4. Estimation of DNA content in a given tissue extract by colorimetric technique
5. To determine the protein content in a given sample using Lowrys' technique
6. To perform Sodium Dodecyl sulphate (SDS) polyacrylamide gel electrophoresis technique for protein visualization

**SUGGESTED READING**

1. Molecular cloning by Maniatis, Cold Spring Harbor Laboratory 1982.
2. DNA cloning by Glover, Oxford University Press, 1995, 1996, .
3. Genome analysis – a practical approach by Davis K.E. Oxford University Press, 1988.
4. Molecular Biotechnology, Principles and applications of recombinant DNA by Glick and Pasternak ASM Press; 3 edition 2003.
5. Biochemistry – 3rd edition by Lubert Stryer , W.H. Freeman and Company 1995.
6. Protein Biochemistry and Biotechnology by Gary Walsh, Wiley; 2nd ed. 2001
7. Introduction to Protein Science. Architecture, Function and genomics by Lesk AM, Oxford University Press, USA; 1 ed. 2004.

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**Semester: VI**

**BPH-C14: Molecular Biophysics**

**THEORY**

**Total Lectures: 60**

**Credits: 4**

*Objective: Molecular biophysics is an interdisciplinary area of research that explains the biological phenomena in terms of physical and chemical properties of a molecule. This course is designed to understand the complexity of biomolecular system by using various biophysical techniques and methods for elucidating the structure, function, dynamics and interaction behavior of biomolecules at various levels of complexity. Some of the practicals (FTIR, NMR and SAXS) need to be carried out at the sophisticated instrument center at Panjab University after covering the relevant theory and sample preparation in the department.*

**UNIT 1: (Introduction of Molecular Biophysics and spectroscopy) (15 hrs)**

Overview of molecular biophysics; Electronic structure of atoms and molecules; Brief introduction to various spectroscopies in the regions of electromagnetic spectrum (NMR, ESR, Microwave, IR, UV-Vis, X-ray, Gamma rays); Types of molecular motions, Vibrational and rotational; Atomic and molecular energy levels; Molecular transitions and selection rules; Atomic-Molecular spectra; Frank-Condon principle and Woodward Fieser rules; Concept of absorption and emission of radiation by molecular species; Absorption laws; Parameters governing absorption and emission spectroscopy; Chromophores and reported groups; Factors affecting their absorption; Absorption and intensity shifts (bathochromic, hypsochromic, hyperchromic and hypochromic); Theoretical principles of atomic absorption and atomic emission spectroscopy; Apparatus for measuring atomic absorption spectroscopy; Limitations of atomic absorption and atomic emission spectroscopy.

UV-Visible spectroscopy; Principle, instrument design, methods & applications of UV-Visible spectroscopy; UV-Visible range, energy-wavelength-color relationships; Interaction of UV-Vis radiation with matter and its effects. Applications related to structural studies of nucleic acids (helix coil transition, single stranded and double stranded) and proteins (native and denatured proteins by using absorption spectroscopy)

**UNIT 2: (Rotational-Vibrational Spectroscopy) (15 hrs)**

Introduction to rotational and vibrational spectroscopy: Basic principles, instrumentation (radiation sources, sample preparation, monochromator and deflectors) and applications of Infrared (IR) & Raman. Advantages and disadvantages of IR and Raman spectroscopy; Fourier Transform Infrared Spectroscopy (FTIR); principle, salient instrumental features and applications.

Circular Dichroism Spectroscopy: Concept of polarization, linear and circular polarized light, optically active and inactive molecules, molar ellipticity, cotton effect, circular dichroism (CD), linear dichroism (LD), vibrational dichroism (VD), optical rotatory dispersion (ORD); Principle of absorption by oriented molecules; Relation between CD and ORD; Instruments used for measuring CD and ORD; Advantages and disadvantages of CD and ORD; Applications of CD and ORD.

**UNIT 3: (Spin Resonance Spectroscopy)**

**(15 hrs)**

Principle and operation of spin resonance; Principle, instrumentation and applications of electron spin resonance spectroscopy (ESR); Concept of Bohr magneton, Lande splitting factor and Zero-field splitting; Spin label probes and factors affecting spin labeling; Relaxation processes; Analysis of ESR spectra and their limitations; Comparison between ESR and NMR spectroscopy and their applications.

Nuclear magnetic resonance spectroscopy (NMR): Introduction, Principle of chemical shift and coupling; Factors affecting chemical shift and coupling; CW and FT-NMR; Instrumentation, free-induction decay (FID) and application of NMR to biomolecules. NMR spectra of protein and nucleic acids.

Mossbauer Spectroscopy/Gamma Ray Spectroscopy: Introduction to Mossbauer effect; Mossbauer nuclei; Principle, instrumentation and applications of Mossbauer Spectroscopy.

**UNIT 4: (X-ray crystallography)**

**(15 hrs)**

Introduction to lattices and unit cells, crystal systems and symmetry operations, Miller Indices; Principle of crystallography and crystallization; Reciprocal Lattice, Ewalds Construction, Bravais lattices, Bragg's equation and Laue's equation; X-ray diffraction, Diffraction methods-Laue's method, rotating crystal methods and powder method; Atomic scattering factors and structure factors, amplitude and phase. Calculating electron density, diffraction patterns, interpretation of results and phase problem in interpretation of results. Crystallization of proteins and nucleic acids, preparation of heavy metal derivatives, Patterson synthesis, isomorphous replacement methods, structure factors of centro-symmetric and non-centrosymmetric crystals. General remarks on Protein/nucleic acid-structure determination from X-ray diffraction data; Comparison of X-ray crystallography and Cryo-EM for large macromolecular complexes.

Small angle X-ray scattering and small angle neutron scattering (SAXS and SANS): Basic principles and theory of SAXS and SANS, R-factor, Sample preparation, data analysis, *Ab-initio* model building

and interpretation, NMR and SAXS/SANS: two complementary techniques, SAXS with crystallography

**BPH-C14: Molecular Biophysics  
PRACTICALS**

**Total Lectures: 30**

**Credits: 2**

1. To verify the Lambert Beer's law by using variable solvents of different concentration.
2. To study of DNA-acridine orange interaction using absorption spectroscopy.
3. To determine the effect of temperature, pH and polarity on absorption spectra of protein/DNA.
4. To determine the mutarotation of glucose/amino acids by using polarimeter.
5. Sample preparation and analysis of FTIR spectra of biological samples.
6. To determine the ESR spectra of DPPH.
7. NMR sample preparation, dataset acquisition and analysis of protein/RNA.
8. To identify various Bravais lattice unit cells.
9. SAXS sample preparation, data acquisition, analysis and model building of protein or nucleic acid.

**SUGGESTED READING**

1. Biophysics (1989) Hoppe et. al., Springer, ISBN: 978-3-642-68877-5.
2. Introduction to Molecular Biophysics (2003) Tuszynski, J.A. and Kurzynski, M., CRC Press, ISBN: 978-0849300394.
3. Atkins' Physical Chemistry (2006) 8<sup>th</sup> Edition, Atkins, P. and Paula, J.D., Oxford University Press, ISBN: 978-0195685220.
4. Fundamental of Molecular Spectroscopy (1995) 4<sup>th</sup> Edition, by Banwell, C.N. and McCash, E.M., Tata McGraw Hill, ISBN: 978-0077079765.
5. Optical methods in biology (1970) Slayter, E. M., John Wiley & Sons Inc, ISBN: 978-0-471796701.
6. Electron Paramagnetic Resonance: Elementary Theory and Practical Applications (2006) 2<sup>nd</sup> Edition, Weil, J. A. and Bolton, J.R. McGraw Hill, ISBN: 978-0471754961.
7. NMR in Biological Systems: From Molecules to Human (2010) 1<sup>st</sup> edition, Chary, K.V.R. and Govil, G., Springer, ISBN: 978-1-4020-6680-1.
8. Protein Crystallography (1976) Blundell T.L. & Johnson L., Academic Press, ISBN: 978-0-121083502.
9. Small angle X-ray and Neutron scattering from solutions of Biological macromolecules (2013) Svergun, D. I. et. al., Oxford University Press, ISBN: 978-0-199639533.

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## DISCIPLINE ELECTIVE COURSES FOR SEMESTER V AND VI

### BPH-DSE1: Cytology and Cell Physiology

#### THEORY

**Total Lectures : 60**

**Credits : 4**

**Objectives:** *This course is in continuation with BPH-C2 (Cell Biology) offered in BSc I. This course deals with details of a cell; including structure, function (cell physiology) and chemistry of it with particular focus on the membranes, nucleus, nucleoplasm, and gametogenesis in detail. It also introduces the basics of stem cell biology and concepts of histochemistry.*

#### Unit I

**15 Hrs**

Membrane composition, membrane models, Membrane asymmetry, membrane fluidity, Evidence from model systems and biomembranes, extraneous coats of cell membranes.

*Membrane Dynamics:* Transport of ions and molecules through cell membranes, Types of transport across cell membrane, passive diffusion, facilitated diffusion and protein mediated transport, active transport, basic principles of membrane potential, resting membrane potential, recording of membrane potential (patch-clamp), role of ion channels,

#### Unit II

**15 Hrs**

*Nucleus :* Metabolism, light and submicroscopic organization of an interphase nucleus, dynamics of the nuclear envelope-inner and outer membranes and perinuclear space, nuclear pore complex, electrophysiological properties and enzymatic activities of nuclear envelope (4)

*Nucleoplasm:* Physicochemical changes in the nuclear matrix, nuclear environment vis-vis cytoplasmic environment. Nucleolus-composition, submicroscopic organization, isolation, chemistry and functions.

#### Unit III

**15 Hrs**

*Cytology of gametogenesis, Cell cycle and Programmed cell death (Apoptosis):* Overview of cell cycle. Intracellular control of cell cycle events, components of cell cycle control system. Apoptosis, extra cellular contents of cell division, cell growth and Apoptosis. Apoptotic pathways and role of various factors in Intrinsic and extrinsic pathways of apoptosis.

**Unit IV**

**15 Hrs**

*Stem cell Biology:* Epidermis and its renewal by stem cells. Renewal of sensory epithelia, airways, gut, blood vessels and endothelial cells. Renewal by pluripotent stem cells, blood cell formation. Genesis, modulation and regeneration of skeletal muscles, fibroblast and their transformation. Connective tissue cell family, Stem cell engineering

*Histochemistry:* Basic concepts of Histochemistry. Histochemistry of lipids, carbohydrates, proteins and nucleic acid. Enzyme histochemistry, Immunohistochemistry. (4)

**BPH-DSE1: Cytology and Cell Physiology**

**PRACTICAL**

**Total Lectures : 30**

**Credits: 2**

1. To Study the polysaccharides by PAS staining technique in paraffin sections from intestine with negative control with pyridine and its reversal with NaOH
2. To study Feulgen reaction for DNA in the given section with negative control.
3. Simultaneous demonstration of DNA and RNA in the given tissue by methyl green-pyronine reactions.
4. Himae and Moriber technique (triple stain) for the demonstration of proteins, DNA and Carbohydrates.
5. To study mucopolysaccharides by Alcian Blue and Mucicarmine
6. Demonstration of calcium deposits in the section of foot of snails by alizarin red S and Von Kossa's Silver substitution method. Use of negative control.
7. To localize and study mitochondria in tissue section by Altman's method.
8. To study active transportation of Phosphate with H<sup>+</sup> ions in yeast cells.

**SUGGESTED READING**

1. Molecular Biology of the Cell by Alberts, Bray, Lewis, Raff, Roberts and Watson. Garland Science; 1997
1. Handbook of Molecular Cytology by Lima de Farier Elsevier Science 1969.
2. Cell and Molecular Biology by EDP. De Robertis and EMF De Robertis Lea & Febiger;1987.

3. The Cell – A Molecular Approach by Geoffrey M.Cooper, ASM Press Washington-DC, Oxford University Press 2000.
4. Molecular Cell Biology by Darnell, Lodish, Baltimore, Scientific American Books 1990.

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## **BPH-DSE2: Biomedical Imaging**

### **THEORY**

**Total Lectures: 60**

**Credits: 4**

Objectives: Medical imaging in diagnostic radiology has evolved as a result of the significant contributions of a number of disciplines from basic sciences, engineering, and medicine. Computerized image reconstruction, processing, and analysis methods have been developed for medical imaging applications. The application - domain knowledge has been used in developing models for accurate analysis and interpretation.

This course already assumes the knowledge of general Physiology, essential electronics for instrumentation, Physics of human body, Radiation Biophysics, Physics (as general elective) taken up by the students during 1<sup>st</sup> to 4<sup>th</sup> semesters of the B.Sc. (Hons.). Topics include computed tomography, image reconstruction and analysis, MRI, ultrasound and imaging applications in therapy. The fundamental physics and engineering underlying each imaging modality are reviewed.

Course is so designed that student get opportunity of placement in the radiodiagnostic centres in the tertiary Hospitals as well as in the imaging centres in the private sector. Student are encouraged to undergo one or two months training in the diagnostic centres, by their own initiatives in addition to the efforts made by the department in developing such collaborations.

#### **Unit 1**

**15 Hrs**

X-Ray Imaging, X-Ray Generation, X-Ray 2-D Projection Imaging, X-Ray Mammography, X-Ray CT, Spiral X-Ray CT, Contrast Agent, Spatial Resolution, and SNR

#### **Unit II**

**15 Hrs**

Magnetic Resonance Imaging (MRI): Principles of NMR, MR imaging instrumentation, MR pulse sequences, Magnetic Resonance Spectroscopy, fMRI

**Unit III**

**15 Hrs**

Ultrasound Imaging: Propagation of Sound in a Medium, Reflection and Refraction, Transmission of Ultrasound Waves in a Multilayered Medium, Attenuation, Ultrasound Reflection Imaging, Ultrasound Imaging Instrumentation, Imaging with Ultrasound: A-Mode, Imaging with Ultrasound: M-Mode, Imaging with Ultrasound: B-Mode, Doppler Ultrasound Imaging, Contrast, Spatial Resolution, and SNR.

**Unit IV**

**15 Hrs**

Image Processing: Image types and linear processing, Fourier domain processing, Image Analysis, Visualization software.

There will also be sessions devoted to reviewing companies in medical imaging. The format is that each student reads and summarizes a research paper or literature from a company related to medical imaging, and then presents the summary to the class. Presentation time is restricted to 5-10 minutes, depending upon the class size.

Company selections for review will be given out in class, but generally are taken from advertisers in Medical Physics.

**BPH-DSE2: Biomedical Imaging**

**PRACTICAL**

**Total Lectures: 30**

**Credits: 2**

The capital cost of the imaging technology is extremely high and runs into crores. Therefore it is not possible for the educational institutions to have in house facilities for imaging. Even the cost of softwares such as MATLAB is prohibitive, for all institutes to procure. Globally also such facilities are available only in renowned institutions having world ranking in top 200, having high budgetary allocations. Taking these constraints into considerations, following practicals are designed, which needs to be kept updated regularly, with increased availability of resources.

1. Download few images (2D X-ray, Ct and MRI) of Bones and analyse the same.

2. Download few images(2D X-ray, Ct and MRI) of Brain and analyse the same.
3. Few Numerical exercises for image analysis.
4. Image analysis exercises continued.
5. Image analysis exercises continued.
6. Search the open source softwares available for image processing and shortlist the most appropriate one.
7. Applying the shortlisted software, carry the image processing.
8. Develop a design for Phantom of Hard/Soft tissue.

### SUGGESTED READING

1. **Physics of Radiology**, 2<sup>nd</sup> Edition, (2005) by Anthony Brinton Wolbarst, Medical Physics Publishing, Madison Wisconsin.
2. **Fundamentals of Medical Imaging**, Paul Suetens, Cambridge University Press, 2002.
3. **Biomedical Imaging and Sensing**, T. Furukawa (Ed.), Series - Biological and Medical Physics, Biomedical Engineering, Springer, 2004.
4. **Digital Image Processing**, 2<sup>nd</sup> Edition, Rafael C. Gonzalez, Richard E. Woods, Pearson Education, 2002.
5. **The Essential Physics of Medical Imaging**, 2nd Ed., by J. T. Bushberg, J. A. Seibert, E. M. Leidholdt, and J. M. Boone, Lippencott, Williams and Wilkins, Publ. 2002.

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### **BPH-DSE3: Advanced Microscopic Techniques**

#### **Theory**

Total Lectures: 60

Credits : 4

#### **Unit- I**

#### **Light (optical microscopy)**

**15 hrs**

**Compound light microscope:** Mechanism of fixation process, Electromagnetic radiation and its interaction with the matter (reflection, refraction, diffraction, interference and polarization), image formation in light microscope, lens aberrations, types of objective lenses, design of compound light microscope, phase, interference and polarization methods for optical contrast.

#### **Unit-II**

**Confocal fluorescence microscopy:** basic concept, instrumentation, sample preparation, confocal laser scanning microscopy, uses in biology and medicine **15 hrs**

**Two photon excitation microscopy:** basic concept, instrumentation, sample preparation, application

### Unit-III

**Electron microscopy** **15 hrs**

Transmission electron microscopy (TEM) and scanning electron microscopy (SEM)

**Specimen preparation for electron microscopy:** Fixation, Embedding, buffers and fixatives used in specimen preparation, cryofixation, negative staining, specimen drying techniques, fracturing procedure, replication procedure, mounting and specimen coating for conductivity, immunogold labeling

**Instrumentation:** Design of lenses and electromagnet lenses used in electron microscopy, Defects in the lenses, Design of the electron microscope (illuminating system, specimen manipulation system, imaging and vacuum system),

**Analytical microscopy:** interaction of electron beam with specimen, microscopes used for detecting analytical signals, specimen preparation for X-Ray microanalysis, environmental and variable pressure SEM

Applications of TEM and SEM in examining biological ultra structure and various cryogenic techniques used in electron microscopy.

**Quantitative electron microscopy**

### Unit-IV

**Specialized microscopy techniques** **15 hrs**

Atomic force microscopy (Scanning force microscopy), Principles, imaging modes (contact, tapping and non contact mode), probes, piezoelectric scanners, application (surface topology), Scanning tunneling microscope, principle, instrumentation, sample preparation, application, X-ray microscopy, invention and basic concept, advanced light source, scanning transmission mode, resolution, sample analysis.

## BPH-DSE3: Advanced Microscopic Techniques

### PRACTICAL

**Total Lectures: 30**

**Credits: 2**

- 1) To study the design, working and principle of rotary pump.
- 2) To examine the design of microscopic components and collection of data pertaining to the laboratories having confocal fluorescence microscope , phase contrast and electron microscope (national and international)
- 3) Sample preparation ( any biological tissue) for scanning electron microscopic analysis: drying, fixation, mounting and coating specimen with conductive material (gold sputtering)
- 4) Acquisition and interpretation of scanning electron microscopic image of a biological specimen.

### **SUGGESTED READING**

- 1) Bioimaging: Current concepts in light and electron microscopy by Douglas E. Chandler
- 2) Biomedical electron microscopy (Illustrated methods and interpretations) by Arvid B. Maunsbarch and Bjorn A. Afzelius
- 3) Electron Microscopy (Principles and techniques for Biologists) by John J. Bozzola and Lonnie D. Russell.

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### **BPH-DSE4: Biomaterials**

#### **THEORY**

**Total Lectures: 60**

**Credits : 4**

*Objective: The aim of studying biomaterials is to delineate the physical as well as biological principles that serve as the scientific basis for understanding the interactions of biological molecules and cells with biomaterials. Also, we will study factors affecting for the formation of a successful bio-implants and their application in selected subspecialties of medicine*

#### **UNIT 1: Introduction to Biomaterials**

**15 hrs**

Brief history and overview of biomaterials; Concept of biomaterials; Understanding the properties and general applications of biomaterials

Physico-chemical properties of biomaterials: Mechanical properties (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), Electrical properties, Thermal properties, Surface properties (morphology and texture) and Optical properties

Characterization of biomaterials on the basis of function: Bio-active; Bio-tolerant; Bio-inert; Natural and Synthetic; Permanent and Biodegradable implants

Characterization of biomaterials on the basis of composition: Metals, alloys, ceramics, glass, composites, polymers etc.

## **Unit 2 Fundamentals of Biomaterials**

**15 hrs**

Interaction of materials with biological system (molecular and cellular events); Structural – property relationships of biological implants, Wound healing process, body response to implants, factors affecting bio-interactions, selection criteria's for biomaterials

## **Unit 3 Biocompatibility, Biodegradation and Bioethics**

**15 hrs**

Concept of biocompatibility and Biodegradation; Biointerfaces; Biofilms; Factors affecting biocompatibility and biodegradation; Desinfection and sterilization of biomaterials

Essential factors for designing, fabrication and testing of biomaterials (*in vitro* and *in vivo*); Special Considerations for Implants, Devices and Biomaterials (Regulatory Compliance, Commercialization and legal/ethical aspects/regulations)

## **UNIT 4: Applications of Biomaterials in Medicine**

**15 hrs**

Soft tissue replacement: Sutures, Tissue adhesives, Artificial skin, Maxillofacial implants, blood interfacing implants, heart valve implants and artificial organs (heart, kidney)

Hard Tissue replacement: Internal Fracture fixation devices; Dental and joint replacement implants; Wires and Screws, Intramedullary devices, Nail and Plate Devices, Materials used for Internal Fractures, Fixation Devices

Recent advancements in biomaterials: 3D printing of biomaterials, Stem cell engineering

## **BPH-DSE4: Biomaterials**

### **PRACTICAL**



**Total Lectures: 60**

**Credits : 2**

1. To distinguish between various types of biomaterials on the basis of physiochemical properties
2. To study different types of suture materials and knot tying techniques
3. To evaluate tensile strength/elasticity of various implant materials by using Hooke's Law
4. To analyse the biocompatibility of various materials
5. Problem solving activity related to biomaterials

### **SUGGESTED READING**

1. "Biomaterials Science: an Introduction to Materials in Medicine," B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemmon (editors) (Elsevier; ISBN 0-12-582461)
2. Biomaterials - Temenoff and Mikos (Pearson Prentice Hall; ISBN 0-13-009710-1)
3. Materials Science and Engineering: An Introduction - Callister (John Wiley and Sons; ISBN 0-471-13576-3)
4. Williams, D.F.: Williams dictionary of biomaterials, Liverpool University Press (1999)
5. Biomaterials: An introduction by Joon Bu Park, Plenum Press, 1979.

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### **BPH-DSE5: NeuroBiophysics**

#### **THEORY**

**Total Lectures: 60**

**Credits: 4**

**Objectives:** *The course provides a basic understanding about signal transduction, nerve action potential, functioning of synapses, neurotransmitters, structural and anatomical details of various regions. The course will also include special senses and intellectual function of brain. Distinct human traits like languages, memory and thought processes have also been included.*

#### **Unit I**

**Introduction to Neurobiophysics**

**15 hrs**

Principles of cellular organization in the nervous system and population of cells. Functional groups of neurons, neuron circuits and neuroglia cells; concepts of membrane transport: Transport of ions and molecules through cell membrane, diffusion and active transport through cellular sheets, factors that affect net rate of diffusion; Basic principles of membrane potential, action potential, resting membrane potential; Ion Channels: Role of Na/K pump and leak channel, role of Voltage gated channels in conductance of ion during action potential; Nerve action potential: initiation and propagation, recording of membrane potential. Signal transmission, synapses, physiology, neurotransmitters, excitatory and inhibitory post-synaptic potentials, synaptic summation and facilitation. Synaptic plasticity; Neuromuscular junction and transmission

## **UNIT II**

**15 hrs**

### **Neuroanatomy**

Brain and its gross anatomy: cerebral hemispheres, basal ganglia, brain stem, Pons, Thalamus, hypothalamus, cerebellum, medulla, corpus striatum and related nuclei, hippocampal formation, amygdala and olfactory pathways, cerebral, cerebellar and cerebrospinal tracts, meninges. Spinal cord, internal structures, spinal nerves, cytoarchitectural lamination, dorsal root afferents, spinal tracts

### **Autonomic nervous system**

Basic characteristics of sympathetic and parasympathetic function, Chemical transmission of autonomic nerve endings; Concept of autonomic reflexes and its role in hypothalamus and its relation to autonomic functions

## **Unit III**

**15 hrs**

**Somatic sensation:** Sensory receptors and their basic mechanisms of action; Tactile and position sensation pathway for transmission to CNS; Sensory pathways, Somatosensory cortex and association areas; Pain: types of pain, pathways and associated abnormalities, headache and thermal sensation.

**Special Senses:** Anatomy and function of structural elements of retina, photochemistry of vision, colour vision, neural functions of retina, organization and function of visual cortex. The sense of hearing-tympanic membrane and ossicular system, anatomy of Cochlea and transmission of sound waves through Cochlea, functions of organ of corti, determination of sound frequency and loudness, auditory pathway and the role of cerebral cortex in hearing.

## **Unit IV**

**15 hrs**

**Motor mechanisms:** Cortical and Brain Stem Control of Motor function, Vestibular Apparatus; Cerebellum, Basal Ganglia and overall motor control

**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.

**Neurophysiologic basis of behavior, motivation and cerebral blood flow:** Limbic system and hypothalamus, regulation of biologic rhythms, sexual behavior, fear and range, motivation, mechanism of sleep, wakefulness and self stimulation. Medulla oblongata in control of respiration, heart rate and blood pressure

### **BPH-DSE5: NeuroBiophysics**

#### **PRACTICALS**

**Total Lecture : 30**

**Credit:2**

To study the human brain anatomy:

- a) Sagittal and Mid-Sagittal sections.
  - b) Coronal sections displaying Thalamic, basal ganglion, limbic lobe and ventricular regions.
  - c) Basal section and various Cranial nerves.
  - d) Cross-section of the spinal cord.
2. Study of rat brain section. Identification of different areas and to stain brain section with
    - a) H/E b) Luxol fast blue c) Gallocyanine stain d) Cresyl violet stain
  3. To demonstrate nerve fibres with silver impregnation technique
  4. To study teased nerve preparation and stain them with methylene blue
  5. Demonstration of myelin with Sudan Black B stain.

#### **SUGGESTED READING**

1. Core Textbook of Neuroanatomy by Carpenter, MB, Williams & Wilkins; 4 Sub ed. 1991.
2. Textbook of Medical Physiology by AF Guyton, Saunders, 11<sup>th</sup>ed. 2005
3. The Human Nervous System- Basic Principles of Neurobiology by Charles R. Noback and Robert J. Demarest McGraw-Hill (Tx); 3 Sub ed 1980.

4. Physiology by Ganong McGraw-Hill/Appleton & Lange; 21 edition, 2003

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## **BPH-DSE6: Gene Organization and regulation THEORY**

**Total Lectures: 60**

**Credits :4**

*Objective: This subject aims to understand the structural and functional organization of chromosomes, genes emphasizing on regulation of gene expression at various molecular levels including transcriptional and epigenetic regulations. Further concepts of gene mapping, genetic polymorphism and methods to detect them are introduced.*

### **Unit 1: Gene Organization**

**15 Hrs**

Concept of gene: Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families.

Chromosomal organization: Chromosomal DNA and its packaging in the chromatin, Metaphase chromosomes: centromere and kinetochore, telomere and replication origins, Histones, DNA, nucleosome morphology and higher-level organization; Heterochromatin and euchromatin, lampbrush and polytene chromosomes

### **Unit 2: Gene linkage and chromosome mapping**

**15 Hrs**

Linkage of genes in chromosomes, crossing over and its molecular mechanism, recombination frequency, construction of genetic maps, three-point cross, Detection and Estimation of Genetic Linkage in Humans, The Logarithm of the Likelihood Ratio Method of Linkage Analysis: LOD Score

### **Unit 3: Control of Gene Expression**

**15 Hrs**

An overview of gene control, DNA binding motifs in gene regulatory proteins, Operons – positive and negative regulation, concept of promoter, repressor and operator using examples of Lac, Trp. Regulation of transcription in eucaryotes, epigenetic regulation of gene expression eg: DNA methylation. Basic introduction to posttranscriptional controls of gene expression

### **Unit 4: Genetic and Physical Mapping of the Human Genome**

**15 Hrs**

Genetic Mapping of Human Chromosomes, Genetic Polymorphism, Restriction Fragment Length Polymorphism, Short Tandem Repeat Polymorphism, Mapping of a Genetic Disease Locus to a Chromosome Location, Multilocus Mapping of Human Chromosomes, Inserting a Disease Gene into a Linkage Map, Physical Mapping of the Human Genome, Assembling Contigs from BAC Libraries.

## **BPH-DSE6: Gene Organization and regulation PRACTICALS**

**Total Lectures: 30**

**Credits :2**

1. Identification of various stages of mitosis and visualization of chromosomes in onion root tip.
2. Primers designing using bioinformatics tools.
3. Preparation of cDNA from RNA
4. Amplification of constitutive gene by PCR.
5. Demonstration of Real Time PCR
6. Formation of micronuclei
7. DNA fragmentation using DNA ladder studies

***SUGGESTED READING***

1. Gene IX, by Benjamin Lewin, Oxford University Press 2007. ISBN-13: 978-0763740634
2. Molecular Biology of the Cell by Alberts, Bray, Lewis, Raff, Roberts and Watson. Garland Science; 2002. ISBN-10: 0-8153-3218-1 ISBN-10: 0-8153-4072-9
3. Molecular Biology and Biotechnology 4<sup>th</sup> edition by J.M. Walker and R. Rapley, Panima Publishing Company, 2009. ISBN 0-85404-606-2.
4. Molecular Biology of the Gene by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann Benjamin Cummings; 6 Ed 2011. ISBN: 9780321507815, 0321507819
5. Biochemistry—3rd edition by Lubert Stryer, W.H. Freeman and Company 1988. ISBN 10: 071671843X ISBN 13: 9780716718437
6. Recombinant DNA : A Short Course **John Tooze; James D. Watson; David Kurtz** Published by Freeman & Company, W. H. 1983. ISBN 10: 0716714841 ISBN 13: 9780716714842
7. Method in Molecular Biology Vol. I & II by Walker Humana Press, 1983. ISSN: 1064-3745
8. Lehninger Principles of Biochemistry by, David L. Nelson, Michael M. Cox, Palgrave Macmillan 5th Edition, 2008. **ISBN: 978-0-716-77108-1**
9. Introduction to Human Molecular genetics by Jack J Pasternak, John Wiley & Sons. ISBN: 0-471-47426-6. 2005
10. Human Molecular Genetics by Andrew Tom Strachan, Garland Science: ISBN: 1136844074.

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**BPH-DSE7: Immunology**

**THEORY**

**Total Lectures: 60**

**Credits :4**

Objective: The objective of this course is to cover basic concepts on the immune system. The course encompasses the importance of cells, Organs, and Microenvironments of the Immune Cells and their role in development of immunity.

**Unit I**

**15 Hrs**

Overview of the Immune System: Historical Perspective, Innate Immune response and its role in protection, Adaptive Immune response / Humoral and cellular component of the Immune response  
Comparison between Innate and adaptive immunity, Hematopoiesis

Cells and Organs of the Immune System. Primary and Secondary Lymphoid Organs ; T Cell Maturation , Activation , Differentiation B/ Cell Maturation , Activation , Differentiation

**Unit II**

**15 Hrs**

Antigen : Characteristics of antigens , Factors that influence immunogenicity, Cross reactivity , Epitopes , Haptens , Adjuvants, Allotypes, Idiotypes, Isotypes

Immunoglobulins: Structure, Classification& Functions.;Genetic events in synthesis of Ig Chains: Organization & Synthesis of Light chain genes & Heavy chain genes, Class & Isotype Switching; Monoclonal Antibodies: Production by Hybridoma Technology & Applications

**Unit III**

**15 Hrs**

MHC molecules and organisation of their genes , Structure and function of MHC gene products T Cell and B Cell Receptors

Transplantation Immunology: Graft rejection, Mechanism of Graft rejection, Prevention of Graft rejection, Immunosuppressive Drugs; Hypersensitive Reactions

**Unit IV**

**15 Hrs**

Antigen and Antibody Interactions : Agglutination,Precipitation,ELISA,RIA,Immunoflorescence & Western Blotting

Complement System : Function, Component , Activation and Regulation

Cell Mediated Effector Responses

**BPH-DSE7: Immunology**

**PRACTICALS**

**Total Lectures: 30**

**Credits :2**

- 1.Total & Differential Count of blood cells
2. Blood Grouping
- 3.Widal Test (Slide /Tube)
4. Oucterlouny Double diffusion (ODD)
5. SRID (Single Radial Immunodiffusion)Test
6. Gel Techniques; SDS PAGE/Western blot.

**SUGGESTED READING**

1. Janis Kuby, Immunology, 5th Edition
2. Ivan Roitt, Essential Immunology, 9th Edn.
3. Mary S. Leffell, & Noel R. Rose, Handbook of Human Immunology, CRC press
- 4 Tizzard, Immunology
5. Elgert Immunology
6. Lidyard, Instant notes in Immunology, 2nd Edition.
7. A handbook of practical and clinical immunology. Talwar GP and Gupta SK (1992) CBS Publications .

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## **BPH-DSE8: CELL AND TISSUE CULTURE TECHNIQUES THEORY**

**Total Lectures: 60**

**Credits:4**

Objective: To familiarize the students with the basic concept of cell and tissue culture. The course encompasses the overall perspective of exploiting cell cultures as genetic and commercial tools and the further applications of these techniques in basic research.

### **UNIT-1**

**15 Hrs**

#### **HISTORICAL BACKGROUND AND BIOLOGY OF CULTURED CELLS:**

Historical Background, advantages of tissue culture, control of environment, characterisation of cells, limitations of culture, types of tissue culture, the culture environment, cell adhesion, cell proliferation, differentiation, origin of cultured cells, initiation, evolution of cell lines, senescence, transformation and development of continuous cell lines.

### **UNIT-2**

**15 Hrs**

#### **ASEPTIC TECHNIQUE, CULTURE VESSELS, SUBSTRATES, MEDIA AND SUPPLEMENTS**

Objectives of aseptic technique, elements of aseptic environment, sterile handling, standard procedure, substrates, treated surfaces, choice of culture vessel, specialized system, development of media, physicochemical properties, balanced salt solutions, complete media, serum, selection of media and serum, other supplements, immortalization

### **UNIT-3**

**15 Hrs**

## **PRIMARY CULTURE, SUBCULTURE AND CELL LINES**

Initiation of primary cell culture, isolation of tissue, types of primary culture, subculture and propagation, choosing a cell line, routine maintenance, subculture, sources of contamination, monitoring for contamination, cross contamination, eradication of contamination, disposal of contaminated cultures.

### **UNIT-4**

**15 Hrs**

## **CRYOPRESERVATION, QUANTITATION AND CYTOTOXICITY**

Rationale for freezing, principles of cryopreservation, cell banks, transporting cells, quantitation, cell counting, cell proliferation, growth curve, suspension cultures, phases of growth cycle, plating efficiency, cell migration, viability, toxicity and survival, in vitro limitations, nature of the assay, applications and cytotoxic assays, inflammation

## **BPH-DSE8: CELL AND TISSUE CULTURE TECHNIQUES**

### **PRACTICALS**

**Total Lectures: 30**

**Credits:2**

1. To check the viability of isolated cell using trypan blue dye exclusion technique.
2. Demonstration of cytotoxicity by MTT Assay
3. To carry out primary cell culture technique using whole tissue.
4. To quantitate the given population of cells using Neubauer Chamber
5. To extract viable cells from tissue and to maintain them in culture

### **SUGGESTED READING**

- Culture of animal cell by R. Ian Freshney (Sixth Ed.)
- Basic cell culture protocols by Cheryl L Miller (IVth edition)

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