

**CURRICULUM**  
**OF**  
**PHYSIOLOGY**  
**BS (HONS)**  
**MS (HONS)**

(Revised 2006)



**HIGHER EDUCATION COMMISSION**  
**ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

Prof. Dr. Syed Altaf Hussain	Member (Acad/R&D)
Prof. Dr. Altaf Ali G. Shaikh	Adviser (Acad/R&D)
Malik Ghulam Abbas	Deputy Director
Miss Ghayyur Fatima	Deputy Director (Curri)
Mr. M. Tahir Ali Shah	Assistant Director
Mr. Shafiullah Khan	Assistant Director

Composed by Mr. Zulfiqar Ali, HEC Islamabad

# CONTENTS

1.	Introduction	7
2.	Curriculum for BS (Hons)	
	i) Scheme of Studies	12
	ii) Details of Courses	13
3.	Curriculum for MS (Hons)	
	i) Scheme of Studies	50

## PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

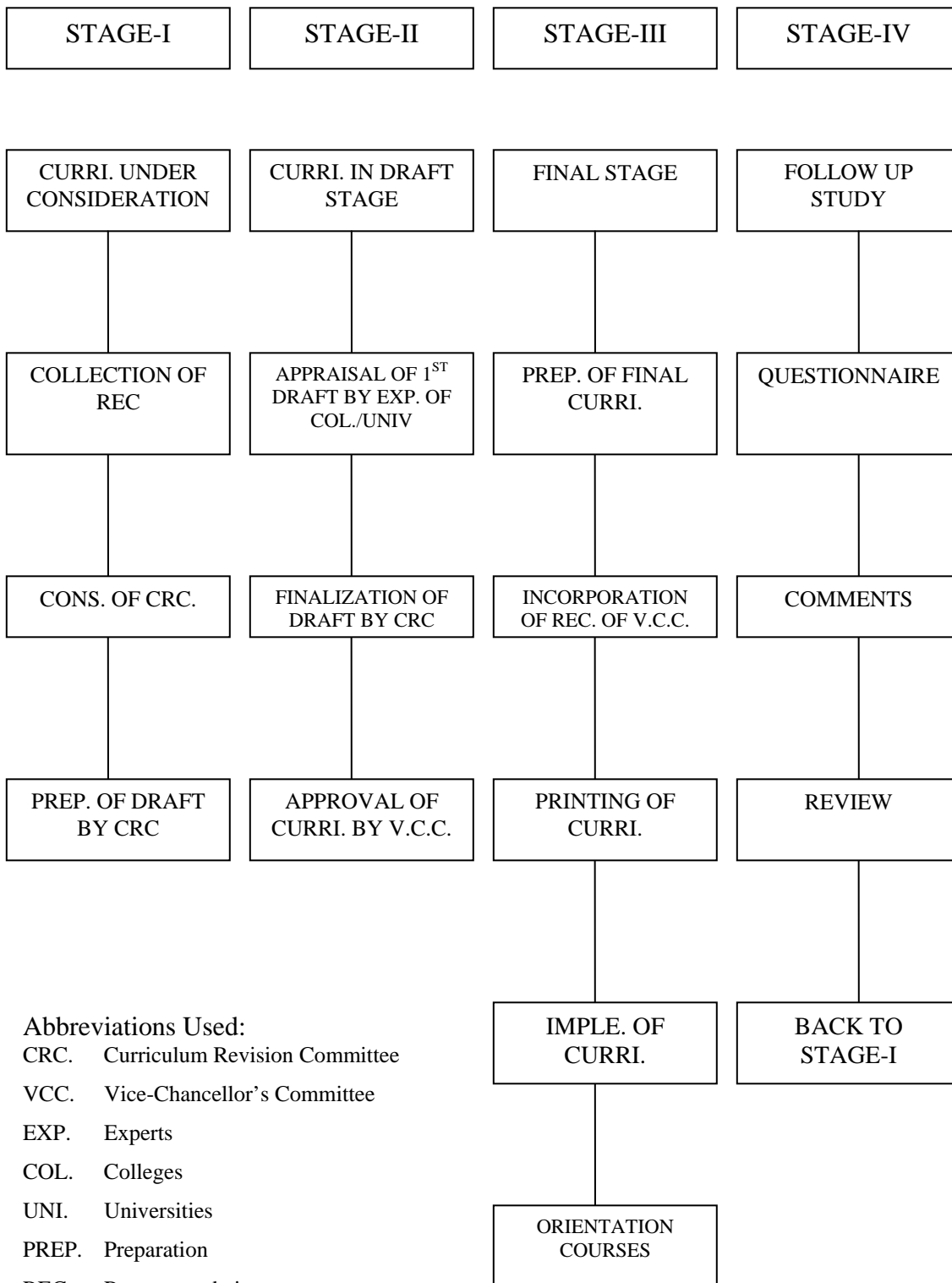
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Physiology in its meeting held in June 15-17, 2006 at the HEC Regional Centre, Lahore revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by the institutions.

*Prof. Dr. Altaf Ali G. Shaikh*  
*Adviser (Acad/R&D)*

August 2006

# CURRICULUM DEVELOPMENT





## INTRODUCTION

A final meeting of the National Curriculum Revision Committee in Physiology to review / revise the existing curriculum in Physiology at Graduate (4 year BS) and Postgraduate (2 year MS) was held on June 15-17, 2006 at HEC, Regional Center Lahore. The following attended:

- |    |  |                 |
|----|--|-----------------|
| 1. | Dr. M. Abdul Azeem,<br>Chairman,<br>Department of Physiology,<br>University of Karachi,<br>Karachi.  | <b>Convener</b> |
| 2. | Dr. Shahzad A Mufti,<br>Advisor,<br>COMSATS Institute of Information Tech,<br>Sector H-8/1, Islamabad  | Member          |
| 3. | Dr. Saghir Ahmad Jafri,<br>Professor,<br>The Institute of Molecular Biology &<br>Biotechnology,<br>University of Lahore,<br>Lahore.                | Member          |
| 4. | Dr. Zeenat Ayoob<br>Professor of Physiology,<br>Dow University of Health Sciences,<br>Baba-i-Urdu Road, Karachi                                    | Member          |
| 5. | Dr. Abdur Rahim Khan<br>Department of Biological Sciences,<br>Gomal University,<br>D.I. Khan. (N.W.F.P)  | Member          |
| 6. | Prof. Dr. Umar Ali Khan<br>Islamic International Medical College,<br>Ripha International University,<br>Al-Mizam 274, Peshawar Road, Rawalpindi.   | Member          |
| 7. | Prof. Dr. Ahmed Kamal Ansari,<br>Department of Physiology,<br>Hamdard University,<br>Karachi.  | Member          |
| 8. | Prof. Dr. Zia-ur-Rahman,<br>Chairman/Director Academics,<br>Department of Physiology and Pharmacology,<br>University of Agriculture,<br>Faislabad. | Member          |
| 9. | Dr. Tasawar Hussain Khan,<br>Associate Professor,<br>Institute of Biology,<br>B.Z. University, Multan  | Member          |

- |     |  |                  |
|-----|--|------------------|
| 10. | Dr. Ghulam Mustafa Seehar,<br>Professor, & Chairman,<br>Department of Physiology,<br>University of Sindh,<br>Jamshoro.   | Member           |
| 11. | Dr. Shahid Ali,<br>Prof of Zoology,<br>Department of Zoology,<br>University of the Punjab,<br>New Campus, Lahore.  | Member           |
| 12. | Dr. Abdullaev Abdumanon,<br>HEC Foreign Expert<br>University of Malakand,<br>Chakdara NWFP.  | Member           |
| 13. | Dr. Ergashov Abdullo,<br>HEC Foreign Expert,<br>University of Agriculture,<br>Faislabad.   | Member           |
| 14. | Professor Maqbool A. Memon,<br>Professor & Chairman,<br>Department of Veterinary Physiology,<br>Sindh Agriculture University, Tandojam.                          | Member           |
| 15. | Dr. Muhammad Hussain Qureshi<br>HEC, Foreign Faculty Expert,<br>Government College, University, Lahore   | Member           |
| 16. | Dr. Saleema Bashir<br>Assistant Professor,<br>Kinnaird College for Women Lahore.   | Member           |
| 17. | Mrs. Tasnim Farasat,<br>Associate Professor,<br>Lahore College for Women University, Lahore.   | Member           |
| 18. | Prof. Dr. Hidayat-ur-Rahman,<br>NWFP Agriculture University, Peshawar  | Member           |
| 19. | Dr. Abdul Rauf Bhutta,<br>Federal Seed Certification & Registration<br>Department, G / 9-4 Islamabad.  | Member           |
| 20. | Dr. Rubina Mushtaq,<br>Chairperson,<br>Department of Physiology,<br>University of Balochistan, Quetta  | Member           |
| 21. | Prof. Dr. A Majeed Cheema,<br>Chairman, Faculty of Biotechnology & informatics<br>Balochistan University of Information technology<br>Management Sciences Quetta | <b>Secretary</b> |

The meeting of the committee held in HEC Regional Center Lahore. The meeting started with the recitation of verses from the Holy Qur'an. by Mr. Bashir Ahmad Deputy Regional Director HEC, Lahore. Mr. Riaz Cheema, Director HEC Regional Center welcomed the participants on behalf of the Chairman Higher Education Commission Islamabad.

Mr. Muhammad Tahir Ali Shah, Assistant Director (Curriculum), HEC, Islamabad expressed his pleasure over the worthy participation of academia and R&D organizations from around the country, representing both the public and private sector institutions. He also pointed out the need to revise/prepare/update the curricula for 4 year BS and 2 year MS in the discipline in Physiology. He emphasized the need of standardized curricula for all HEC recognized Universities/Institutes for quality education and uniformity at the national level. He stated the importance of the programme and stressed that in order to compete with the international universities it is essential to introduce 4 year BS and 2 year MS degree programs. This will facilitate our student to continue higher education abroad and compete for international job market.

Mr. Tahir Ali Shah, then requested the convener and secretary of the NCRC in Physiology to take over the proceeding of the meeting. Dr. M. Abdul Azeem, Convener, and Prof. Dr. A Majeed Cheema thanks the representatives of HEC present in the meeting and ensured that vigorous effort will be made by all of us collectively to produce a Final Draft of a quality document in Physiology with consensus and participation of all the members.

### **3. Aims and Objectives**

In the meeting following objectives were considered:

- To develop international standard Physiology curriculum for 4 year BS and 2 year MS curriculum so that the uniformly could be adopted by the public and privately sector institutions through out the country.
- To impart up to date knowledge and practical skills amongst Physiology graduates through theory and practical.
- To introduce practical utility of the ramifications of geographical knowledge and tools like maps, surveying techniques and tools essential for transparency, accountability and rational decision-making.

Final curriculum for 4 year Bachelor and 2 year MS in Physiology for the first time at the national level was discussed in length and developed.

# **BS Physiology**

## **(Duration 4 years and 8 semesters)**

**Entry Requirement:** 12 years (Pre Medical/ Pre-Engineering)

**Credit requirement:** 124 – 136

### **Objectives:**

1. Study of normal Physiology/Physiological functions in Human/Plant/Animal at the level of cells, tissues, organs, systems and body as whole.
2. Application of the above knowledge in the understanding of disease process taking few selected examples.
3. To provide fundamental knowledge in statistical concepts and regulatory approach in Physiology.
4. To adopt multidisciplinary approach to equip the students for multidimensional carrier opportunities.
5. Experiments to demonstrate some of the important physiological concepts.
6. Training the students to demonstrate few clinical signs and laboratory work.
7. Encourage the students capacity for self learning by:
  - Project work
  - Seminars
  - Research Work
  - Internship

### **Learning Outcome:**

A student holding a degree of BS will be able to:

1. Understand the physiological functions of cells, tissues, organs, systems and body as a whole.
2. Student will be able to apply physiological knowledge with respect to the understanding of the diseases associated with various systems.
3. Student will be able to integrate all the systems with respect to the regulatory aspects of whole body.
4. Student's concepts will mature for the physiological phenomenon with the performance of experiments on animal models and human subject using non-invasive techniques.
5. The student will develop confidence in communication, research protocols and career identification due to capacity building during studies.

i) Compulsory courses:	English (Communication Skills)	12
	Islamiat:	2
	Pak- Studies:	2
	Math / Biology: (FSc/Inter Level)	6
	Computer:	3
	Total:	25

Note: The contents of these courses are available in their respective curricula

ii) Allied (Minor)	25
iii) <b>Major + Project and Internship</b>	<b>58</b>
iv) <u>Multidisciplinary</u>	<u>25</u>
Total:	133

- \* This is only a model and every University may adjust the Allied (minor) courses and multidisciplinary courses according to their own needs and resources.  
The course number should be assigned as 300,400,500 and 600 levels from 1<sup>st</sup> to 8<sup>th</sup> semester respectively

**Following is the year wise and Semester wise outline of BS 4 year Program in Physiology**

# SCHEME OF STUDIES

<p><b>YEAR I</b></p> <p><b>Semester I</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td>English-I</td><td style="text-align: right;">3</td></tr> <tr><td>Islamiat</td><td style="text-align: right;">2</td></tr> <tr><td>Mathematics-I / Biology-I</td><td style="text-align: right;">3</td></tr> <tr><td><i>Biochemistry-I*</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><i>Cell and Molecular Biology-I *</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><b>Functional Anatomy and Physiology-I</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>18 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR 2</b></p> <p style="text-align: center;"><b>Semester III</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td>English-III</td><td style="text-align: right;">3</td></tr> <tr><td>Introduction and Application to Computer</td><td style="text-align: right;">3(0 +3)</td></tr> <tr><td><u>Humanities/Civilization</u></td><td style="text-align: right;">2</td></tr> <tr><td><b>Homeostasis</b></td><td style="text-align: right;"><b>1</b></td></tr> <tr><td><b>Physiology of blood and ECF</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><i>Plant Physiology*</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><i>Prokaryotic Physiology*</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>18 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR 3</b></p> <p style="text-align: center;"><b>Semester V</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><u>Biostatistics</u></td><td style="text-align: right;">3(1 + 2)</td></tr> <tr><td><b>Cardiovascular Physiology</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td><b>Pulmonary Physiology</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><b>Renal Physiology</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><b>Gastroenteropancreatic Physiology</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>16 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR 4</b></p> <p style="text-align: center;"><b>Semester VII</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><i>Pharmacology *</i></td><td style="text-align: right;">4(3 + 1)</td></tr> <tr><td><b>Environmental Physiology*</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><b>Physiology of Health, Fitness and Exercise *</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><u>Research Methodology</u></td><td style="text-align: right;">3(0 + 3)</td></tr> <tr><td><b>Project</b></td><td style="text-align: right;"><b>3</b></td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>16 credits</b></td></tr> </table>	English-I	3	Islamiat	2	Mathematics-I / Biology-I	3	<i>Biochemistry-I*</i>	3(2 + 1)	<i>Cell and Molecular Biology-I *</i>	3(2 + 1)	<b>Functional Anatomy and Physiology-I</b>	<b>4(3 + 1)</b>	<b>Total</b>	<b>18 credits</b>	English-III	3	Introduction and Application to Computer	3(0 +3)	<u>Humanities/Civilization</u>	2	<b>Homeostasis</b>	<b>1</b>	<b>Physiology of blood and ECF</b>	<b>3(2 + 1)</b>	<i>Plant Physiology*</i>	3(2 + 1)	<i>Prokaryotic Physiology*</i>	3(2 + 1)	<b>Total</b>	<b>18 credits</b>	<u>Biostatistics</u>	3(1 + 2)	<b>Cardiovascular Physiology</b>	<b>4(3 + 1)</b>	<b>Pulmonary Physiology</b>	<b>3(2 + 1)</b>	<b>Renal Physiology</b>	<b>3(2 + 1)</b>	<b>Gastroenteropancreatic Physiology</b>	<b>3(2 + 1)</b>	<b>Total</b>	<b>16 credits</b>	<i>Pharmacology *</i>	4(3 + 1)	<b>Environmental Physiology*</b>	<b>3(2 + 1)</b>	<b>Physiology of Health, Fitness and Exercise *</b>	<b>3(2 + 1)</b>	<u>Research Methodology</u>	3(0 + 3)	<b>Project</b>	<b>3</b>	<b>Total</b>	<b>16 credits</b>	<p><b>YEAR I</b></p> <p><b>Semester II</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td>English-II</td><td style="text-align: right;">3</td></tr> <tr><td>Pak Studies</td><td style="text-align: right;">2</td></tr> <tr><td>Mathematics-II / Biology-II</td><td style="text-align: right;">3</td></tr> <tr><td><i>Biochemistry-II*</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><i>Cell and Molecular Biology-II *</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><b>Functional Anatomy and Physiology-II</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>18 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR2</b></p> <p style="text-align: center;"><b>Semester IV</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td>English-IV (Communication Skills)</td><td style="text-align: right;">3</td></tr> <tr><td><u>Introduction to Bioinformatics *</u></td><td style="text-align: right;">3(0 + 3)</td></tr> <tr><td><b>Neurophysiology</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td><b>Muscle Physiology</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><u>Principles of Immunology</u></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>16 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR 3</b></p> <p style="text-align: center;"><b>Semester VI</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><b>Endocrinology</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td><b>Reproductive and Developmental Physiology</b></td><td style="text-align: right;"><b>4(3 + 1)</b></td></tr> <tr><td><b>Physiology of Special Senses</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><i>Comparative Animal Physiology*</i></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><u>Human and Animal Behavior</u></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>17 credits</b></td></tr> </table> <p style="text-align: center;"><b>YEAR 4</b></p> <p style="text-align: center;"><b>Semester VIII</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><b>Pathophysiology (Plant/Human/Animal)</b></td><td style="text-align: right;"><b>3(2 + 1)</b></td></tr> <tr><td><u>Physiological Biotechnology *</u></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><u>Toxicology*</u></td><td style="text-align: right;">3(2 + 1)</td></tr> <tr><td><u>Ergonomics*</u></td><td style="text-align: right;">2</td></tr> <tr><td><b>Internship</b></td><td style="text-align: right;"><b>3</b></td></tr> <tr><td style="text-align: right;"><b>Total</b></td><td style="text-align: right;"><b>14 credits</b></td></tr> </table>	English-II	3	Pak Studies	2	Mathematics-II / Biology-II	3	<i>Biochemistry-II*</i>	3(2 + 1)	<i>Cell and Molecular Biology-II *</i>	3(2 + 1)	<b>Functional Anatomy and Physiology-II</b>	<b>4(3 + 1)</b>	<b>Total</b>	<b>18 credits</b>	English-IV (Communication Skills)	3	<u>Introduction to Bioinformatics *</u>	3(0 + 3)	<b>Neurophysiology</b>	<b>4(3 + 1)</b>	<b>Muscle Physiology</b>	<b>3(2 + 1)</b>	<u>Principles of Immunology</u>	3(2 + 1)	<b>Total</b>	<b>16 credits</b>	<b>Endocrinology</b>	<b>4(3 + 1)</b>	<b>Reproductive and Developmental Physiology</b>	<b>4(3 + 1)</b>	<b>Physiology of Special Senses</b>	<b>3(2 + 1)</b>	<i>Comparative Animal Physiology*</i>	3(2 + 1)	<u>Human and Animal Behavior</u>	3(2 + 1)	<b>Total</b>	<b>17 credits</b>	<b>Pathophysiology (Plant/Human/Animal)</b>	<b>3(2 + 1)</b>	<u>Physiological Biotechnology *</u>	3(2 + 1)	<u>Toxicology*</u>	3(2 + 1)	<u>Ergonomics*</u>	2	<b>Internship</b>	<b>3</b>	<b>Total</b>	<b>14 credits</b>
English-I	3																																																																																																								
Islamiat	2																																																																																																								
Mathematics-I / Biology-I	3																																																																																																								
<i>Biochemistry-I*</i>	3(2 + 1)																																																																																																								
<i>Cell and Molecular Biology-I *</i>	3(2 + 1)																																																																																																								
<b>Functional Anatomy and Physiology-I</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Total</b>	<b>18 credits</b>																																																																																																								
English-III	3																																																																																																								
Introduction and Application to Computer	3(0 +3)																																																																																																								
<u>Humanities/Civilization</u>	2																																																																																																								
<b>Homeostasis</b>	<b>1</b>																																																																																																								
<b>Physiology of blood and ECF</b>	<b>3(2 + 1)</b>																																																																																																								
<i>Plant Physiology*</i>	3(2 + 1)																																																																																																								
<i>Prokaryotic Physiology*</i>	3(2 + 1)																																																																																																								
<b>Total</b>	<b>18 credits</b>																																																																																																								
<u>Biostatistics</u>	3(1 + 2)																																																																																																								
<b>Cardiovascular Physiology</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Pulmonary Physiology</b>	<b>3(2 + 1)</b>																																																																																																								
<b>Renal Physiology</b>	<b>3(2 + 1)</b>																																																																																																								
<b>Gastroenteropancreatic Physiology</b>	<b>3(2 + 1)</b>																																																																																																								
<b>Total</b>	<b>16 credits</b>																																																																																																								
<i>Pharmacology *</i>	4(3 + 1)																																																																																																								
<b>Environmental Physiology*</b>	<b>3(2 + 1)</b>																																																																																																								
<b>Physiology of Health, Fitness and Exercise *</b>	<b>3(2 + 1)</b>																																																																																																								
<u>Research Methodology</u>	3(0 + 3)																																																																																																								
<b>Project</b>	<b>3</b>																																																																																																								
<b>Total</b>	<b>16 credits</b>																																																																																																								
English-II	3																																																																																																								
Pak Studies	2																																																																																																								
Mathematics-II / Biology-II	3																																																																																																								
<i>Biochemistry-II*</i>	3(2 + 1)																																																																																																								
<i>Cell and Molecular Biology-II *</i>	3(2 + 1)																																																																																																								
<b>Functional Anatomy and Physiology-II</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Total</b>	<b>18 credits</b>																																																																																																								
English-IV (Communication Skills)	3																																																																																																								
<u>Introduction to Bioinformatics *</u>	3(0 + 3)																																																																																																								
<b>Neurophysiology</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Muscle Physiology</b>	<b>3(2 + 1)</b>																																																																																																								
<u>Principles of Immunology</u>	3(2 + 1)																																																																																																								
<b>Total</b>	<b>16 credits</b>																																																																																																								
<b>Endocrinology</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Reproductive and Developmental Physiology</b>	<b>4(3 + 1)</b>																																																																																																								
<b>Physiology of Special Senses</b>	<b>3(2 + 1)</b>																																																																																																								
<i>Comparative Animal Physiology*</i>	3(2 + 1)																																																																																																								
<u>Human and Animal Behavior</u>	3(2 + 1)																																																																																																								
<b>Total</b>	<b>17 credits</b>																																																																																																								
<b>Pathophysiology (Plant/Human/Animal)</b>	<b>3(2 + 1)</b>																																																																																																								
<u>Physiological Biotechnology *</u>	3(2 + 1)																																																																																																								
<u>Toxicology*</u>	3(2 + 1)																																																																																																								
<u>Ergonomics*</u>	2																																																																																																								
<b>Internship</b>	<b>3</b>																																																																																																								
<b>Total</b>	<b>14 credits</b>																																																																																																								

# DETAILS OF COURSES

## YEAR I

### Semester I

English-I	3
Islamiat	2
Mathematics-I / Biology-I	3

### **Biochemistry-I\*      3 (2 + 1)**

Amino Acids; Peptides and Proteins; The Covalent and 3-D structure of proteins sequences and evolution; Carbohydrates: monosaccharides; oligosaccharides; polysaccharides. Glycoconjugates: Glycosaminoglycans; Proteoglycans; Glycoproteins; Carbohydrates as informational molecules. Enzymes: How enzymes work; Mechanism of enzyme action and enzyme kinetics; regulatory enzyme precursors and associates,. Nucleic Acids: Structure and function of basis, nucleosides and nucleotides; DNA double helical structure, Lipids: Storage Lipids, Fatty acids and their types, Triacylglycerols, Structural Lipids, Glycerophospholipids, Sphingolipid, glycolipid Steroles and Isoprenoids.

#### **Practicals:**

1. Study of hydrolysis of starch by using mineral acids
2. Various qualitative tests for monosaccharides, oligosaccharides and polysaccharides
3. Preparation of calibration curve for glucose
4. Estimation of serum glucose by using calibration curve
5. Detection of reducing sugars in the presence of non-reducing sugars
6. Qualitative tests for different lipids
7. Fractionation of brain lipids and their analysis by thin-layer chromatography
8. Various qualitative tests for amino acids
9. Paper and thin-layer chromatography of sugars
10. Paper chromatography of various amino acids
11. Determination of pKa values of amino acids (Glycine, Alanine) by preparation of titration curves.
12. Qualitative and quantitative analysis of proteins by colorimetric methods (Biuret and Lowry's)

#### **Books Recommended:**

- Nelson, D. L. and Cox, M. M., Lehninger Principles of Biochemistry, 4<sup>th</sup> ed; W.H. Freeman and Company, New York, 2005.
- Voet, D., Voet, J.G. and Pratt, C. W., Fundamentals of Biochemistry; John Wiley and Sons. Inc., New York, 2002.
- Berg, J. M., Tymoczko, J. L. and Stryer, L., Biochemistry 5<sup>th</sup> ed; W.H. Freeman and Company, New York, 2002.

- Devlin, T. M., Textbook of Biochemistry with Clinical Correlations 5<sup>th</sup> ed; John Wiley and Sons. Inc., New York, 2002.
- Zubay, G., Biochemistry 4<sup>th</sup> ed; W. C. Brown Publishers, Inc., Oxford England, 1995.
- Plummer, D. T., An Introduction to Practical Biochemistry 4<sup>th</sup> ed; McGraw-Hill Book Company, London, 1990.
- Wilson, K. and Walker, J., Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> ed; Cambridge Univ. Press, London 1994

## **Cell and Molecular Biology-I\* 3 (2 + 1)**

Brief recapitulation of ultrastructure of cell and function of various cellular organelles with specific emphasis on: the relationship of membrane structure and permeability, membrane transport, the role of mitochondria and chloroplast in cellular metabolism and energy transformation, role of ribosomes and endoplasmic reticulum in protein synthesis and protein transduction, the role of endoplasmic reticulum in drug metabolism, golgi apparatus and cell secretions, role of lysosomes with endocytosis, phagocytosis and metabolic disorders due to defects of lysosomal function. Cytoskeleton, microfilaments and microtubules, receptor proteins and cell to cell interaction.

### **Practicals:**

1. Detection and quantitative determination of DNA by diphenylamine method.
2. Detection and quantitative determination of RNA by orcinol method.
3. Culturing and characterization of bacteria
4. Staining of Bacterial Cells
5. Culturing of yeast
6. Staining and study of budding in yeast cell
7. Identification of various types of blood cells in human blood through smear preparation technique
8. Counting of prokaryotic cells (bacteria) and blood cells by using hemocytometer

### **Books Recommended:**

- Karp, G., Cell and Molecular Biology: Concepts and Experiments, 4<sup>th</sup> ed; John Wiley and Sons, Inc., 2005.
- Lodish H, Bresk A., Matsumura, P., Kaiser, C.A., Kriger, M., Scott, M.P., Zipursky, S.L. and Darnel J., Molecular Cell Biology, 5<sup>th</sup> ed;. W.H. Freeman and Co., New York., 2004.
- Roberties, E.D.P. and Roberties, E. M. F. Cell and Molecular Biology, 8<sup>th</sup> ed. Lippin Cott William and Willkins, New York, 2001.

## Functional Anatomy and Physiology-I 4 (3 + 1)

### Objectives:

1. To provide understanding of the human tissues, organs and systems with respect to their basic functions.
2. To provide the knowledge of the components of individual systems and their role in body functions.
3. To inculcate the concept of regulation of physiological functions through different body system.
4. To understand the mechanism of various physiological processes related with individual system.

Introduction: Organization of human body including chemical and cellular levels, Basic anatomical terminologies, body planes and cavities.

Tissue: Structure and function, Epithelial, Connective, Muscle and Nervous tissues. Bone and Cartilage, Adaptive cellular and tissue behavior: Hyperplasia, Hypertrophy, Atrophy, Genetic abnormalities.

Blood: Physical characteristics and components of blood, origin and development of blood cells, structure and function of RBC, WBC, and platelets, blood groups, and homeostasis.

Cardiovascular System: Structure and function of heart, Cardiac cycle, heart sounds, cardiac conduction system. Structure and function of blood vessels, Blood pressure and its regulatory factors.

Lymphatic System: Overview of Lymph. Structure and function of lymphatic tissues and organs. Antibodies and Immune cells. Specific and non specific immune reactions.

Respiratory System: Structure and function of the Respiratory organs: Nose. Pharynx, Larynx, trachea, Bronchial tree and lungs. Pleural cavity and Pleural fluid. Lung volumes and capacities. Non-respiratory air movements. Alveolar ventilation: mechanism of alveolar gas exchange.

Digestive System: Structure and function of the digestive organs. Salivary glands and their secretion. Anatomical and morphologic aspects of pharynx, esophagus, and stomach. Phenomenon of deglutition. Gastric and pancreatic juice. Digestion, absorption and movements of GIT.

### Books Recommended:

- Shier, D., Butler, J., Lewis, R., Hole's Essentials of Human Anatomy and Physiology, 8<sup>th</sup> ed; McGraw-Hill, 2003.
- Tortora, G.J. and Grabowski, S.R., Principles of Anatomy and Physiology, 9<sup>th</sup> ed; John Wiley and Sons, 2000.
- Guyton, A. C. and Hall, J. E. Textbook of Medical Physiology, 12<sup>th</sup> ed; W.B Saunders, 2005.
- Waugh, A., Grant, A., Ross and Wilson Anatomy and Physiology in Health and Illness, 9<sup>th</sup> ed; Churchill Livingstone, 2002.
- Marieb, E.N., Human Anatomy and Physiology, 4<sup>th</sup> ed; Benjamin/Cummings Science Publishing, 1997.

**Practicals:**

1. Study of the organization of human body in torso model.
2. Examination of the gross structure of various tissues.
3. Study of various systems, organs, tissues and cells and their functions with the help of charts and models.
4. Methods of obtaining blood samples, choice of anticoagulants and preservation.
5. To determine the specific gravity and viscosity of blood and plasma.
6. To record the human blood pressure by using Palpatory and Auscultatory methods.
7. To observe and record normal heart activity in exposed frog heart by Kymography.
8. To record and relate the changes in circumference of chest during normal breathing with activity of respiratory muscles.
9. To observe respiratory movement and determination of respiratory rate by Kymography.
10. Comparison of health and disease states of different body tissues and organs with the help of slides or charts.
11. To determine the normal chemical composition of human saliva.
12. To observe gastro-intestinal movements in exposed abdomen of anesthetized animals and discussion on their nervous control.

**Semester II**

English-II	3
Pak Studies	2
Mathematics-II / Biology-II	3

**Biochemistry-II\* 3 (2 + 1)**

Bioenergetics and thermodynamics: Glycolysis; Gluconeogenesis and pentose phosphate pathways and their regulation. Biosynthesis and breakdown of glycogen in animals; regulation of glycogen metabolism. Citric acid cycle: production of acetyl-CoA; citric acid cycle reactions and its regulations. The glyoxylate cycle; electron transport chain reactions and oxidative phosphorylation in mitochondria and its relationship with energy production in the cell; role of mitochondria in Apoptosis and oxidative stress; photosynthesis; photophosphorylation and light absorption; the central photochemical events. Fat metabolism; digestion, mobilization and transport of fats; oxidation pathways of fatty acids; ketone bodies. Biosynthesis of fatty acids and Eicosanoids; biosynthesis of triacylglycerols, membrane phospholipids, cholesterol and steroids. Nitrogen metabolism: Biosynthesis of amino acids. Integration and hormonal regulation of mammalian metabolism.

**Practicals:**

- Glycogen isolation from liver and study of its hydrolysis.
- Enzymatic determination of glucose.
- Extraction and salting out of proteins.

- Isolation and purification of proteins by various column chromatographic techniques (gel filtration and ion exchange).
- Determination of molecular size of proteins by SDS-PAGE technique.
- Quantitative analysis of proteins by UV spectrophotometry
- Extraction and quantitative analysis of amino acids.

#### **Books Recommended:**

- Nelson, D. L. and Cox, M. M., Lehninger Principles of Biochemistry, 4<sup>th</sup> ed; W.H. Freeman and Company, New York, 2005.
- Voet, D., Voet, J.G. and Pratt, C. W., Fundamentals of Biochemistry; John Wiley and Sons. Inc., New York, 2002.
- Berg, J. M., Tymoczko, J. L. and Stryer, L., Biochemistry 5<sup>th</sup> ed; W.H. Freeman and Company, New York, 2002.
- Devlin, T. M., Textbook of Biochemistry with Clinical Correlations 5<sup>th</sup> ed; John Wiley and Sons. Inc., New York, 2002.
- Zubay, G., Biochemistry 4<sup>th</sup> ed; W. C. Brown Publishers, Inc., Oxford England, 1995.
- Plummer, D. T., An Introduction to Practical Biochemistry 4<sup>th</sup> ed; McGraw-Hill Book Company, London, 1990.
- Wilson, K. and Walker, J., Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> ed; Cambridge Univ. Press, London 1994.

### **Cell and Molecular Biology-II \*      3 (2 + 1)**

Molecular structure of prokaryotic and eukaryotic chromosomes, significance of histones and high mobility group proteins in the packing of chromosomes and gene expression. Replication of DNA: mechanism in prokaryotes and eukaryotes. DNA polymerase, other replication enzymes and DNA binding proteins involved in replication.. DNA repair mechanisms. Transcription, RNA polymerases, transcriptional control in prokaryotes and eukaryotes. Post-transcriptional processing of RNAs (mRNA, rRNA and tRNA). RNA splicing , ribozymes. Genetic code, genetic code in mitochondrial DNA. Mutagens, point mutations and their consequences, inborn errors of metabolism. Protein synthesis. Post-translational processing of proteins. Gene expression, Lac operon, Try operon. Recombinant DNA technology: Cloning vectors, Restriction endonucleases, constructions and screening of gene libraries. cDNA cloning. DNA sequencing, Southerning and Northern blotting, site-specific mutagenesis. Protein engineering. Cell cycle

#### **Practicals:**

- Purification and characterization of proteins on polyacrylamide gel electrophoresis.
- Quantitative analysis of DNA and RNA by UV spectrophotometry.
- Separation of different sized DNA fragments by agarose gel electrophoresis
- Study of transformed bacteria on the basis of antibiotic resistance.

**Books Recommended:**

- Karp, Gerald, Cell and Molecular Biology: Concepts and Experiments, 4<sup>th</sup> ed, John Wiley and Sons, Inc. 2005.
- Darnel Jr., Lodish Harvey and Balimore, D., Molecular Cell Biology, Scientific American Inc. New York 1990.

**Functional Anatomy and Physiology-II 4 (3 + 1)**

Excretory system: System organization. Kidneys: Gross and microscopic anatomy. Nephron: Structure and blood supply. Urine formation: Glomerular filtration, Processes of tubular reabsorption and secretion. Urine transportation, storage and micturition.

Endocrine System: Cellular secretions and their types. Structure and function of endocrine glands, Basic mechanism of hormone action. Control of hormone secretion by Hypothalamo-pituitary axis. Secretions of nonendocrine glands of body.

Reproductive System: Female reproductive system: Ovary: Gross anatomy and histology, Oogenesis and its hormonal regulation, Structure and function of fallopian tubes, uterus, cervix and vagina. Menstrual cycle: Phases of menstruation, hormonal regulation. Overview of secondary sex characteristics, external genitalia and mammary glands. Male reproductive system: Testes: Gross and microscopic anatomy, Spermatogenesis. Structure and function of scrotum, epididymis, ductus deference, ejaculatory ducts, penis. Accessory sex glands and composition of semen. Male sex hormones and their role in spermatogenesis.

Musculo-skeletal System:

Skeletal organization: Axial and Appendicular skeleton. Structure of Bone. Anatomy and classification of joints. Structure and function of muscle. Neuromuscular junction.

Nervous System: Structure and function of neuron, neuroglial cells and their classification. Membrane potential and nerve impulse. Synaptic transmission.

Organization of CNS: Sensory and motor system.

Spinal Cord: Anatomy and Physiology, Protective structures, Nerve pathways: Sensory and motor tracts and Spinal nerves. Reflexes and reflex arc.

Brain: Anatomical divisions, protective coverings, formation and regulation of cerebrospinal fluid, cerebral blood flow and blood brain barrier, Functional areas of brain and cranial nerves. Receptors and their classification.

Special Senses: Structure and Function of Ear, Eye, Nose and Tongue.

Integumentary system: Accessory structures of skin, hair and nails. Overview of skin glands.

**Books Recommended:**

- Shier, D., Butler, J., Lewis, R., Hole's Essentials of Human Anatomy and Physiology, 8<sup>th</sup> ed; McGraw-Hill, 2003.

- Tortora, G.J. and Grabowski, S.R., Principles of Anatomy and Physiology, 9<sup>th</sup> ed; John Wiley and Sons, 2000.
- Guyton, A. C. and Hall, J. E. Textbook of Medical Physiology, 12<sup>th</sup> ed; W.B Saunders, 2005.
- Waugh, A., Grant, A., Ross and Wilson Anatomy and Physiology in Health and Illness, 9<sup>th</sup> ed; Churchill Livingstone, 2002.
- Marieb, E.N., Human Anatomy and Physiology, 4<sup>th</sup> ed; Benjamin/Cummings Science Publishing, 1997.

### **Practicals:**

1. To observe and determine the normal physical and chemical properties of urine sample.
2. Alterations in normal physical properties of urine in different pathological states.
3. Detection of abnormal constituents of urine.
4. Microscope examination of urinary sediments.
5. To determine (quantitative) blood urea nitrogen in the provided pathological sample for the detection of uremia.
6. Spectrophotometric determination of urinary calcium concentration.
7. Spectrophotometric determination of urinary phosphate concentration.
8. To study the gross structure of male and female reproductive organs and their functions in animal models.
9. Identification and isolation of endocrine glands in dissected frog/uromastix.
10. Comparison of health and disease states of different body tissues and organs with the help of slides or charts
11. The microscopic examination of cartilaginous and bone matrix in prepared slides.
12. Study of cranial and spinal nerves and their functions with the help of charts.
13. To study the spinal reflexes in animal model (frog).
14. Isolation of nerve and muscle (Sciatic and Gastrocnemius) in frog and to observe irritability on mechanical and electrical stimulation.
15. To locate cold, warm, pain and pressure spots on human skin.
16. Comparison of health and disease states of different body tissues and organs with the help of slides or charts.

## **YEAR 2**

### **Semester III**

English-III	3
Introduction and Application to Computer	3(0 +3)
<u>Humanities/Civilization</u>	2
The course content will be provided by the relevant department of the University	

# Homeostasis

1

Physiological homeostasis, homeostasis of organism water regulation, sugar homeostasis, temperature regulations in animals, other mechanisms of homeostasis, changes in internal environment, costs and benefits of homeostasis, endocrine system and homeostasis, feed back circuits.

## Books Recommended:

- Ezeilo, G. C., Text book of Physiology. Oxford University Press, New Delhi, 2002.
- Campbell, N.A., Reece, J.B., Mitchell, L.G., Biology, 7<sup>th</sup> ed: Benjamin/Cummings, Menlo Park, 2005.

## Physiology of blood and ECF

3 (2 + 1)

Body fluid Compartments: Classification, composition of body fluids, regulation of fluid composition and volume, regulation of fluid exchange and osmotic equilibrium between intra and extra cellular fluid.

Interstitial Fluid: Overview, function, interstitial fluid, colloidal osmotic pressure.

Blood: Hemopoiesis, stem and progenitor cells, differentiation of blood cells.

Erythropoiesis: Overview, regulation of erythropoiesis, development of erythroid lineage.

red blood cell development, Hb synthesis, structure and function, Heme synthesis, iron metabolism, transport and storage. destruction of RBCs.

Leukopoiesis: Development, morphology and functions of granulocytes and agranulocytes, macrophages, distribution, functions and fate.

Megakaryopoiesis: Megakaryocytes Morphology, synthesis, distribution.

Functions of platelet, Role of platelets in hemostasis; platelet adhesion, platelet release reaction, platelet aggregation.

Fibrinogen binding, release of ADP and Thromboxane production.

Principles of Hemostasis: Coagulation factors, Natural Inhibitors. The blood coagulation cascade. The contact activation system. Fibrinolytic system and Anticoagulation system.

ABO system: Introduction, Principles of ABO Group determination. The Rh system, Hemolytic disease of the newborn.

Plasma: Composition and function, synthesis of plasma proteins. Plasma protease inhibitors, plasma colloid osmotic pressure.

Lymph: Lymph nodes and channels, capillaries and their permeability, rate of lymph flow.

Composition and function, effect of Interstitial fluid on lymph flow.

Cerebrospinal Fluid: Formation, Flow and Absorption. Cerebrospinal Fluid Pressure, Cerebrospinal Fluid and Blood Brain Barriers, Cushioning Function of the Cerebrospinal Fluid.

Brain edema.

Sweat: Glands, formation, volume regulation.

Saliva: Synthesis, defensive role.

Ocular fluids: Overview, production and turn over of Tears, Aqueous and Vitreous humor.

Synovial fluid: Composition and regulation of volume and function.

Amniotic fluid: Synthesis, regulation of volume and function.

Bile: Significance, formation, secretion, Hepatic excretory function.

Milk: Composition, Metabolic drain, Anti infectious role.

Body Cavity Fluids: Overview of Pleural, Pericardial fluid, peritoneal fluid and surfactant

### **Books Recommended:**

- Pallister, C., Blood Physiology and Pathophysiology.. Butterworth — Heinemann Ltd.,1994.
- Schmaier A. H. and Petruzelli L. M., Hematology: Lippincott Williams and Wilkins, 2003.
- Talib V.H. and Khurana S.K., Haematology For students (Clinical and Practical Approach). CBS Publishers and Distributors, 1995.
- Ogsten, D., The Physiology of Hemostasis: Biddies Ltd, Guildford and King's Lynn,1983.
- Ganong, W. F., Review of Medical Physiology: International ed. McGrawHill.2005.
- Guyton, A. C. and Hall, J. E. Textbook of Medical Physiology, 12<sup>th</sup> ed; W.B Saunders, 2005.

### **Practicals:**

1. Determination of erythrocyte count in a sample of blood.
2. Determination of absolute red cell Indices by calculations:
3. Determination of total leukocyte count in a sample of blood.
4. Determination of bleeding time and clotting time.
5. Determination of blood groups
6. Determination of differential leukocytes count.
7. Determination of platelet count.
8. Estimation of hemoglobin concentration by Sahli's method.
9. To study the osmotic fragility of RBCs.
10. To determine the erythrocyte sedimentation rate (ESR) by Westergren's method.
11. To determine the packed cell volume (PCV) or Hematocrit ratio by Wintrobe's method.

## **Plant Physiology\***

**3 (2 + 1)**

### **Introduction**

Concepts and significance of plant physiology, terms used in plant physiology, the organization of plants (including seed and planting material) at cell, tissue and organ level.

### **Cell structure and Function**

Cell membrane, cell wall, vacuole, sub-cellular organelles.

### **Water relation and plant nutrition**

Properties of water, diffusion, bulk flow, active and passive transport, osmosis, water potential and its components, significance of water potential, mechanism of water uptake from soil and air, macro and micro nutritional elements and uptake, N, P, K, role in plant.

### Metabolism

Photosynthesis, light and pigments, photosynthetic apparatus, cyclic and non cycle electron transport chain, transpiration chain, light reaction, CO<sub>2</sub> reduction, carbon metabolism, C<sub>3</sub> pathway dark reaction, C<sub>3</sub> and C<sub>4</sub>-plants, C<sub>4</sub>-carbon reduction pathway, three main types, CAM (Crassulacian acid metabolism) pathway, factors effecting photosynthesis, translocation and distribution of photoassimilated, photorespiration, respiration.

Nitrogen assimilation: Nitrogen cycle, nitrogen fixation, entrances of nitrogen to life compounds i.e. amino acids main pathways.

Translocation of food: Phloem anatomy, sieve tube and sieve cells, experiment for food translocation in phloem, source and sink concepts, pressure flow mechanism for translocation of food.

Physiology of ripening and dormancy: Physiology of fruits ripening and development, seed development and germination. Physiology of dormancy, senescence, death, and abscission, importance of dormancy, condition for dormancy of seed.

Plant growth and development: Patterns in plant developments, plant growth regulator (PGR), classification of PGR, role of plant growth regulators in plant and seed growth and development.

Mode of action of PGR, photoperiodism.

Stress Physiology: Types of biotic and abiotic stresses, physiology of plants and seed under stress.

### **Practicals :**

1. Preparation of solutions (Molar, Molal, Normal, Percent, ppm)
2. Demonstration and performance of seed germination of monocot and dicot seeds.
3. Measurement of water potential and its components (by water potential apparatus)
4. Demonstration of photosynthetic and transpiration rates by using Infra-Red Gas Analyzer.
5. Demonstration of nutrients diagnostic techniques (Hydroponics, Aeroponic, sand and water cultures).
6. Use of physical and chemical methods of analysis in plant physiology

### **Books Recommended:**

- Hopkins, W.G. and Hunner, N.P.A., Introduction to plant physiology. John Willey and Sons, Inc., N.Y., 2004.
- Raven P.H., Evert R.F., Eichhorn S.E, Biology of Plants. 6<sup>th</sup> ed; Worth Publishers, 1998.
- Ahmad, I. and Bhutta, A.R., Textbook of Introductory Plant Pathology. National Book Foundation, 2005.

- Buchanan, B.B., Ruissem, W., Jones, R.L. and Rockville, M.D., Biochemistry and molecular biology of plants. American Society of Plant Physiologists, 2000.
- Nobel, P.S. Physiochemical and environmental plant physiology. Academic Press, 1991.
- Mohr, H. and Schopfer, P. Plant Physiology. Springerlink Publishers. Berlin, 1995.
- Taiz, L. and Zeige, E. Plant Physiology. Sinauer Associates Inc. Publishers. Sunderland, Massachusetts. 2002.
- Pessaraki, M. Hand book of plant and crop physiology. 2<sup>nd</sup> ed; Marcel and Decker, N.Y., 2002.
- Malik, T. A. Plant Physiology. The Caravan Book House, Lahore. 1999.
- Meidner, H. Class experiments in plant physiology. George Allen Unwin. Ltd., London, 1984.
- Baracharya, D. Experiments in plant physiology. Narosa Publishing House, New Delhi, 2003.
- Wilson, K. and Walker, L.. Practical Biochemistry Principle Techniques  
4th ed. Cambridge University, Press. Cambridge. 1994.
- Gupta, N.K. and. Gupta, S. Plant physiology. Practical Exercises. Oxford and IBH Publishing Co. Pvt. Ltd. , New Delhi, 2005.

### **Prokaryotic Physiology\***

**3 (2 + 1)**

Properties and behavior of bacteria with respect to their chemical and physical requirements for sustainability and reproduction; Metabolic pathways; Protein export; Chemiosmosis and multiple transport system.; Functions of bacterial membrane and antibiotic resistance mechanism; Principles of enzyme action; Fermentation respiration; Novel bacteria pathways and biotransformation; Structure and classification of virus; Status and nature of virus in life system; Multiplication, lysogeny, episomy, and transducing bacteriophages, Interference with viral multiplication.

#### **Practicals**

Bacterial culture, Experiments to explore applied aspects of microbial physiology and identification of bacteria.

#### **Books Recommended:**

- White, D. The Physiology and Biochemistry of Prokaryotes.. Oxford University Press, Oxford. 1999.
- Caldwell, D. R. Microbial Physiology and Metabolism. Star Bop. Co. 1999.

# Semester IV

English-IV (Communication Skills)  
Introduction to Bioinformatics \*

3  
3(0 + 3)

## Objectives:

1. This course provides an introduction to bioinformatics with a focus on fundamental bioinformatic problems, the tools used to compute solutions to those problems, and the theory upon which those tools are based. The students will be able to
2. Access, retrieve, and analyze bioinformatic data available from several bioinformatic databases;
3. Assess the quality of bioinformatic data available from the Internet;
4. Use standard bioinformatic tools to answer specific biological questions;
5. Understand the theories used to build the tools and their relationship to biology;
6. Critically assess solutions to bioinformatic problems.

Overview of Bioinformatics: The scope of Bioinformatics, Bioinformatics and internet, Useful Bioinformatics sites on the WWW.

Basic Principles of Computing in Bioinformatics: Running computer software, Computer operating systems, Software downloading and installation, Database management

Data Acquisition: Sequencing DNA, RNA and proteins, Determination of protein structure, Gene and protein expression data, Protein interaction data.

Databases – Contents, Structure and Annotation: File formats, Annotated sequence databases, Genome and organism-specific databases, Miscellaneous databases.

Retrieval of Biological Data: Data retrieval with Entrez and DBGET/LinkDB, Data retrieval with SRS (sequence retrieval system).

Searching Sequence Databases by Sequence Similarity Criteria: Sequence similarity searches, Aminoacid substitution matrices, Database searches (FAST and BLAST), Sequence filters, Iterative database searches and PSI-BLAST.

Multiple Sequence Alignment-Genes and Protein Families: Multiple sequence alignment and family relationships, Protein families and pattern databases, Protein domain families.

Phylogenetics: Phylogenetics, cladistics and ontology, Building phylogenetic trees, Evolution of macromolecular sequences.

Sequence Annotation: Principles of genome annotation, Annotation tools and resources.

Structural Bioinformatics: Conceptual models of protein structure, relationship of protein three-dimensional structure to protein function, The evolution of protein structure and function, Obtaining, viewing and analyzing structural data, Structural alignment, Classification of proteins of known three-dimensional structure: CATH and SCOP, Introduction to protein structure prediction by comparative modeling, Secondary structure prediction, Advanced protein structure prediction and prediction strategies.

Microarray Data Analysis: analysis methods, tools and resources, Sequence sampling and SAGE.

Proteomic Data Analysis: Analyzing data from 2D-PAGE gels, Analyzing protein spectrometry data.

### **Books Recommended and Web Sites:**

- Gibas, C. and Jambeck, P. Developing Bioinformatics Computer Skills. O'Reilly Publishers. 2001.
- Westhead, D.R., Parish, J.H. and Twyman, R.M.. Instant Notes on Bioinformatics. Viva Books Private Limited. 2003.
- Lesk, A.M.. Introduction to Bioinformatics. Oxford University Press, Oxford. 2002.
- Baxevanis, A.D. and Ouellette, B.F.F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3<sup>rd</sup> ed. O'Reilly Publishers. 2004.
- Krane, D.E. and Raymer, M.L.. Fundamental Concepts of Bioinformatics. Benjamin Cummings. 2002.
- Moody, G.. Digital Code of Life: How Bioinformatics is Revolutionizing Science, Medicine, and Business. John Wiley and Sons. 2004.
- Orenge, C.A., Jones, D.T. and Thornton, J.M.. Bioinformatics: Genes, Proteins and Computers (Advanced Text). Routledge. 2003.
- <http://www.ncbi.nlm.nih.gov>
- <http://www.ebi.ac.uk>
- <http://foldoc.doc.ic.ac.uk/foldoc/index.html>

## **Neurophysiology**

**4 (3 + 1)**

### **Objectives:**

1. To inculcate understanding for the role of neuron as functional unit in neural activities.
2. To provide understanding of electrical transmission and their pathways in spinal cord and brain.
3. To develop ability of understanding the communication between and within the neuron along with cable and threshold properties with the help of analogous models.
4. To provide understanding for the transduction of signals at receptor level and adaptation in receptors.

5. To give understanding of various levels of brain with respect to their individual role in motor control and their integration for somatic, vegetative and behavioral activities.

Introduction: Introduction to Neurophysiology, Types and Structure of Neuron and associated neuronal cells.

Neural functions and Pathways: Anatomical and Physiological methods for the identification of neuronal functions and their pathways.

Communication within neurons: Flow of electrical currents along nerves and in electrical analog models of nerve cell membrane, Cyclic regeneration of action potential. Dependence of membrane potential on ionic permeability, dependence of ionic permeability on membrane potentials. Nerve conduction velocity, classification of nerves, Compound action potential

Threshold properties: Refractory period, accommodation, all or none law, Neural codes, initiation of impulse

Communication between neurons: Electrical transmission, Types of channels. Sensory receptors and transduction in paccinian corpuscles

Receptor adaptation: Function of adaptation. Synaptic and neuromuscular transmission

Local Motor Control: Motor Neurons, descending pathways, Sensory feedback from muscles; spindle reflexes, the servo hypothesis

Control of Posture: The importance of Support, Role of Brain Stem, Vestibular contribution to posture, Visual contribution to posture, Vestibular and visual interaction. Decerebrate rigidity, Clasp knife reaction, neck reflexes, posture as a whole

Higher functions: cerebral cortex; Integration between sensory, motor, parietal, temporal and occipital cortices, cerebral cortex; Integration between sensory, motor, parietal, temporal and occipital cortices.

Global Motor Control: Motor cortex, Corticospinal concept, Input and Output Circuits in Cerebellum, Cerebellar functions and theories.

Basal ganglia: Functions and clinical conditions

Physiology of Autonomic Nervous System: Sympathetic and parasympathetic control, Autonomic reflexes

Neurotransmitters, Types; Cholinergic and Adrenergic Receptors,

Denervation hypersensitivity.

Recognition and Memory: Types of learning, central circuits of learning, Role of cerebellum in learning. Mechanism of Temporary and permanent memory storage.

Hypothalamus limbic system: Motivation, Emotion, Hypothalamus, Sleep and cortical arousal, EEG and its clinical use, Limbic system, role of amygdala and Hippocampus.

### **Practicals:**

1. To calculate the conduction velocity of sciatic nerve in frog by the help of recorded twitches on kymograph.
2. Demonstration of various tendon reflexes in human being.
3. Demonstration of various common (daily use) examples for the understanding of spinal reflexes in human subjects.

4. Demonstration of the principle and use of an oscilloscope in various neurophysiological studies.
5. Recording of an action potential from Frog/Uromastix sciatic nerve on physiograph by using extracellular electrodes.
6. To observe the neurophysiological influence of vagus nerve on heart activity(Uromastix/Rabbit/Frog)
7. Elicitation of spinal reflexes in Frog.
8. Effect of strychnine on spinal reflexes in Frog.
9. Effect of acid treatment to observe withdrawal reflexes in frog.
10. Demonstration of the recording of an action potential from sciatic nerve bundle by using intracellular glass capillary microelectrode.

**Books Recommended:**

- Carpenter, R.H.S. Neurophysiology. 4<sup>th</sup> ed; Oxford University Press, Oxford. 2002.
- Jessel, K.S. Principles of Neural Science, 4<sup>th</sup> ed; McGraw Hill, 2000.
- Guyton, A. C. and Hall, J. E. Textbook of Medical Physiology. 12<sup>th</sup> ed; W.B Saunders Co. 2005.
- West, J. B. Best and Taylor's Physiological Basis of Medical Practice. 12<sup>th</sup> ed; 1991.

**Muscle Physiology**

**3 (2 + 1)**

**Objectives:**

1. To understand the significance of muscle study with respect to their role in various systems of human body.
2. To understand the types of muscles with respect to their structures and physiological functions.
3. To understand ultrastructure of various types of muscles.
4. To understand the nomenclature of skeletal muscles with respect to their functions.
5. To understand the excitability and contractility in skeletal, cardiac and smooth muscles.
6. To understand the muscle mechanics and their relationships to determine their importance with respect to structure and function.

Introduction: Significance of muscle physiology in various systems (CVS, Respiration and Special senses) Muscle characteristics, functions and types.

Gross Structure of Skeletal Muscle: Covering, Connective tissue layer, Aponeurosis, tendon sheath

Nomenclature: Direction, location, and origin, insertion and various actions

Movement: Lever system, Leverage

Fiber Arrangement: Arrangement of Fasciculi, fiber arrangement and their correlation with various movements

Muscular Actions: Individual and group actions. Role of Skeleton and muscle in various movements

Muscle Classification: On the basis of Color, Fiber type, nerve and blood supply to muscle

Neuromuscular Junction: Motor unit, Neuromuscular junction, and mechanism of action at NMJ, ACh formation and secretion

Electrical Activity of Muscles: Resting membrane potential, Ionic channels, conductance and generation of action potential.

Microanatomy: Sarcolemma, Sarcoplasm, Nuclei, SR, Mitochondria, Transverse tubules, Myoglobin, Myofilaments, Molecular structure of contractile proteins, Excitation contraction coupling

Mechanism of Contraction: Sliding Filament theory, Ratchet theory and their molecular aspects, other theories of contraction

Muscle Mechanics: Elementary mechanics, Force and mechanics, Classical Mechanics, Muscle models (AV Hill), Kinematics and Kinetics of joint complexes.

Twitch, tetanus, summation, staircase, fatigue, isotonic and isometric contraction, tone

Various Relationships: Length Tension relationship, Force Velocity relationship, Strength Duration relationship

Muscle Heat: Muscle heat and efficiency of muscle, sources of energy, Location and function of Muscle proprioceptors

Microanatomy of Smooth Muscle: Sarcoplasm, Mitochondria, Caveolea, sub surface, cisterns, Sarcolemma, cell to cell contacts. Classification, Cell cytoskeleton, dense bodies, intermediate filaments and myofilaments

Excitation, Contraction and Regulation: Neuronal and hormonal influence, Excitation and inhibition at NMJ. Electrical activity (membrane potentials, Action potentials). E-C coupling, Physical basis of contractile process, Regulation of control by Ca and Latch mechanism.

Microanatomy of Cardiac Muscle: Mechanism of excitation and contraction, Action potential, Types of Cardiac muscle and their function.

### **Practicals:**

1. To dissect out nerve and muscle from Frog's leg and fixation for recording.
2. Recording of simple muscle Twitch
3. Recording of summation of twitches
4. To record the effect of tetanizing current
5. To record the effect of repeated direct and indirect stimulation on the muscle to observe its fatigue
6. To record the Stair case effect
7. Experiment to demonstrate muscle tone, tension, isometric and isotonic contractions and fatigue in human muscles
8. To demonstrate the preparation of isolated intestinal strip and its use for the recording of rhythmic activity on oscillograph
9. To demonstrate the rhythmic contraction and relaxation in isolated heart of mammal
10. To record EMG during voluntary contraction of human muscle
11. To determine the work performed by human muscles, using an Erogograph

### **Books Recommended:**

- Tortora, J. T. and Grabowaski, S. R Principles of Anatomy and Physiology, 9<sup>th</sup> ed; John Wiley and Sons. 2002.
- Berney, R. M. and Levy, M. N. Physiology. Mosby Air book, 1992.
- Berney, R. M. and Levy, M. N. The Structure and Function of Muscle. Academic Press, 1968.
- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology, 12<sup>th</sup> ed. W. B. Saunders, 2005.
- West, J. B. Physiological Basis of Medical Practice. Williams and Wilkins. 1990.
- Davidson, B. and Smith, E. Textbook of Physiology and Biochemistry. **W. B. Saunders.**

### **Principles of Immunology \***

**3 (2 + 1)**

Introduction to immune system: Adaptive and innate immunity, cells and organs of immune system, soluble mediators of immunity, antigens, immune responses, inflammation, defenses against intracellular and extracellular pathogens, immunopathology, vaccination.

Cells, tissues and organs of immune system: Cells of innate and adaptive immune system, lymphoid tissue and lymphocytes traffic.

Cell migration and inflammation: Mechanism and pattern of cell migration, complement.

Antibodies: Immunoglobulins, interaction of antibodies with antigens, function of antibodies, antibodies diversity, immunoglobulins gene recombinations, somatic mutations.

T-cell receptors and major histocompatibility molecules complex: T-cells receptors, genes of T-cell antigen receptors, Major histocompatibility complex molecules (MHC), interaction of MHC molecules with antigenic peptides, interaction of T-cells receptors with MHC and antigens.

Antigen presentation: Antigen presenting cells, antigen processing and presentation, T-cell activation.

Cytokines: Cytokines and cytokines receptors families, cytokine production by T-cells subset.

Cell cooperation in antibody response: Development of B-cells, activation of B-cells by T-dependent and independent antigens.

Mononuclear phagocytes in immune defense.

Concepts in immunological tolerance; immunodeficiency, hypersensitivity type1-4; transplantation and rejection; autoimmunity.

Immunological techniques

### **Practicals:**

Identification of blood cells and their functions in immunological processes.  
Experiments in antigen-antibody interactions: precipitation reactions; hemagglutination etc.

Preparation of various immunogens;

Separation of gamma globulin by salt precipitation method

Demonstrations of immunoassays  
Protocols and demonstrations of immunoblotting and immunoprecipitation.  
Protocols of monoclonal antibody production.

**Books Recommended:**

- Roitt, I., Brostoff, J. and Male, D. Immunology, Mosby, Edinburgh, 2005
- Kindt, T.J., Osborne, B.A. and Goldsby, R.A. Immunology, W.H. Freeman and Co Ltd., London, 2006.
- Goldsby, R.A., Kindt, T. J., Osborne, B.A. and Kuby, J. Immunology, W.H. Freeman and Co Ltd., London, 2006.
- Lydyard, P.M., Whelan, A. and Fanger, M.W. Instant Notes on Immunology, Bios Scientific Publisher Ltd., 2003.

## **YEAR 3**

### **Semester V**

#### **Biostatistics**

**3 (1 + 2)**

**Objectives:**

1. To get the knowledge of statistical tools used in the data analysis of biological nature.
2. To understand the variations in the data and its measurement to reject or accept the hypothesis for a particular study.
3. To apply various testing tools on a two sets of data for their comparison.
4. To develop the ability to determine the co-relation between two parameters available in a data.
5. To develop the ability to perform multiple comparison for more than two variables, using statistical tools.

Introduction: History, sampling theories, Variables, Design and Interference.

Frequency Distribution: Data and its analysis, Histogram, Frequency polygon, Ogives, Frequency curves

Measure of Central Tendencies: Mean, Median, Mode.

Measure of Dispersion: Range, Mean deviation, the Semi interquartile range. Quartiles, Deciles and Percentiles. Variance and Standard deviation. Skewness and Kurtosis.

Probability: Dependant and Independent Discrete and continuous probability distribution, Permutations and Combinations, Binomial, Normal and Poisson distributions, Confidence interval.

Hypothesis Testing: Z – test, Student’s t – test and Chi-Square test.

Relationships among Parameters: Correlation and Regression analysis, Spearman’s and Pearson’s correlation coefficients.

Analysis of Variance: One-way and two-way ANOVA, Tukey’s HSD test, Kruskal-Wallis one-way analysis of Variance, and The Friedman two-way analysis of Variance.

## Practicals:

1. To find out class boundaries, class marks and class widths for the given experimental results.
2. To construct frequency distribution tables for given primary data.
3. Graphical presentation of statistical data through frequency histogram, polygon, ogive and stem and leaf display.
4. To calculate various measures of central tendency of the given grouped and ungrouped data.
5. To calculate measures of dispersion for the given grouped and ungrouped data.
6. Graphical presentation of variations in data by constructing the box plot.
7. Estimation of skewness and kurtosis from given distribution of data.
8. To construct the venn diagram.
9. To find out the probability of given event with the help of combination and permutation.
10. To solve different probability problems with the help of binomial distribution.
11. To solve different probability problems with the help of poisson distribution.
12. To solve different probability problems with the help of normal distribution.
13. Use of z-test, t-test and  $\chi^2$  test to solve statistical problems.
14. To calculate correlation and regression from the given data
15. Use of one way and two way ANOVA to compare data variables.
16. Use of computer in statistics (MS Excel/Minitab/SPSS)
17. Assignment / Population survey for the collection of data and its analysis

## Books Recommended:

- Walpole, R. E., Myers, R. H, and Myers, S. L. Probability and Statistics for Engineers and Scientists. 6<sup>th</sup> ed; Prentice Hall International. New Jersey.
- Daniell, W. W. Biostatistics: A foundation for analysis in the Health Sciences, 5<sup>th</sup> ed; John Wiley and Sons. 1991.
- Dawson-Saunders, B. and Trapp, R. G. Basic and Clinical Biostatistics. Prentice Hall International, 1990. New Jersey.
- Towened, J. Practical Statistics for Environmental and Biological Scientists,. John Wiley and Sons. 2003.
- Wardlaw, A. C. Practical Statistics for Experimental Biologists. 2<sup>nd</sup> ed; John Wiley and Sons. 2000.
- Feinstein, A.R. Principles of Medical Statistics. Chapman and Hall. 2002.
- Weiss, N. A. Introductory Statistics. 4<sup>th</sup> ed. Addison Wesley Publishing Company Inc. 1995.
- **Steel, R. G. D. and Torrie, J. S. Principles of Statistics. John Wiley and Sons. 1990.**

## Objectives:

1. To understand the organization and components of cardiovascular system
2. To understand the excitability and contractility in heart with respect to its role in pumping of blood in circulatory system.
3. To understand various phases of the cardiac cycle along with variation in blood volume and pressures in ventricles aorta and atria.
4. To understand ECG with respect to its recording and analysis for cardiac functions.
5. To understand the regulation of cardiac activity and blood pressure in arterial tree.
6. To know the role of vascular bed and importance of coronary circulation.

Introduction: Organization of circulatory system

Structure of Heart: Specialized cells and functional anatomy of heart

Electrical Properties of Heart: Pace makers, mechanism of self-excitation, rhythmicity, types of cardiac potentials and excitation of ventricular fibers

Cardiac Cycle: Cardiac cycle and output, atria as primer pump, Ventricle as pump work output of heart and pressure volume curves

ECG and its Analysis: characteristics of normal ECG; methods of recording, ECG leads, principles of vectorial analysis of normal ECG. Electrical analysis of ventricular QRS, abnormal voltages of QRS (causes)

Regulation of Cardiac Activity: Control of rhythmicity by autonomic innervations, myocardial performance and its neural and hormonal control

Vascular Bed: Arrangements of vessels, routes from arterial to venous system, volume of blood in different vessels. architecture of the terminal vascular bed, volume distensibility, mean velocity of flow. circulation time and flow in capillaries. measurement and meaning of circulation time, shunts and AV-Anastomoses

Blood Vessels: Elastic nature of vessels (Hooke's and Laplace Law).

The Arterial System: Arterial blood pressure, relationship between flow and pressure in capillaries, importance of transmural pressures, Pressure gradients, viscosity and blood flow, peripheral resistance, regulation of blood pressure

Control of Cardiac Output: Relationship between cardiac output and venous return, influence of various factors

Coronary Circulation: Functional anatomy of coronary vessels, Factors influencing coronary blood flow. Cutaneous, Skeletal muscle, Cerebral, Pulmonary,

Special Circulation: Renal and splanchnic circulation, Peripheral circulation and Intrinsic and extrinsic control of peripheral blood flow and its control central and peripheral factors (Exercise and Hemorrhage)

## **Practicals:**

1. To record normal cardiogram and observe the effect of temperature on frog's heart
2. Effect of Stannius ligature on the heart of frog/uromastix
3. To observe the effect of Vagal stimulation on heart
4. To observe the effect of various factors (1) posture, (2) breath holding, (3) exercise, (4) over ventilation and (5) stress on blood pressure
5. To record and study ECG
6. To observe the microcirculation in the frog's web.
7. Studies on capillary circulation in human volunteers on reactive hyperemia
8. To evaluate the cardiac efficiency after exercise by scoring chart.

## **Books Recommended:**

- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology. 12<sup>th</sup> ed. W. B. Saunders, 2005.
- Berne, R. M., Matthew, N., M.D. Levy and Levy, M. N. Cardiovascular Physiology. Mosby, Inc. St. Louis. 2001.
- Mohrman, D. E. and Heller, L. J., Cardiovascular Physiology. McGraw Hill, Boston, 2002.
- Katz, A. M.. Physiology of the Heart. Raven Press, New York, 1992.
- Timmis, A. Essentials of Cardiology. Blackwell Scientific Publications. 1989.

## **Pulmonary Physiology**

**3 (2 + 1)**

### **Objectives:**

1. To understand the structure of respiratory organs with respect to their functions.
2. To understand the role of respiratory passages in conditioning of air, speech and resonance.
3. To understand the transport of respiratory gases
4. To understand the mechanism of respiration with respect to the involvement of respiratory muscles, chest cage and pleural, lung and atmospheric pressures.
5. To understand the nervous and chemical/humoral regulation of respiration.

Introduction: Overview of respiratory mechanism, anatomical and physical relationship, lung volumes and capacities.

Functions of Respiratory Passages: Air-conditioning, speech and resonance.

Mechanism of Respiration: Muscles of respiration, pressure, compliance and elasticity. surface tension, surfactants. work of breathing.

Ventilation-Perfusion Relationship: Oxygen transport from air to tissue, Hypo and Hyperventilation, Respiratory quotient. ventilation-perfusion ratio.

Transport of Respiratory Gases: Henry's law, Dalton's law, oxygen and carbon dioxide dissociation curves and factors affecting, Bohr and Haldane effect.

Acid-Base Status: Respiratory and metabolic, acidosis and Alkalosis.

Control of Respiration: Nervous and Chemical/humoral .

**Practicals:**

1. To record and relate the changes in circumference of chest (normal and maximal breathing) with activity of respiratory muscles.
2. To obtain a graphical record of normal respiration.
3. To study the effect of exercise on respiration.
4. To observe the effect of deglutition on respiration.
5. To observe the effect of rebreathing of expired air on respiratory rate.
6. To observe the effect of voluntary apnea on normal respiration.
7. To observe the effect of mental concentration on respiration.
8. To measure/calculate the lung volumes and capacities by spirometer/vitalograph
9. To determine the oxygen consumption of cockroach per hour by potometer.
10. To determine respiratory gases in expired air by Douglas Bag method

**Books Recommended:**

- Mines, A. H. Respiratory Physiology. 2<sup>nd</sup> ed., Raven Press, New York, 1986.
- West, J. B. Respiratory Physiology; The essentials, 7<sup>th</sup> ed., Williams and Wilkins, London, 2005.
- Stuch, N. C. Basic Respiratory Physiology. Churchill Livingstone, London, 1991.
- Leff, L. A. and Schumaccker, P. T. Respiratory Physiology, Basic and Application. W.B. Saunders Company, London, 1993.
- Davis, A. The Respiratory System, Basic Science and Clinical conditions. Churchill Livingstone, London. 2003.
- Levitzky, M. G. Pulmonary physiology, 6<sup>th</sup> ed., McGraw Hill, New York, 2003.
- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology. 12<sup>th</sup> ed. W. B. Saunders, 2005.

**Renal Physiology**

**3 (2 + 1)**

Introduction: Overview of renal system, structural and functional characteristics of nephrons.

Fluid Dynamics: Glomerular fluid, filtration process, composition and affecting factors.

Renal Blood Flow and Glomerular filtration Rate: Control and regulation of flow rate.

Renal Clearance: Para-amino hippuric acid and Inulin based estimation of Glomerular filtration rate and Renal blood flow.

Renal Tubular Functions: The proximal tubule, The Loop of Henle, Distal tubules, Collecting ducts, mechanisms of dilution and concentration of urine.

Dialysis: Principle, basic mechanism.

Renal Regulation: Body fluids Osmolarity, Volume, pH, and electrolytes.

Respiratory and Metabolic Acidosis and Alkalosis.

**Practicals:**

1. To study various procedures for collection and preservation of urine specimens for urinalysis.
2. Urinalysis to determine the physical and chemical properties of urine.
3. Spectrophotometric examination of the urine sample (Ascorbic acid, Iron, Glucose, Uric (acid, Proteins)
4. To observe the effects of diuretics on urinary volume and pH.
5. Determination of threshold time for micturition using diuretics on animal model.
6. Microscopic examination of urinary sediments.
7. Preparation of slide to study the animal kidney histology.

**Books Recommended:**

- Lote, C. J. Principles of Renal Physiology, 3<sup>rd</sup> ed., Chapman and Hall, London, 1994.
- Pitts, R. F. Physiology of Kidney and Body Fluids, An Introductory Text. Year Book Medical Publisher, Chicago. 1964.
- Valtin, H. Renal Function: Mechanisms Preserving Fluid and Solute Balance in Health. Little Brown and Company, Boston, 1973.
- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology. 12th ed. W.B Saunder. . 2005.
- Berliner, C. W. and. Giebisch, G. H. Renal Physiology. American Physiological Society, Bethesda. 1987.
- De-Wardener, H.E. The Kidney: An Outline of Normal and Abnormal Structure and Function, 4<sup>th</sup> ed. The English Language Book Society and Churchill Livingstone. 1975.

**Gastroenteropancreatic Physiology****3 (2 + 1)****Objectives:**

1. To understand the organization of gastrointestinal system with respect to its functions.
2. To understand the role of liver, gall bladder and pancreas in secretion, storage and release of chemical substances for digestion.
3. To provide understanding of different segments of GIT with respect to processing of food, digestion, absorption and excretion.
4. To understand the physiological mechanism of secretions and regulation of secretions and movements in GIT.

Introduction: An overview of Gastrointestinal system, general organization, autonomic supply, chemical mediators.

Mouth: Anatomy, mastication. Structure and function of salivary glands, composition and regulation of salivary secretions.

Esophagus: Esophageal secretions, esophageal peristalsis, swallowing, lower sphincter control.

Stomach: Structure and innervation, gastric glands and their secretions, composition and regulation of gastric secretions, gastric motility.

Pancreas: Functional anatomy, composition, mechanism and regulation of pancreatic secretion, cellular mechanism of secretion, cholecystokinin and acetylcholine as pancreatic exocrine secretion mediators.

Liver and Gall Bladder: Structure and function, composition of bile. Mechanism and control of bile secretion. Transport and storage of Bile. Enterohepatic circulation. Gall stone.

Small Intestine: Epithelial cells, intestinal glands. Motility and intestinal reflex.

Assimilation: Digestion and absorption of Carbohydrates, Proteins, Fats, Iron and Electrolytes.

Large Intestine: Structure and motility. Electrolyte transport. Microflora. Defecation reflex.

Gastroenteropancreatic Hormones; Gastric, pancreatic, duodenal hormones and their roles in digestion

### **Practicals:**

1. To observe the digestive organs in a dissected animal model (Frog, Uromastix, Rabbit)
2. To study the histology of digestive organs by slides and charts.
3. To determine the composition and normal physical and chemical properties of saliva.
4. To study the effect of enzyme concentration on enzyme activity by arbitrary method.
5. To study the effect of temperature on enzyme activity.
6. To study the effect of ionic concentration on enzyme activity.
7. To study effect of pH on enzyme activity.
8. To find the effect of substrate concentration on enzyme activity.
9. To determine the effect of boiling on salivary amylase.
10. To observe the protein digestion by the action of pepsin.
11. To observe the effect of Renin on milk protein.
12. To observe the effect of Pancreatin on carbohydrate digestion.
13. To observe the effect of Pancreatin on protein digestion.
14. To observe the effect of Pancreatin on fat digestion.
15. To study the action of Bile on fat digestion

### **Books Recommended:**

- Johnson, L. R. and Gerwin, T. A. Gastrointestinal Physiology. Mosby Inc., 2001
- Sanford P. A. Digestive System Physiology, Edward Arnold. 1992.
- Berne, R. M. and Levy, M. N. Physiology. Mosby Company, 1988.
- Moffett, D. F. and Moffett, S. B. Human Physiology Foundations and Frontiers;. Mosby Company, 1993
- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology. 12th ed. W.B Saunder. 2005.

# Semester VI

## Endocrinology

4 (3 + 1)

Functional anatomy of different endocrine glands, Hormonal signaling and its role in coordination of molecular, cellular and tissue functions, General account of chemical nature and biosynthesis of hormones, Transport of hormones to the site of action, Mechanisms of hormone actions; conceptual account of different types of signaling and transductions, Feed back regulation of hormonal homeostasis, The hormones and physiological actions of the hormones of hypothalamus, anterior pituitary, posterior pituitary, thyroid gland, parathyroid gland, endocrine pancreas, adrenal cortex, adrenal medulla, gonads, corpus luteum, placenta, al and other endocrine mechanism including hormones of pineal, thymus gland, atrial natriuretic hormone, hormones related to blood formation, renal and adipose tissue. Invertebrate hormones

### Practicals

1. To demonstrate the position of various endocrine glands
2. Experiments to reveal the roles of endocrine glands and their hormones in physiological functions
3. The effect of insulin on glycemic level
4. To perform oral glucose tolerance test in human/animals
5. To determine the effect of cortisol on biochemical parameters (glucose/protein)
6. To determine the effect of MSH on skin pigmentation.
7. To determine the random and fasting glycemia

### Books Recommended:

- Greenspan, F. S. and Strewler, G. J. Basic and Clinical Endocrinology. Prentice-Hall, New York, 2004.
- Molina, P. E. . Endocrine Physiology. McGraw Hill, Boston, 2003.
- Kacsoh, B.. Endocrine Physiology. McGraw Hill, Boston. 2000.
- Wilson, J. D., Foster, D.W., Larsen, P.R and Kronenberg, H. Williams Textbook of Endocrinology. W. B. Saunders, Philadelphia. 2002.
- Guyton, A. C. and Hall, J. E. Text book of Medical Physiology. 12th ed. W.B Saunder. .2005.
- Ganong, W. F. Review of Medical Physiology. 24<sup>th</sup> ed. McGraw-Hill. 2005.

## Reproductive and Developmental Physiology

4 (3 + 1)

Gender, its identity and **sexuality**, Roles of gonadotrophic hormones, somatomammotrophic polypeptides, cytokines, steroids and other such hormones in reproduction along with their mechanism of action, Hormones of testis and ovaries with their functions, spermatogenesis and folliculogenesis and their hormonal regulation, Female reproductive cycles, Puberty and maturation of hypothalamic-pituitary gonadal axis, Coitus and fertilization, Implantation, Maternal recognition of pregnancy, maintenance of gestation,

Parturition, Lactation, Post-partum anoestrous, Fertility and infertility.  
Reproductive states in aging.

**Practicals:**

1. To study the histology of male and female reproductive organs with the help of slides
2. Study of female reproductive cycle through vaginal smear in mice
3. To observe the morphology and motility of sperm in testicular tissue
4. Effects of hormones on cyclic activity,
5. Influence of gonadectomy on the targets,
6. Metabolic pattern in different reproductive states.

**Books Recommended:**

- Greenspan, F.S. and Strewler, G.J. Basic and Clinical Endocrinology. Prentice-Hall, New York. 2001. .
- Kacsoh, B. Endocrine Physiology. McGraw Hill, Boston. 2000.
- Wilson, J.D., Foster, D.W., Larsen, PR and Kronenberg, H.. Williams Textbook of Endocrinology. W. B. Saunders, Philadelphia, 2002.
- Molina, P E. Endocrine Physiology. McGraw Hill, Boston, 2003.
- Knobil, I. and Neill, J. The Physiology of Reproduction. Raven Press, New York, 2005. .

**Physiology of Sensory System**

**3 (2 + 1)**

**Objectives:**

1. To provide understanding of various sensory apparatus, their location, structure and functions.
2. To inculcate the understanding of various sensory modalities their transduction, transmission and sensations.
3. To provide understanding of different receptors available in various sense organs, their mechanism of function and processing of signals.
4. To understand the pathways for the transmission of sensory signals from sense organs towards brain with respect to excitation and inhibition.
5. To study molecular mechanisms in generation of receptor potentials

Introduction: Receptors and sensations, sensory coding, transduction, types of receptors, mechanism of sensory adaptation, somatic and special senses,

Somatic Sensations: Pain; types, receptors, transmission of signal to CNS and causes of pain, Headache and thermal sensations

Tactile sensation: Sensory modalities, types of receptors and central projections, neural responses from smaller afferents, receptive fields, lateral inhibition, central responses

Gustation: Primary sensations of taste, threshold for tastes, taste buds and their functions, transmission of taste signals , transduction mechanism and taste preference

Olfaction: Olfactory cells; structure, mechanism of excitation and adaptation, central olfactory projections and psychophysics of smell, transduction mechanisms and olfactory pathway.

Proprioception: Muscle spindle; ultra structure and function, Golgi tendon organ: ultra structure and function, vestibular apparatus; ultra structure and function

### Visual System

Optics of vision: Physical principles of optics; refraction of light and application of refractive principles to lenses, optics of eye; mechanism of accommodation, image formation

The Eye: Photoreceptor and neural function of retina; photochemistry of vision and color vision

mechanisms of adaptation and visual acuity and factors affecting visual acuity, visual pathways; function of lateral geniculate nucleus and visual cortex, fields of vision and eye movements and their control, visual localization and, autonomic control of accommodation and pupillary aperture

Auditory System: Structure of ear (external, middle and internal), nature of sound and sound spectra, Fourier analysis by cochlea and responses from auditory fibers, spatial localization of sound and determination of loudness, functional organization of central auditory pathways.

Sensory Potential: Molecular mechanisms in hair cell potential, gustatory, olfactory and photopotential.

### **Practicals:**

1. Study of superficial, pupillary, cutaneous and kinaesthetic reflexes in human.
2. Determination of visual acuity of human subject by using Snellen's and Jagger's eyes chart.
3. Determination of visual field by perimetry.
4. To assess the color vision by wooltest and Ischihara chart.
5. To locate Gustoreceptors present on human tongue by using Chemical methods.
6. Determination of hearing ability of human subject by using air conduction, bone conduction and sound perception methods.
7. To observe various physiological phenomenon related with the focusing of light on the retina of human eye in a simulated model.
8. Locate and plot the boundary of the blind spot of eye using the computer-simulated program.
9. To distinguish the different odors by examining various samples.
10. Experiments related to sensory adaptations.

### **Books Recommended:**

- Carpenter, R. H. S. Neurophysiology, Oxford University Press, 2000..
- Guyton, A.C. and Hall, J.E Text Book Of Medical Physiology. W.B. Saunders Co., 2005.
- Berne, R. M. and Levy, M. N. Physiology. Mosby Airbook, 1992.

## Objectives:

1. To acquire a comparative knowledge of various important systems in different vertebrates.
2. To understand the functional diversity and phylogeny associated with different animals.
3. To understand the concept of biological rhythm, temperature regulation and behavioral differences among different classes of animals.
4. To understand the differences in energy production, utilization and its uses in various functions.

Introduction: Theme, diversity and phylogeny

Circulatory system: Open and closed circulation, comparative functional heart morphology

Neurogenic and myogenic heart, cardiovascular response to extreme environmental condition, regulation of circulatory system,

Respiration: Comparative respiratory system morphology and pigments

Gas exchange and distribution, diving bradycardia response

Regulation and adaptation to extreme environmental conditions

Body fluids: Osmoregulation, osmoregulators and osmoconformers

Osmoregulation in aquatic and terrestrial environment

Energy: Acquiring energy, feeding methods, Nutritional requirements and

adaptation of alimentary system in different animals, ruminant digestion,

Energetics of different modes of locomotion (swimming, flying, running)

Biological rhythm: Rhythms in different groups

Temperature: Thermal biology, Physiological classification of animals using thermal biology, temperature compensations in ecto-, endo- and hetrotherms

Nervous system: A comparative overview of neuronal structure, function and organization

Sensory reception: Comparative aspects of general, chemo-, mechano-, thermo- and photo-reception

Glands and Hormones: comparative aspects of hormonal responses in various groups.

## Practicals:

1. To compare the differences in the respiratory structures in different animals
2. To record the differences in the contractile activity of the gastrocnemius muscles of a reptile, amphibian and mammal
3. To compare the differences in the locomotory behaviour of mammals and reptiles with respect to the role of their skeletal muscles.
4. To compare cardiac rate and force among different vertebrates.
5. To compare the adaptations in the digestive tracts of various vertebrates.

### **Books Recommended:**

- Randell, D., Burggen, W. and French, K. Eckert Animal Physiology. 5<sup>th</sup> ed, W. H. Freeman and Co. New York, 2002.
- Withers, P. C. Comparative Animal Physiology-International ed, Saunders College Publishing, 1992.
- Hill, R. W. and Wyse, G. A. Animal Physiology 2<sup>nd</sup> ed, Harper and Row Publisher New York, 1989.
- Gillespie, J. R. Modern Livestock and Poultry production 2<sup>nd</sup> ed, Delmar Publisher Inc, 1989.
- Sturkie, P. D. Avian Physiology 4<sup>th</sup> ed, Springer Verlag. NY, 1986.
- Dukes, H. H. Dukes Physiology of Domestic Animals. 11<sup>th</sup> ed. Comstock Publishing associates. Ithaca. 1993.

### **Human and Animal Behavior**

**3 (2 + 1)**

Introduction: Understanding Behavior, instinct learning and memory. Natural Selection and Evolution in development of Behavior

Ingestive Behavior: Drinking: The Nature of Physiological Regulatory Mechanisms; Drinking and Salt Appetite; Brain Mechanisms of Thirst and Salt Appetite; Mechanisms of Satiety.

Learning and Memory: Basic Mechanisms: The Nature of Learning; Learning and Synaptic Plasticity; Perceptual Learning; Classical Conditioning; Instrumental Conditioning and Motor Learning.

Relational Learning and Amnesia: Human Anterograde Amnesia; Relational Learning in Laboratory Animals.

Sleep and Biological Rhythms: A Physiological and Behavioral Description; Why Do We Sleep?; Physiological Mechanisms of Sleep and Waking; Disorders of Sleep; Biological Clocks.

Reproduction Behavior: Sexual Development; Hormonal Control of Sexual Behavior; Neural Control of Sexual Behavior; Parental Behavior.

Social Organization: Social behavior in animals

Emotion: Emotions as Response Patterns; Expression and Recognition of Emotions; Feelings of Emotions; Aggressive Behavior.

Human Communication: Speech Production and Comprehension: Brain Mechanisms; Disorders of Speech, Reading and Writing.

Behavioral disorders in human: Anxiety, depression,

### **Books Recommended:**

- Neil, R. *Physiology of Behavior*. Allyn and Bacon. 2000.

# YEAR 4

## Semester VII

### Pharmacology \*

4 (3 + 1)

Introduction: Nature of drugs and routes of drug administration.

Pharmacodynamics: Drug receptors, their nature and interaction. Agonist and antagonist. Signalling mechanism: Receptor desensitization. Drug dose response, variations and curves.

Pharmacokinetics, absorption, distribution and metabolism: Absorption and physical factors influencing absorption. Bioavailability and affecting factors, drug distribution. Metabolism and clearance of drug.

Drugs affecting Autonomic Nervous System: Cholinergic agonists and antagonists. Alpha and beta adrenergic agonists and antagonists.

Drugs affecting Central Nervous System: CNS stimulants, anxiolytic and hypnotic drugs. General and local anaesthetics. Neuroleptic, opioid and analgesics.

Drugs affecting Circulatory System: Antihypertensive agents, vasodilators, antiarrhythmic drugs. Haematinics, anticoagulants, thrombolytic drugs, anti-inflammatory and autacoids.

Drugs affecting other Systems and Chemotherapeutic drugs:

Bronchodilators. Antiemetic drugs. Diuretic agents. Antimicrobial and antifungal drugs. Chemotherapeutic drugs.

Drugs affecting Endocrine System: Hormone therapy for dysfunction of Hypothalamus, Pituitary, Thyroid, Adrenal, Gonads and Pancreas.

### Practicals:

1. To study the effect of Neostigmine on muscle contraction.
2. To perform the screening test for Paracetamol and Phenothiazines in urine samples.
3. To demonstrate the Duke bleeding time method in rabbit.
4. To observe the effect of Warfarin and Heparin on bleeding time in rabbit.
5. To study and compare the effect of Adrenaline, Neostigmine and Acetylcholine on the contraction of skeletal muscle.
6. To study the effects of drugs on rabbit eye pupil diameter.
7. To study the effect of Acetylcholine, Atropine and Adrenaline on cardiac muscle.
8. To observe the effect of central nervous system depressants and stimulants in animal models.
9. To study the effect of hypoglycaemic drugs in rabbit.

### Books Recommended:

- Katzung, B. G. Basic and Clinical Pharmacology. 9<sup>th</sup> ed., Appleton and Lange. 2004.
- Harvey, R. A. and Champe, P. C. Pharmacology, 2<sup>nd</sup> ed., Lippincott Publication. 2001.
- Girdwood, R. H. Clinical Pharmacology, 2<sup>4th</sup> ed., Bailliere Tindall, London, 1979.

## **Environmental Physiology\***

**3 (2 + 1)**

Introduction.: The atmosphere, aquatic and terrestrial environment, the extracellular, intracellular environment, Homeostasis and regulation, Tolerance and resistance, acclimatization and Acclimation, Regulatory mechanisms.

Ecology and Environmental Problems: Ecological factors, biological pyramids, water and food webs, Balance in nature, Cycles of food and nutrients, Impact of population growth on the environment. Ecological monitoring.

Osmoregulation: Water, ionic and osmotic balance and excretion in animals, Control of osmoregulation.

Thermoregulation: Heat exchange: conduction, convection, radiation.

Biochemical and physiological effects of temperature, temperature classification of animals particularly animals. Mechanisms of heat production, heat dissipation and heat conservation for temperature relations.

Interaction within Terrestrial and Aquatic Environment: Osmotic, thermal, respiratory and reproductive adaptation in organisms inhabiting marine shorelines and estuaries, freshwater, special aquatic habitats, terrestrial life, extreme terrestrial habitats and parasitic habitats.

Modes of Interaction: Predation and its effects, Antipredators, Defences, Symbiosis, Parasitism, Commensalisms, mutualism.

Competition for Existence: Exclusion principle, Human intervention

Environmental Concerns: Land, water and air pollution influence on physiological targets in human and animals.

### **Books Recommended:**

- Willmer, P., Stone, G and Johnson, H. Environmental Physiology of Animals. Blackwell Science Ltd. 2000.
- Schmidt-Neilsen, K. Animal Physiology, Adaptation and Environment. Cambridge University Press, Cambridge, 1998.
- Randall, D., Burggeren, W. and French, K. Eckert Animal Physiology, Mechanism and Adaptation. Freeman and Company, New York, 1998.
- Withers P.C. Comparative Animal Physiology. Saunders College Publishing Company, 1992.

## **Physiology of Health, Fitness and Exercise \***

**3 (2 + 1)**

The base of human performance, Macro and micro nutrients. Mechanisms of energy transfers in body, energy transfer in exercise, energy transfer in rest and physical activity, energy expenditure during walking, jogging, running and swimming, individual differences in energy requirements; Pulmonary functions in energy delivery; Cardiovascular system and its regulation during exercise; Skeletal muscles in energy utilization. Roles of endocrine system in exercise. Enhancement of energy capacity: Training for anaerobic and aerobic power, muscle strength and training; Special aids for training to enhance performance. Exercise performance and environmental stress:

Exercise at high altitude, thermal stress, stress in diving and microgravity.  
Effects of overweight, obesity on performance, weight control

**Practicals:**

1. Epidemiological surveys related to pattern of health and disease
2. Designing exercise and nutrition programmes
3. Experiments to evaluate cardiorespiratory fitness.
4. Health estimation parameters in; games, strenuous exercise, climbing, swimming
5. and jogging

**Books Recommended:**

- McArdle, W. D., Katch, F.I. and Katch, V. L.. Exercise Physiology: Energy, Nutrition and Human Performance. Lippincott Williams and Wilkins, Baltimore. 2001.
- Powers, S. K. and Howley, E. T. Theory and applications to fitness and Performance. Brown and Benchmark. 1997.

**Research Methodology**

**3 (0 + 3)**

**Objectives:**

1. To guide the student in obtaining necessary knowledge about the aspects of research.
2. To guide the student in acquiring an understanding of the utilization of the resources available for Research Projects.
3. To guide the student in deciding upon the topic for his/her culminating experience.

Introduction, research and profession, Understanding the research process, aims of research, the research topic, title and research problem, literature review, research design, Search, retrieve, manage information, Plagiarism and its professional consequences, Research study design, Epidemiological studies, Choosing an appropriate epidemiologic approach to investigate a problem, Sample size, population and sampling types, data-collecting methods and measuring instruments in quantitative research, types of quantitative research designs, Statistical approaches for data analysis, Parametric, non-parametric and semi-parametric methods, Qualitative Methodologies and interpretation of results, validity of conclusions, report writing and the research proposal, Community Research, Aboriginal Research, Clinical Trials, Research Ethics-history, history of research ethics, principles of research ethics, conflicts of interest, Principles of presentation, Communication-oral, posters, abstract and manuscript preparation, Communicating your own credentials, Communicating own work-CV, development of a grant proposal using the grant format of national and international agencies, Interviewing techniques

## Learning Outcomes:

After the completion of this course the student will be able to:

1. Design and conduct experiments independently.
2. They will be able to browse the resources available to funding.
3. They will be able to read and write a research article.
4. They will be able to participate and present their studies in conferences independently.
5. They will be able to design research proposals and submit them for funding.

## Books Recommended:

- Hully, S., Cummings, S., Browner, W., Grady, D., Hearst, N. and Neuman, T. Designing Clinical Research, 2nd ed; Lippincott Williams and Wilkins, Philadelphia, 2001.
- Baumgartner, T. and Hensley, L. Conducting and Reading Research in Health and Human Performance 4<sup>th</sup> ed McGraw Hill, New York, 2006,
- Community-Based Participatory Research for Health (2003), by M. Minkler and N. Walderstein, Josey Boss, San Francisco, CA
- Qualitative Research and Evaluation Methods 3rd ed (2002), by M. Patton, Sage Publications Inc., Thousand Oakes, CA
- Handbook of Health Research Methods (2005), by Ann Bowling and Shah Ebrahim Open University Press, Two Penn Plaza, New York, NY.

## Project

3

Experimental work/survey will be done by the student under the guidance of a Research Supervisor and a bound Report will be submitted with a presentation.

## Semester VIII

### Pathophysiology (Human/Animal/Plant)

3 (2 + 1)

#### Human and Animal

Molecular Genetics and Neoplasia, Disorders of Red Blood Cells, Disorders of Coagulation, Disorders of White Blood Cells, Inflammation and the Immune Response, Hypersensitivity Disorders and Immune Deficiencies. Cardiovascular Disorders, Gastrointestinal and Liver Disorders, Respiratory Disorders :, Renal Disorders: Musculoskeletal Disorders: Endocrine Disorders.

#### Plant

Comparative analysis of diseases physiology; influence of plant pathogens on photosynthesis; host pathosystems; physiological and biochemical changes due to pathological problems in transit and storage; effects of biotic diseases on human and animal health and role of mycotoxin

### **Books Recommended:**

- Agries, G. N. Plant Pathology. 4<sup>th</sup> ed, Academic Press., N-Y. 2005.
- Strange, R. N. Introduction to plant pathology. John Wiley and Sons Ltd. 2005.
- Pathophysiology: Concepts of Altered Health States Carol Mattson Porth, Rn , Carol Porth Lippincott Williams and Wilkins. 2004.
- Understanding Pathophysiology. Sue E. Huether, Kathryn L. McCance, Sue Huether  
Pathophysiology: The Biologic Basis for Disease in Adults And Children Kathryn L. McCance Mosby Inc (November 2005)
- Pathophysiology LEE-ELLEN C. COPSTEAD-KIRHORN, Ph.D., Jacquelyn L. Banasik Elsevier Science Health Science div (February 2005)
- Porth, C. Pathophysiology. Lippincott Williams and Wilkins. 2003.
- Moreau, D. Pathophysiology. 3rd ed. Lippincott Williams and Wilkins.2003.
- Ahmad, I. and Bhutta, A. R. Textbook of Introductory Plant Pathology, National Book Foundation. Islamabd. 2005.

### **Physiological Biotechnology \* (BIOTECHNOLOGY IN PHYSIOLOGY)**

**3 (2 + 1)**

#### **Add subheadings**

To overview the various principles of biochemical, biophysical, rDNA technology techniques etc. at molecular, cellular, tissue and organ levels in understanding the physiological mechanisms.

Some model studies: The isolation and purification of hormonal and bioactive compounds in differing physiological states by various chromatographic techniques and assaying of these specifically immunoassays such as radioimmunoassay, ELISA, immunocytochemical techniques.

Application of molecular techniques of SDS-PAGE, agarose gel electrophoresis, PCR, Southern, Northern and Western blotting in understanding physiological processes.

Use of rDNA technology in bacterial cloning for the industrial production of hormones and bioactive compounds such as insulin, growth hormone, interferons etc.

Use of bioinformatics or the data bases of proteins and genomic sequences in understanding the signal proteins in various physiological diseases e.g. of mutant strain of neurofibromatosis (NF1), protein tyrosine phosphatase 1B (PTP-1B) overexpression role in insulin resistance of type 2 diabetes and phylogenetic relationship among proteins in understanding of comparative mechanisms of actions.

Plant tissue cultures use in plant physiology and biochemistry.

Animal tissue cultures, embryonic stem cells cultures in higher animal cloning for experimental development of knock out mice.

Superovulation, *in vitro* fertilization, nuclear transfer techniques and cloning for obtaining breeds with specific physiological overexpressions through proteins. Use of this technology in gene therapy e.g. in cystic fibrosis.

Transgenic animals and plants. Genetically modified foods; their uses and risks.

Use of biosensors in clinical treatment such as glucose and insulin sensor in the treatment of insulin dependent diabetes mellitus.

Ethical significances in this discipline of biotechnology. Animal rights and use of experimental animals in physiological researches.

### **Practicals:**

by visiting the various laboratories with advanced techniques and demonstrating the use of those techniques in understanding the physiological mechanisms and planning researches.

### **Books Recommended**

- Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Willey and Sons Inc. New York, 2005.
- Lodish, H., Berk, A., Matsudairia, P., Kaiser, C.A., Kreiger, M., Scott, M..P., Zipursky, S.L. and Darnell, J. Cell Molecular Biology, W.H. Freeman and Company, NewYork, 2003.
- Nelson, D.L. and Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, 2005.
- Websites on the various above topics.

### **Toxicology\***

**3 (2 + 1)**

Introduction. Concepts in toxicology

Disposition of toxic compounds. Metabolism of foreign compounds. Dose-response relationships. Absorption of toxicants. Types of exposure and response. Distribution and storage of toxicants. Physiology of toxicity due to drinking water. Physiology of biotransformation and bio-detoxification also the elimination of the toxicants. Drugs as toxic substances. Toxicology and industry (heavy metals and metalloids. radionuclides). Toxicity of natural foods and food additives (taste enhancers, emulsifiers colors and preservatives). Toxicity coming from pesticides and fertilizers. Environmental pollutants ( petrochemicals and dioxins). Natural products. Household products. Toxicants as teratogens. Toxicity test (Lethal doses LDs Effective Doses EDs, Effective Concentration ECs. Toxicity testing and risk assessment.

### **Practicals:**

Case studies related to hazardous toxicity incidences in affected areas.

Field Trips to these particular sights

Concepts and determination of LD50, ED50 and ECs in insects / birds

Demonstrations of toxic effects of toxicants on fresh water protozoans.

Demonstrations of teratogenic effects (chick and rat models)

Determinations of effects of any toxic substance on biochemical and hemotological parameters

## Books Recommended:

- Casarett and Doulls Toxicology: The basic Science of poisons, 2001.
- Casart, L.J., Curtis D., Klissen.(editor)Doull, J. and Klaasen CD. McGraw-Hill Professional Publishing New York.
- Comparative Toxicology : Cellular and Molecular Toxicology 2002 Vanden Heuel, J.P., perdew, G.H and Mattes,WB (eds) Pergamon press, New York.

## Ergonomics\*

2

### Course Aims and Outcomes

This course is designed to introduce the basic concepts of technology and human needs in relation to efficiency and environment. After completion of the course students will be able to understand the relationship between physiology, human factor and ergonomics. They will be able to learn the design and ergonomics relationship using examples of various models in different work condition. They will understand the concept of occupational health and safety in terms of ergonomics.

### Theory

- 1. Introduction and concepts:** Multidisciplinary nature of ergonomics, History of ergonomics.
- 2. Human factor and physiology in ergonomics:** Energy, the fuel of work; Work as output of skeletal-muscular activity; limitations of a function and emergence of health problems;
- 3. Workstation Injuries/diseases:** Repetitive work at workstation and injuries; common injuries/diseases. Loss of work output and remedial strategy.
- 4. Workstation design and work efficiency interactions:** Workstation, Sitting work design, Standing work design, Hand tools and their control design and Heavy physical work in Repetitive Strain Injury (RSI) development; Physiological indices in RSI; Modification in design.
- 5. Ergonomics in action (A few models):**
  - a) Computer workstation:** Setting up of station, Keyboard trays, Selecting chairs, Ergonomics tips for users, Operator's risk factors.
  - b) Industrial production workstation:** Identity of repetitive work RSIs; Physiological stresses and effects on work output.
- 6. Role of Health & Safety Representative:** Awareness of workers to workplace RSIs; Workers' information on ergonomics issues; Administrative awareness to ergonomical issues.

### Practical and Field Work

1. Making hazard data sheets of repetitive work in University laboratory and any other work site.
2. Identifying problems and developing solution s to ergonomic problems.
3. Data collection on physiological targets in heavy physical workstations.
4. Preparation of job design check-lists and workers' work behaviour.

5. Study of Cumulative Trauma Disorder/Injury e.g. in garment industry.
6. Evaluation of jobs for various risk factors.

### **Books Recommended**

- Ergonomics (How to design for ease and efficiency). 2000. 1<sup>st</sup> ed. Kroemer, K. H. E., Kroemer, H. B. and Kroemer-Elbert, K. E. Prentice Hall International Inc. London, UK.
- Introduction to Ergonomics. 1995. 1<sup>st</sup> ed. Bridger, R. S. McGraw-Hill Higher Education, New York, USA.
- Ergonomics (How to design for ease and efficiency). 2000. 1<sup>st</sup> ed. Kroemer, K. H. E., Kroemer, H. B. and Kroemer-Elbert, K. E. Prentice Hall International Inc. London, UK.
- Introduction to Ergonomics. 1995. 1<sup>st</sup> ed. Bridger, R. S. McGraw-Hill Higher Education New York, USA.

### **Internship**

**3**

Internship of at least five weeks in teaching, research, health and commercial organizations. At the end of Internship a report will be submitted to the Department/Institution.

## SCHEME OF STUDIES

# MS Physiology (2years/4 semesters)

### SEMESTER – I

### SEMESTER - II

Course Title	Cr Hours	Course Title	Cr Hours
Physiology of excitable cells (core course – I)	2+1	Special/Optional Course-II	2+1
Advances in Endocrinology (Core Course- II)	2+1	Special/Optional Course-III	2+1
Special/Optional Course-I	2+1	Special/Optional Course – IV	3

### SEMESTER – III

### SEMESTER - IV

Research Reading – I	3	Research Reading - II	3
Research Thesis			6

### **List of Core Courses:**

1. Advances in Clinical Endocrinology
2. General Pathologic Physiology
3. General Hematology
4. Poultry Physiology
5. Crop Physiology
6. Plant Cell Physiology
7. Physiology of Smooth Muscle
8. Myocardial Cell
9. Electrophysiology
10. Comparative Structure & Function of Muscle
11. Reproductive Endocrinology
12. Physiological techniques

### **List of Specializations:**

1. Endocrinology  
Neuroendocrinology  
Reproductive Endocrinology  
Clinical Endocrinology

2. Neuromuscular Physiology

Advances in muscle structure & function  
Diseased muscle (Clinical & Experimental)  
Pathophysiology of Neuromuscular System  
Electromyography & Nerve Conduction Studies

3. Hematology

Clinical Hematology  
Immunology

4. Pathophysiology

Advances in Pathologic Physiology

5. Plant Physiology

Plant Nutrition  
General Crop Physiology  
Plant Ecology  
Plant Biophysics

6. Poultry Physiology

Poultry Pathology  
Incubation & Hatchery  
Poultry Vaccine Production  
Poultry Nutrition  
Poultry Economics & marketing  
Poultry Extension  
Poultry Housing & Management

7. Biology