

**CURRICULUM**  
**OF**  
**BIOCHEMISTRY**  
**(BS/MS)**

**(Revised 2013)**



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

## **HEC CURRICULUM DIVISION**

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Mr. Riaz-ul-Haque	Assistant Director (Curr)

Composed by Mr. Zulfiqar Ali, HEC Islamabad

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# PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled "Supervision of Curricula and Textbooks and Maintenance of Standard of Education". With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

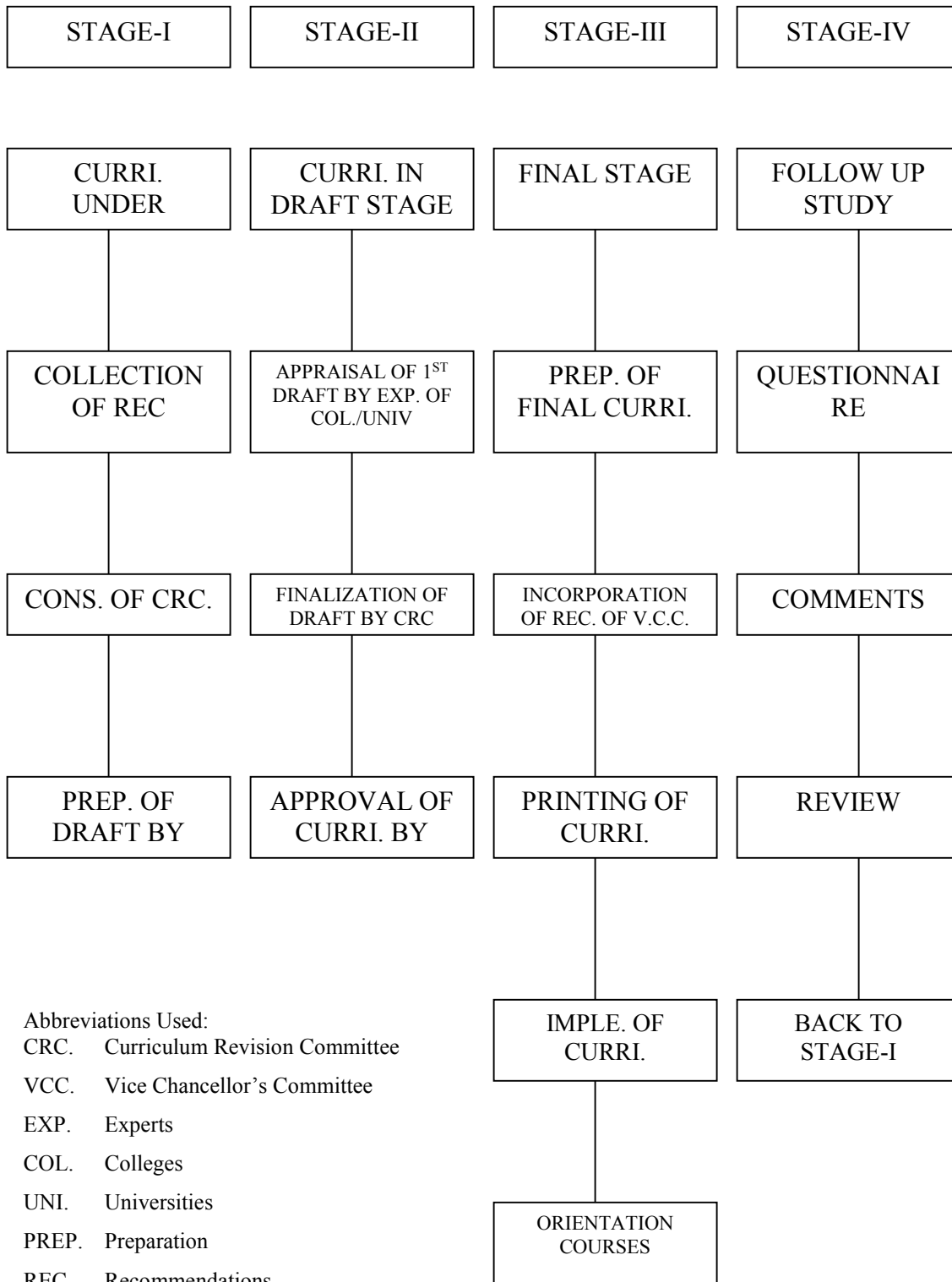
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC ([www.hec.gov.pk](http://www.hec.gov.pk)).

**(Fida Hussain)**  
**Director General (Academics)**

# CURRICULUM DEVELOPMENT PROCESS



## INTRODUCTION

### MINUTES OF THE FINAL MEETING OF HEC NATIONAL CURRICULUM REVISION COMMITTEE ON BIOCHEMISTRY HELD AT HEC REGIONAL CENTRE, PESHAWAR FROM JUNE 24-26, 2013.

The members of the National Curriculum Revision Committee on Biochemistry, developed frame work and revised the curriculum of BS & MS in Biochemistry in two different meetings. The first meeting was held from December 26-28, 2012 at Karachi. The Second meeting was held from June 24-26, 2013 at HEC Regional Centre, Peshawar. The following experts attended these meeting:

1. **Dr. Muhammad Hassan Khaskeli** **Convener**  
Professor  
Department of Biochemistry  
Shah Abdul Latif University  
Khairpur
2. **Dr. Asma Gul** **Secretary**  
Assistant Professor & Chairperson  
Department of Bioinformatics & Biotechnology  
International Islamic University  
H-10, Islamabad
3. **Dr. Sajid Mehmood** **Member**  
Assistant Professor & Head of Department  
Department of Biochemistry & Molecular Biology  
University of Gujrat, Gujrat
4. **Dr. Naveed Wasif** **Member**  
Assistant Professor  
Center for Research in Molecular Medicine  
The University of Lahore  
Lahore
5. **Dr. Tahir Mahmood** **Member**  
Assistant Professor  
Department of Chemistry  
University of Sargodha  
Sargodha
6. **Dr. Asma Saeed** **Member**  
Assistant Professor  
Department of Biological Sciences  
Gomal University  
Dera Ghazi Khan

- |     |   |        |
|-----|---|--------|
| 7.  | <b>Dr. Asnad</b><br>Assistant Professor<br>Department of Biochemistry<br>Abdul Wali Khan University<br>Mardan                 | Member |
| 8.  | <b>Dr. Muhammad Zahoor</b><br>Assistant Professor<br>Department of Chemistry<br>University of Malakand<br>Chakdara, Lower Dir | Member |
| 9.  | <b>Mr. Aftab Ahmed</b><br>Lecturer<br>Deptt: of Biochemistry,<br>University of Peshawar<br>Peshawar                           | Member |
| 10. | <b>Ms. Fatima Syed</b><br>Lecturer,<br>Institute of Chemical Sciences,<br>University of Peshawar,<br>Peshawar                 | Member |
| 11. | <b>Dr. Zahid Khan</b><br>Assistant Professor,<br>Institute of Chemical Sciences,<br>University of Peshawar,<br>Peshawar       | Member |
| 12. | <b>Dr. Iram Murtaza</b><br>Assistant Professor,<br>Department of Biochemistry,<br>Quaid-i-Azam University,<br>Islamabad.      | Member |

**2** The following Members attended the Preliminary meeting held in Karachi but could not attend the final meeting due to their engagements:

1. **Dr. Sohail Asif Qureshi,**  
Dean,  
Department of Biology,  
Lahore University of Management Sciences (LUMS),  
Opp. Sector "U", DHA, Lahore Cantt.
2. **Prof. Dr. Mumtaz Ali Qureshi,**  
Professor and Chairperson,  
Department of Biochemistry,  
ISRA University, Hyderabad, Sindh.

3. **Prof. Dr. Samina Bano,**  
Chairperson,  
Department of Biochemistry,  
University of Karachi, Karachi.
4. **Dr. Ashif Sajjad,**  
Assistant Professor,  
Institute of Biochemistry,  
University of Balochistan, Quetta.
5. **Dr. Allah Bux Ghanghro,**  
Associate Professor,  
Institute of Biochemistry,  
University of Sindh,  
Jamshoro.

3. The Convener of the Preliminary meeting Prof. Dr. Mumtaz Ali Qurashi could not attend the meeting due to his academic engagements, therefore the committee unanimously selected Dr. M. Hassan Khaskheli as Convener and Dr. Asma Gul as Secretary upon the recommendation of Dr. Sohail Asif Qureshi former Secretary, who actively participated behind the scene. The committee members showed grave concern over the least participation from the members of NCRC. In order to complete the quorum, and to increase the local participation, four new members were invited from University of Peshawar & Islamia College for participation. Mr. Riaz-ul-Haque assured the house to bring this issue under kind notice of the Competent Authority for further action against non-active members of the committee. He then requested the Convener to start the technical session as per agenda.

4- The meeting started with the recitation from the Holy Quran by Dr. Sajid Mehmood of University of Gujrat. Mr. Zaheer Ahmed Awan, Director HEC Regional Centre, Peshawar welcomed the participants of the meeting on behalf of Executive Director and the Chairperson HEC and briefed them about the proceeding as per agenda items. Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC, Islamabad in the capacity of meeting coordinator welcomed the participants & requested the convener to chair the proceedings.

5- Prof. Dr. M. Hassan Khaskheli, Professor, Department of Biochemistry, Shah Abdul Latif University, Khairpur as Convener thanked the members for their trust in him and assured his best outcome through participation of all members. The Committee reviewed and discussed the curriculum of Biochemistry, prepared in its preliminary meeting while working in various groups, as a whole. The former Secretary Dr. Sohail Asif Qureshi was also taken on board to guide the committee on various technical issues. The local participants also participated with vigour and enthusiasm.



**6-** The committee, after thorough discussion decided to assign 12 credit hours to the Semester eight of the BS Programme with a rationale to promote research culture at the BS level and motivate students to opt research projects, it was ensured not to affect the total credit hours pre-requisite for degree completion.

**7.** The Committee considered the inputs given by the various members and after detailed discussion incorporated their suggestions in the draft curriculum. The Committee, after three days deliberations, achieved the following objectives:

1. Reviewed and finalized the draft curriculum for Bachelor Studies (BS 4-year) in the discipline of Biochemistry so as to bring it at par with international standards.
2. Incorporated latest reading & writing material against each course.
3. Brought uniformity and developed minimum baseline courses in each and every course of study.
4. Made recommendations for promotion/development of the discipline.

**8.** The Convener of the NCRC thanked the members for their input in revising curriculum keeping in view the requirement of the country and to make it more practical competitive and effective.

**9.** Mr. Riaz-ul-Haque, Assistant Director, Curriculum HEC thanked the Convener and all the members of the committee, on behalf of Mr. Fida Hussain, Director General (Academics), HEC who could not attend the meeting due to official engagements, for sparing precious time and for their quality contribution towards finalization of the preliminary draft curriculum in the discipline of Biochemistry. The committee appreciated the efforts made by the officials of HEC and of HEC Regional Center Peshawar, for providing local hospitality.

**10.** The meeting ended with vote of thanks to and from the chair.

## STANDARDIZED FORMAT FOR BS (4-YEAR) IN BIOCHEMISTRY

### STRUCTURE

Sr.	Categories	No. of courses	Credit Hours
1.	Compulsory courses	8	22
2.	General courses (to be chosen from other Departments)	9	27
3.	Discipline specific foundation courses	7	25
4.	Major courses (including Research Project/Internship)	17	47
5.	Electives within the major	4	12
	<b>Total</b>	<b>45</b>	<b>133</b>

- Total numbers of credit hours 133
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course load per semester 15-18 Credit hours
- Number of courses per semester 5-6

## LAYOUT FOR BS (4 YEAR) IN BIOCHEMISTRY

<b>Compulsory Courses</b> (student has no choice)		<b>General Courses</b> (to be chosen from other Departments)	
<b>8 courses</b>		<b>9 courses</b>	
<b>22 Credit hours</b>		<b>27 Credit hours</b>	
<b>Subject</b>	<b>Cr. hr</b>	<b>Subject</b>	<b>Cr. hr</b>
1. English I	3	1. Social Science-I	3+0
2. English II	3	2. Social Science-II	3+0
3. English III (Writing & Comm)	3	3. Marketing & Management	3+0
4. Pakistan studies	2	4. Organic Chemistry	2+1
5. Islamic studies	2	5. Inorganic Chemistry	2+1
6. Mathematics (Calculus)	3	6. Physical Chemistry	2+1
7. Biostatistics	3	7. Biophysics/Analytical Chemistry	2+1
8. Intro. to Computer Science	3	8. Genetics	3+0
		9. Microbiology	2+1
	<b>22</b>		<b>27</b>

<b>Discipline-Specific Foundation Courses</b>		<b>Major Courses</b>		<b>Elective Courses within the Major</b>		
<b>7 courses</b>		<b>17 courses</b>		<b>4 courses</b>		
<b>25 Credit hours</b>		<b>47 Credit hours</b>		<b>12 Credit Hours</b>		
<b>Subject</b>	<b>Cr hr</b>	<b>Subject</b>	<b>Cr hr</b>	<b>Subject</b>	<b>Cr hr</b>	
1. Introductory Biochemistry	3+1	1. Cell Biology	2+1	1. Elective-I	3+0	
2. Carbohydrates & Lipids	3+1	2. Biochemical Techniques	1+2	2. Elective-II	3+0	
3. Amino Acids & Proteins	3+1	3. Biosafety & Ethics	2+0	3. Elective-III	3+0	
4. Human Physiology	3+0	4. Plant Biochemistry	2+1	4. Elective-IV	3+0	
5. Enzymes	2+1	5. Clinical Biochemistry	2+1	<b>Note:</b> Elective courses are to be chosen from the given list.  OR  Any other course depending upon the expertise available.		
6. Molecular Biology	3+0	6. Biomembranes & Cell Signaling	3+0			
7. Metabolism	4+0	7. Bioenergetics	2+0			
		8. Research Planning & Report Writing (Eng-IV)	2+1			
		9. Nutritional Biochemistry	2+1			
		10. Bioinformatics	2+1			
		11. Industrial Biochemistry	2+1			
		12. Biotechnology	3+0			
		13. Immunology	3+0			
		14. Current Trends in Biochemistry	3+0			
		15. Methods in Molecular Biology	2+1			
		16. Environmental Biochemistry	2+0			
		17. Seminar	1+0			
	<b>25</b>		<b>46</b>			<b>12</b>

**TOTAL CREDIT HOURS = 132**

## SEMESTER-WISE SCHEME OF STUDIES FOR BS (4 YEAR) IN BIOCHEMISTRY

SEMESTER	NAME OF SUBJECT	THEORY	PRACTI CAL	CREDITS
<b>First</b>	English-I	3	0	3
	Pakistan Studies	2	0	2
	Mathematics (calculus)	3	0	3
	Social Sciences-I	3	0	3
	Organic Chemistry	2	1	3
	Introductory Biochemistry	3	1	4
			<b>16</b>	<b>2</b>
<b>Second</b>	English-II	3	0	3
	Islamic studies	2	0	2
	Inorganic Chemistry	2	1	3
	Social Science-II	3	0	3
	Cell Biology	2	1	3
	Carbohydrates & Lipids	3	1	4
			<b>15</b>	<b>3</b>
<b>Third</b>	English-III (Writing & Comm)	3	0	3
	Intro. to Computer Science	2	1	3
	Amino Acids & Proteins	3	1	4
	Physical Chemistry	2	1	3
	Biosafety & Ethics	2	0	2
	Genetics	3	0	3
			<b>15</b>	<b>3</b>
<b>Fourth</b>	Human Physiology	3	0	3
	Biophysics/Analytical chemistry	2	1	3
	Microbiology	2	1	3
	Enzymes	2	1	3
	Nutritional Biochemistry	2	1	3
	Industrial Biochemistry	2	1	3
			<b>13</b>	<b>5</b>
<b>Fifth</b>	Metabolism	4	0	4
	Molecular Biology	3	0	3
	Biochemical Techniques	2	1	3
	Immunology	3	0	3
	Environmental	2	0	2

	Biochemistry			
	Bioenergetics	2	0	2
		<b>16</b>	<b>1</b>	<b>17</b>
<b>Sixth</b>	Clinical Biochemistry	2	1	3
	Methods in Molecular Biology	2	1	3
	Bioinformatics	2	1	3
	Biotechnology	3	0	3
	Biostatistics	3	0	3
	Plant Biochemistry	2	1	3
		<b>14</b>	<b>4</b>	<b>18</b>
<b>Seventh</b>	Research Planning & Report Writing (English-IV)	2	1	3
	Biomembranes & Cell Signaling	3	0	3
	Marketing & Management (Social Sciences-III)	3	0	3
	Elective-I	3	0	3
	Elective-II	3	0	3
		<b>14</b>	<b>1</b>	<b>15</b>
<b>Eight</b>	Current Trends Biochemistry	3	0	3
	Seminar/Research	1	0	1
	Elective-III	3	0	3
	Elective-IV	3	0	3
		<b>10</b>	<b>0</b>	<b>10</b>
	<b>TOTAL</b>	<b>111</b>	<b>22</b>	<b>132</b>

## **DETAIL OF COMPULSORY COURSES**

### **BIOSTATISTICS (3+0)**

#### **COURSE OBJECTIVES:**

To acquaint students with statistical techniques frequently used in biology to process real data.

#### **COURSE CONTENTS:**

Introduction and scope of biostatistics, Frequency distribution, measures of central tendency and dispersion, statistical hypothesis and its significance, null and alternative hypothesis, confidence interval, tests involving binomial and normal distribution, Sampling techniques, Regression and correlation, F-distribution, student's t-distribution, chi-square test, Analysis of Variance (ANOVA), LSD test, experimental designs, Completely Randomized Design (CRD), Randomized Complete Block Design (RCBD), Computer applications of Biostatistics, graphical representation of data.

#### **RECOMMENDED BOOKS:**

1. Mann PS, 2010. Introductory Statistics. 7<sup>th</sup> Edition; John Wiley and Sons.
2. Freund JE and Perles MB, 2005. Modern Elementary Statistics; 12<sup>th</sup> Edition. Pearson.
3. Chaudhry SM, 2005. Introduction to statistical theory. 6<sup>th</sup> Edition; Markazi Kutub Khana, Lahore.
4. Chernick MR and Friis RH, 2003. Introductory Biostatistics for the Health Sciences: Modern Applications Including Bootstrap. 1<sup>st</sup> Edition; Wiley Interscience.
5. Le CT, 2003. Introductory Biostatistics. 1<sup>st</sup> Edition; Wiley Interscience.

### **MATHEMATICS (CALCULUS)**

### **INTRODUCTION TO COMPUTER SCIENCE**

# DETAIL OF GENERAL COURSES

## INORGANIC CHEMISTRY

(2+1)

### COURSE OBJECTIVES:

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of p- block elements as well as use this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

### COURSE CONTENTS:

- ❖ Chemical Bonding: Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.
- ❖ Acids and Bases: Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), relative strength of acids and bases, significance of pH,  $pK_a$ ,  $pK_b$  and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.
- ❖ p-Block Elements: Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

### PRACTICAL:

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid-base titrations, preparation and standardization of acid and alkali solutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, gravimetric analysis, determination of barium in a given sample, determination of chloride in a given solution.

### RECOMMENDED BOOKS:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., *Inorganic Chemistry*, 2<sup>nd</sup> ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, 6th ed., John-Wiley & Sons, New York, (2007).

3. Huheey, J. E., *Inorganic Chemistry: Principles of Structure and Reactivity*, 3<sup>rd</sup> ed., Harper International SI Edition, (2006).
4. House, J. E., *Inorganic Chemistry*, Academic Press. USA, (2008).
5. Lee, J. D., *Concise Inorganic Chemistry*, 5<sup>th</sup> ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., *Inorganic Chemistry*, 3<sup>rd</sup> ed., Pearson Education, India, (2008).
7. Huheey, J. E., Keiter E. A., Keiter L. R., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4<sup>th</sup> ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., *Inorganic chemistry*, 3<sup>rd</sup> ed., Pearson Education India, (1981).
9. Chaudhary S. U., *Ilmi Textbook of Inorganic Chemistry*, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. Housecroft, Alan G. Sharpe, *Inorganic Chemistry*, 3<sup>rd</sup> ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., *Descriptive Inorganic Chemistry*, 2<sup>nd</sup> ed., Brooks Cole, (2010).
12. Wulfsberg G., *Principles of Descriptive Inorganic Chemistry*, 1<sup>st</sup> ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., *Laboratory Safety for Chemistry Students*, John-Wiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> ed., Pearson Education, Ltd., (2000).
15. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, 7<sup>th</sup> ed., (7<sup>th</sup> imp.), Pearson Education, Ltd., (2009).

## **ORGANIC CHEMISTRY (2+1)**

### **COURSE OBJECTIVES:**

Students will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

### **COURSE CONTENTS:**

- ❖ Basic Concepts of Organic Chemistry: Bonding and hybridization, localized and delocalized bonding, structure-aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).
- ❖ Chemistry of Hydrocarbons: Saturated and unsaturated hydrocarbons with emphasis on free radical, electrophilic addition and electrophilic substitution reactions.
- ❖ Chemistry of Functional Groups: preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and



applications, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

### **PRACTICAL:**

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

### **RECOMMENDED BOOKS:**

1. Brown, W. and Poon, T., *Introduction to Organic Chemistry*, 3<sup>rd</sup> Ed., John-Wiley & Sons, Inc., (2005).
2. John, E. M. *Organic Chemistry*, 8<sup>th</sup> ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., *Organic Chemistry*, 6<sup>th</sup> ed., Prentice Hall, New Jersey, (1992).
4. Younus, M., *A Textbook of Organic Chemistry*, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).
5. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry*, 6<sup>th</sup> ed., Pearson Education Limited, England, (1986).
6. Solomons, T. W. G. and Fryhle, C. B., *Organic Chemistry*, 10<sup>th</sup> ed., John-Wiley & Sons, Inc., (2011).
7. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., *Vogel's Textbook of Practical Organic Chemistry*, 5<sup>th</sup> ed., Longman, UK, (1989).
8. Pavia, D. L., Kriz, G. S., Lampman, G. M and Engel, R. G., *A Microscale Approach to Organic Laboratory Techniques*, 5<sup>th</sup> ed., Brooks/ Cole Cengage Learning, (2013).
9. Mayo, D. W., Pike, R. M. and Forbes, D. C., *Microscale Organic to Laboratory with Multistep and Multisacle Syntheses*, 5<sup>th</sup> ed., John-Wiley & Sons, Inc., (2011).
10. Gilbert, J. C. and Martin, S. F., *Experimental Organic Chemistry: A Miniscale and Microscale Approach*, 5<sup>th</sup> ed., Brooks/ Cole Cengage Learning, (2010).
11. Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., *Organic Chemistry*, 6<sup>th</sup> ed., Brooks/ Cole Cengage Learning, (2012).

## PHYSICAL CHEMISTRY (2+1)

### COURSE OBJECTIVES:

Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibrium and to investigate the physical properties of ideal/non-ideal binary solutions. Students should also be able to study the rates of reactions and perform related calculations.

### COURSE CONTENTS:

- ❖ Chemical Thermodynamics: Equation of states, ideal and real gases, the real gas equation and the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.
- ❖ Chemical Equilibrium: General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle.
- ❖ Solution Chemistry: Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non-ideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.
- ❖ Chemical Kinetics: The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

### PRACTICAL:

Determination of viscosity and refractive index of liquids; Determination of percent composition of liquid solutions viscometrically; Determination of refractive index and molar refractivity; Determination of percent composition of liquid solutions by refractive index measurements; Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method); Determination of molecular weight of a compound by lowering of

freezing point (cryoscopic method); Determination of heat of solution by solubility method; Determination of heat of neutralization of an acid with a base; Kinetic study of acid catalyzed hydrolysis of ethyl acetate; Determination of partition coefficient of a substance between two immiscible liquids.

### **RECOMMENDED BOOKS:**

1. McQuarrie, D. A. and Simon, J. D., *Physical Chemistry – A Molecular Approach*, 1<sup>st</sup> ed., University Science Books, (1997).
2. Atkins, P. and Paula, J.D., *Atkin's Physical Chemistry*, 9<sup>th</sup> ed., Oxford University Press, (2010).
3. Shoemaker, D., *Experiments in Physical Chemistry*, 8<sup>th</sup> ed., McGraw-Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., *Physical Chemistry*, 4<sup>th</sup> Ed., (2005).
5. Atkins, P., Jones, L., *Chemical Principles*, 5<sup>th</sup> ed., W. H. Freeman and Company, New York, (2010).
6. James, A. M., Prichard, F. E., *Practical Physical Chemistry*, 3<sup>rd</sup> ed., Longman Group Limited, New York, (1974).
7. Chaudhary, S. U., *Ilmi Textbook of Physical Chemistry*, 2<sup>nd</sup> ed., Ilmi Kitab Khana, Lahore, (2013).
8. Atkins, P., Jones, L., *Chemical Principles: The Quest for Insight*, 5<sup>th</sup> ed., W. H. Freeman, (2010).
9. Linder, B., *Elementary Physical Chemistry*, World Scientific Publishing Co. Ptv. Ltd., (2011).
10. Davis, W. M., Dykstra, C. E., *Physical Chemistry: A Modern Introduction*, 2<sup>nd</sup> ed., CRC Press, (2011).

## **BIOPHYSICS**

**(3+0)**

### **COURSE OBJECTIVES:**

This course is intended for students studying life sciences and aims to impart fundamental concepts of physics in the context of biological systems.

### **COURSE CONTENTS:**

Essentials of thermodynamics; concept of entropy, enthalpy and Gibb's free energy; order and disorder in biological systems; molecules, diffusion, random walks and friction; methods of studying macromolecules; interactions of molecules in 3-D space-determining binding and dissociation constants; molecular motors; sedimentation; Reynold's number; chemical forces and self-assembly; physics of ion channels.

### **RECOMMENDED BOOKS:**

1. Nelson P, 2004. Biological Physics, Energy, Information and Life. 1<sup>st</sup> Edition; WH Freeman & Company.

2. Kirsten et al., 2010. Introduction to Biological Physics for the Health and Life Sciences. 2<sup>nd</sup> Edition; John Wiley & Sons.
3. Davidovits P, 2013. Physics for Biology & Medicine. 4<sup>th</sup> Edition; Academic Press.
4. Newman, 2008. Physics of the Life Sciences. Springer.
5. Duncan, 1975. Physics for Biologist. Blackwell Science.

## **MICROBIOLOGY (2+1)**

### **COURSE OBJECTIVES:**

This course aims to familiarize students with fundamentals of prokaryotic and eukaryotic microbial life including viruses.

### **COURSE CONTENTS:**

Overview and history of microbiology including microbial diversity (Archaea, bacteria, fungi, algae, protozoa), nutrition, growth, metabolism; cultivation; viruses; control of microorganisms: sterilization and disinfection, antimicrobial agents, antibiotics, antibiotic resistance and susceptibility, antifungal and antiviral agents; cell death; symbiosis, carbon, nitrogen, sulfur and phosphorus cycles; microbiology of soil, freshwater and seawater.

### **PRACTICAL:**

Sterilization techniques; culturing of bacteria in liquid and on solid medium; Gram-staining of bacteria; colony and cell morphology; bacterial cell count and growth curves; biochemical tests.

### **RECOMMENDED BOOKS:**

1. Alcamo IE, 2010. Fundamentals of Microbiology. 9<sup>th</sup> Edition, Jones and Bartlett Publishers.
2. Madigan MT and Martinko J, 2010. Brock Biology of Microorganisms. 13<sup>th</sup> Edition; Pearson College Div.
3. Talaro KP, 2009. Foundations in Microbiology: Basic Principles. 7<sup>th</sup> Edition; McGraw-Hill Publisher.
4. Black JG, 2007. Microbiology: principles and explorations. 7<sup>th</sup> Edition; John Wiley and Sons.
5. Baker et al., 2006. Instant Notes in Microbiology. 3<sup>rd</sup> Edition; Taylor and Francis.
6. Prescott et al., 2005. Microbiology. 6<sup>th</sup> Edition; McGraw-Hill Medical Publishing.
7. Cappuccino JG and Sherman N, 2013. Microbiology: a laboratory manual. 10<sup>th</sup> Edition; Pearson Education.

## **GENETICS (3+0)**

### **COURSE OBJECTIVES:**

To acquaint students with classical aspects of genetics.

### **COURSE CONTENTS:**

Classical Mendelian genetics; monohybrid crosses, dominance, recessiveness, codominance, and semidominance; principle of independent assortment; dihybrid and trihybrid ratios; gene interactions; epistasis and multiple alleles; ABO blood type alleles and Rh factor alleles in humans; probability in Mendelian inheritance; structure of chromosomes; organization of genes and genomes; nucleic acid function; DNA as warehouse of genetic information; experimental evidence that DNA is genetic material; sex determination; linkage and crossing over, Population genetics.

### **RECOMMENDED BOOKS:**

1. Snustad DP and Simmons MJ, 2008. Principals of Genetics. 5<sup>th</sup> Edition; John Willy & Son, New York.
2. Klug WS and Cumming MR, 2008. Concepts of Genetics. 9<sup>th</sup> Edition; Prentice Hall, USA.
3. Pierce B, 2004. Genetics: A Conceptual Approach. 2<sup>nd</sup> Edition; WH Freeman, New York.
4. Brooker R, 2011. Genetics: Analysis and Principles. 4<sup>th</sup> Edition; McGraw-Hill.
5. Pierce BA, 2011. Genetics: A conceptual approach. 4<sup>th</sup> Edition. WH Freeman Publisher.

## **DETAIL OF DISCIPLINE-SPECIFIC FOUNDATION COURSES**

### **INTRODUCTORY BIOCHEMISTRY (3+1)**

#### **COURSE OBJECTIVES:**

This course provides fundamental concepts in biochemistry, which focuses upon the major macromolecules and chemical properties of living systems. Primary topics include the structure, properties and functions of amino acids, proteins, carbohydrates, lipids and nucleic acids.

#### **COURSE OUTLINE:**

A general introduction to the science of biochemistry; importance and the scope of biochemistry; forms, functions and brief classification of prokaryotes; cellular architecture and diversity of eukaryotes; structure, physical properties and importance of water; unique properties of carbon and other elements found in biological molecules; nature of organic matter; isomerism; general

reactions of different functional groups; biologically important organic compounds/solvents; overview of biological molecule and their structures including proteins, carbohydrates, lipids and nucleic acids; prebiotic molecular evolution and rise of living systems; review of the variety and ecology of the living world; evolution of life; use and significance of radioisotopes in biochemistry.

### **PRACTICAL:**

Safety measures in laboratory; preparation of solutions routinely used in biochemical experiments (e.g., percent, normal and molar solutions); pH determination using various methods; preparation of buffers

### **RECOMMENDED BOOKS:**

1. Fundamentals of Biochemistry. (2008) 3<sup>rd</sup> Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
2. Text Book of Biochemistry (1970) by E. West & W. Todd Macmillan
3. Biochemistry. (1999) 3<sup>rd</sup> Ed. by C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Prentice Hall.
4. Harper's Illustrated Biochemistry, 27<sup>th</sup> Ed. by R.K. Murray, D.K. Grannar, V. W. Rodwell. McGraw-Hill.
5. Lehninger Principles of Biochemistry (2008) 5<sup>th</sup> Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers

## **CARBOHYDRATES AND LIPIDS (3+1)**

### **COURSE OBJECTIVES:**

To understand the principles and concepts concerning the chemical, physical, and biological properties of carbohydrates and lipid in biological processes including signal transduction.

### **COURSE OUTLINE:**

Introduction and historical background; occurrence, distribution in biosphere, and importance in life processes; structure, nomenclature and classification; general properties, synthesis and breakdown of monosaccharides, oligosaccharides and polysaccharides. Lipids: Structure, classification and their biological role.

**Fatty acids:** Structure, classification, nomenclature and properties of fatty acids. Prostaglandins, thromboxanes and leukotrienes. Triacylglycerols: Nomenclature, physical and chemical properties including hydrolysis, saponification value, rancidity, acid value, iodine value and Reichert – Meissl number. Reactions of glycerol. Phospholipids: Glycerophospholipids, Sphingomyelins and glycolipids; their properties and functions. Steroids: Structure, classification, nomenclature and their biological role. Lipids as signals, cofactors and pigments.

## **PRACTICAL:**

- ❖ Qualitative Analysis of known carbohydrates (e.g., Glucose, galactose, fructose, maltose, lactose, sucrose, starch glycogen and cellulose).
- ❖ Qualitative Analysis of carbohydrates of given unknown samples
- ❖ .3. Extraction of starch from plant sources and its confirmative tests (e.g., Potato, Wheat, Rice, Pulses, Barely, Maize etc).
- ❖ Extraction of Glycogen from animal sources (e.g., liver, muscle, etc) & its confirmative tests.
- ❖ Qualitative tests for lipids and fatty acids;
- ❖ extraction of lipids from animal and plant sources

## **RECOMMENDED BOOKS:**

1. Harpers Illustrated Biochemistry. (2012). 29<sup>th</sup> Ed. By Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.
2. Biochemistry. 7<sup>th</sup> Ed. By Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. **Publisher:** Palgrave MacMillan; 7<sup>th</sup> revised international ed edition (April 1, 2011).
3. Fundamentals of Biochemistry (2008) 3<sup>rd</sup> Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
4. Lehninger Principles of Biochemistry. (2012) 6<sup>th</sup> Ed. By David L. Nelson , Michael M. Cox . W.H. Freeman; 6<sup>th</sup> Edition (November 21, 2012).

## **AMINO ACIDS AND PROTEINS**

**(3+1)**

### **COURSE OBJECTIVES:**

This course will cover the basic concepts about amino acids and proteins.

### **COURSE OUTLINE:**

Introduction to amino acids and their structure; polypeptides; Isomerism, Zwitterions; classification of amino acids; acid-base properties of amino acids; optical activity of amino acids; isoelectric point (pI); separation and purification of amino acids; uncommon amino acids; identification of amino acids by different methods; chemical and enzymatic reactions of amino acids; introduction to proteins, classification; structure and function of proteins; physical and chemical properties; conjugated proteins; primary, secondary, tertiary and quaternary structure determination; protein denaturation and folding; interactions of proteins with other molecules; isolation, purification and characterization of proteins; advanced techniques for protein analysis

## **PRACTICAL:**

Qualitative tests of proteins & amino acids: Biuret Test; Niuhydrin Test; Xanthoproteic Test; Pauly's Test; Hoplein's Test; Ehrich's Test; Sakaguchi Test; Sodium nitroprusside Test; Sullivan Test; Lead sulphate Test;

Phosphate Test; Aldehyde Test; Extraction of proteins from plant sources and their confirmative tests.

(Sources: Wheat, Rice Barely, Maize, Pulses etc); Extraction of proteins from animal sources & their confirmative tests (Sources: Egg White, Milk, Liver, Muscles etc); Separation of Amino Acids using Paper and Thin Layer Chromatography; Determination of total proteins by using different methods (Bradford, lowery and biuret methods); Protein estimation by using UV/Visible spectrophotometer; Determination of Secondary structure of Proteins using online available software; Protein purification by using different chromatographic techniques

### **BOOKS RECOMMENDED:**

1. Lehninger Principles of Biochemistry. (2012) 6<sup>th</sup> Ed. By David L. Nelson, Michael M. Cox W.H. Freeman; 6<sup>th</sup> Edition (November 21, 2012).
2. Principles of Biochemistry. (2011) 5<sup>th</sup> Ed. by Laurence A. Moran, Robert A Horton, Gray Scrimgeour and Marc Perry
3. Fundamentals of Biochemistry (2010) 4<sup>th</sup> Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.4. Textbook of Practical Biochemistry. Joshi A. Rashmi. B. Jain Publishers, 2002
4. Introductory Practical Biochemistry. 2005. 2<sup>nd</sup> Ed. By S. K. Sawhney, Randhir Singh. Alpha Science International, Ltd.
5. Harpers Illustrated Biochemistry. (2012). 29<sup>th</sup> Ed. By Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil. McGraw-Hill Medical.
6. Biochemistry. 7<sup>th</sup> Ed. By Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. **Publisher:** Palgrave MacMillan; 7<sup>th</sup> revised international ed edition (April 1, 2011).

## **HUMAN PHYSIOLOGY (3+0)**

### **COURSE OBJECTIVES**

This course is designed to provide a holistic overview of the various aspects of human physiology

### **COURSE OUTLINE:**

- ❖ **DIGESTION AND ABSORPTION OF MACROMOLECULES:** Digestion, absorption and transport of carbohydrate, lipid and Protein.
- ❖ **HORMONES:** Introduction, classification, chemical nature, general mechanism of action, regulation, secretion, mode of action and biological functions of thyroid, *parathyroid*, pituitary, adrenal, gonadal and *pancreatic hormones*.
- ❖ **BLOOD:** General composition, characteristics and functions; *hemoglobin*: chemistry, properties, synthesis, degradation, functions and derivatives.



*Blood coagulation and blood clotting factors*; blood pressure, groups and buffers.

- ❖ RESPIRATION: Structure and functions of lungs; transport of oxygen and carbon dioxide in blood; acid base balance.
- ❖ SPECIALIZED TISSUES: Structure and functions of muscle. Kidney; structure and functions, *acid base balance*, water and electrolyte balance. Structure and *functions of liver*; with special reference to detoxification functions.

### **RECOMMENDED BOOKS:**

1. Text Book of Medical Physiology (2008) 10<sup>th</sup> Edition by Arthur C. Gyton, John E. Hall, W. B Saunders Company.
2. Fundamentals of Biochemistry (2008) 3<sup>rd</sup> Edition by D. Voet, J. G. Voet, & C. W. Pratt, John Wiley and Sons, New York.
3. Human Physiology, (2003) 5<sup>th</sup> Edition Arthur J. Vender, James H. Sherman, Dorothy S. Luciano, McGraw-Hill Company
4. Principles of Biochemistry (2008), 5<sup>th</sup> Edition by A.L. Lehninger, D.L. Nelson and M. M. Cox, Worth Publishers, New York

## **ENZYMES (2+1)**

### **COURSE OBJECTIVES:**

The objective of this course is to provide in depth knowledge of how enzymes work as biological catalysts and how the rates of reactions are impacted by a variety of different factors and environmental conditions.

### **COURSE OUTLINES:**

Introduction to enzymes, nomenclature, classification, ribozyme, general characteristics of theories of enzyme catalysis, enzyme and substrate specificity, isozymes, coenzymes, cofactors, regulation of enzyme activity, chemical kinetics and enzyme kinetics, Michaelis-Menten equation, effect of various factors on rate of reactions, inhibition of enzymatic reactions and kinetics, multienzyme system and bisubstrate reactions, catalytic mechanisms, regulatory enzymes, immobilised enzyme and enzyme assays.

### **PRACTICAL:**

Extraction and estimation of enzymes from plant source. Acid and enzymatic hydrolysis of glycogen and starch Biosynthesis of enzymes by fungi and bacteria. Effect of Temperature on enzymes activity. Effect of Substrate concentration on enzyme activity. Effect of Enzyme concentration on enzyme activity. Effect of heat on stability of enzyme.

### **RECOMMENDED BOOKS:**

1. Biochemistry (2007) 6<sup>th</sup> edition by J.M. Berg, J.L. Tymoczko & L. Stryer W.H. Freeman & Co.

2. Fundamentals of Biochemistry (2008) 3<sup>rd</sup> Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.
3. Lehninger Principles of Biochemistry 5<sup>th</sup> Ed. by D. L. Nelson, M. M. Cox. W. H. Freeman Publishers
4. Biochemistry. (1999) 3<sup>rd</sup> Ed. by C. K. Mathews, K. E. Van Holde, & K.G. Ahern. Prentice Hall.
5. Harper's Illustrated Biochemistry, 27<sup>th</sup> Ed. By R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw-Hill.
6. Modern Experimental Biochemistry (1993) by R.F. Boyer. Benjamin-Cummings pub. Co.
7. Varley's Practical Clinical Biochemistry (1991) 5<sup>th</sup> Edition by A.H. Gowenlock and M. Bell. CBS Publishers & Distributors.
8. Text Book of Biochemistry (1971) by B. Harrow and A. Mazur W. B. Saunders Company.

## **MOLECULAR BIOLOGY (3+0)**

### **COURSE OBJECTIVES:**

To acquaint students with the chemistry and biology of macromolecules.

### **COURSE CONTENTS:**

Introduction to molecular biology and history; structure and function of DNA; chromatin and structure of chromosomes; organelles genome (Mitochondrial and chloroplast), DNA replication in prokaryotes and eukaryotes; transcription in prokaryotes and eukaryotes; post transcriptional processing (e.g., RNA splicing, alternative splicing, editing); genetic code; translation, post-translational processing in prokaryotes and eukaryotes; protein folding, targeting and turnover; DNA damage and repair, recombination and transposable elements. Signaling and control of gene regulation in prokaryotes and eukaryotes.

### **RECOMMENDED BOOKS:**

1. Nelson D and Cox MM, 2009. Lehninger Principles of Biochemistry. 5<sup>th</sup> Edition; WH Freeman, New York.
2. Lodish et al., 2012. Molecular Cell Biology. 7<sup>th</sup> Edition; WH Freeman, New York
3. Berg et al., 2006. Biochemistry. 6<sup>th</sup> Edition; WH Freeman, New York.
4. Alberts et al., 2007. Molecular Biology of the Cell. 5<sup>th</sup> Edition; Garland Science
5. Weaver R, 2011. Molecular Biology. 5<sup>th</sup> Edition; McGraw-Hill

# **METABOLISM**

**(4+0)**

## **COURSE OBJECTIVES:**

This overall goal of this course is to impart the essential aspects of intermediary metabolism and its importance to the overall biology of an organism

## **COURSE CONTENTS:**

Carbohydrate metabolism: Glucose central role in metabolism of plants, animals and micro-organism .Glycolysis, reactions of glycolysis. Fermentation: anaerobic fate of pyruvate, control of metabolic flux. Regulation of glycolytic pathway. Entry of Galactose , Mannose and fructose into glycolytic pathway. TCA cycle: Overveiw of TCA, Metabolic sources of AcetylCoenzyme A. Amphibolic nature, anaplerotic reactions. TCA Cycle inhibitors, Regulation, pyruvate dehydrogenase complex enzyme. Other pathways of carbohydrate metabolism: Gluconeogenesis, cori cycle, glycogenesis, glygenolysis, glycogen storage diseases, Glyoxalate Cycle reactions, Pentose phosphate Pathway.Carbohydrate synthesis: Synthesis of starch, cellulose and peptidoglycan, glycoproteins.Glycogen metabolism, Synthesis and breakdown, glycogen synthetase and phosphorylase and their regulation, Glycogen Storage diseases. Lipid metabolism: Introduction to lipid metabolism,  $\beta$ -oxidation of fatty acids, ketogenesis. Biosynthesis of Fatty acids. Triacylglycerols and prostaglandins. Metabolism of phospholipids, glycolipids and cholesterol. Lipoproteins: metabolism of HDL Disorder of plasma lipoproteins, fatty liver, obesity, atherosclerosis.Biosynthesis of triacylglycerols, Phospholipids, Cardiolipids, Glycolipids and sphingolipids. Arachidonate metabolism, Prostaglandins:Prostacyclins,Thromboxanes and eukotrienes, synthesis of cholesterol and steroid hormones; degradation to bile acids. Protein metabolism: Digestion and absorption of proteins; General aspects of aminoacids metabolism, deamination, transamination, transmethylation, transpeptidation and decarboxylation. Amino acid degradation and urea cycle. Inborn errors of metabolism. Nitrogen balance, biosynthesis of non-essential amino acids. Major pathways and strategies of energy metabolism: Organ specialization Brain, Muscle, Adipose tissue, liver. Metabolic adaptation –Starvation, Diabetes Mellitus. Shuttle systems: Introduction, importance of Shuttle Systems, Glycerol Phosphate shuttle, Malate aspartate shuttle

## **RECOMMENDED BOOKS:**

1. Lehninger Principles of Biochemistry" by Nelson & Cox, 5<sup>th</sup> edition ISBN 13:978-0-7167-7108-1.
2. Fundamentals of Biochemistry (2008) 3<sup>rd</sup> edition By DJ Voet , GJ Voet and CW Pratt. J Wiley & Sons Inc.
3. Biochemistry (2007) 6<sup>th</sup> edition by JM Berg, JL Tymoczko & L Stryer WH Freeman &Co

4. Biochemistry 3<sup>rd</sup> Edition (Lippincott's Illustrated Reviews Series) by Richard A. Harvey.
5. Harpers Illustrated Biochemistry 29<sup>th</sup> Edition (LANGE Basic Science) by Robert Murray, D. Bender, Kathleen M. Botham and P.J. Kennelly (Feb 7, 2012)

## DETAIL OF MAJOR COURSES

### CELL BIOLOGY (2+1)

#### COURSE OBJECTIVES

To acquaint students with features of eukaryotic cells, functions of different compartments and the overall structure/ultra-structure of cells as visualized by electron microscopy.

#### COURSE CONTENTS:

Introduction to cell theory including historical perspective; prokaryotic and eukaryotic cell differences including cell wall, membrane structure and chemical constituents of the cell; function, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum, golgi bodies, ribosomes, lysosome, micro-bodies, mitochondrial ultra-structure and function, chloroplast ultra-structure and the mechanism of photosynthesis; membrane receptors and transport mechanisms; cell movement - structure and function of cytoskeleton, centriole, cilia and flagella; nucleus; structure and function of chromosomes; cell cycle, mitosis and meiosis, cell death.

#### PRACTICAL:

Microscopy and staining techniques; study of prokaryotic, eukaryotic, plant and animal cells; cell structure in the staminal hair of *Tradescantia*; study of different types of plastids; cellular reproduction; Mitosis: smear/squash preparation of onion roots.

#### RECOMMENDED BOOKS:

1. Alberts B and Johnson A, 2006. Molecular Biology of the Cell. 4<sup>th</sup> Edition; Garland Publishers, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
2. Karp, 2002. Cell and Molecular Biology. 3<sup>rd</sup> Edition; John Wiley and Sons, New York.
3. Alberts et al., 2009. Essential Cell Biology. 3<sup>rd</sup> Edition; Garland Publishers, New York.
4. Lodish et al., 2007. Molecular Cell Biology. 6<sup>th</sup> Edition; Freeman and Company, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
5. Cooper GM and Hausman RE, 2009. The Cell, a molecular approach. 5<sup>th</sup> Edition; Sinauer Associates, Inc.

## **BIOSAFETY AND ETHICS**

(2+0)

### **COURSE OBJECTIVES:**

To acquaint students with principles of biosafety and ethical perspectives pertaining to biochemistry as well as biotechnology

### **COURSE CONTENTS :**

Introduction to Biosafety definition, concept, uses and abuses of genetic information, and biohazards; good laboratory practices; risks related to genetically modified organisms (GMO); international rules and regulations for biosafety and GMOs; introduction to bioethics; ethical issues related to GMOs; euthanasia, reproductive and cloning technologies, transplants and eugenics; patenting, commercialization and benefit sharing; role of national bioethics committees; biosafety guidelines from a national perspective.

### **RECOMMENDED BOOKS:**

1. Altman A and Hasegawa PM, 2012. Plant Biotechnology and Agriculture: Prospects for 21<sup>st</sup> Century. 1<sup>st</sup> Edition; Academic Press.
2. Laboratory Biosafety Manual, WHO, 2006. 3<sup>rd</sup> Edition; AITBS Publishers and Distributors, India. (Available online).
3. Furr AK, 2000. CRC Handbook of Laboratory Safety. 5<sup>th</sup> Edition; CRC Press.
4. Jose Maria A, 2003. Genes Technology and Policy. Available online at; <http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf>
5. Krishna VS, 2007. Bioethics and Biosafety in Biotechnology. New Age International Publishers.
6. National Biosafety Guidelines, 2005. Pakistan Environmental protection Agency (Available online)

## **BIOINFORMATICS**

(2+1)

### **OBJECTIVES:**

To familiarize students with biological data mining from online databases and the use of various bioinformatics tools for extracting and processing biological data.

### **COURSE CONTENTS:**

Introduction to bio-computing; biological databases - types and retrieval of nucleic acid (or genomic) or protein sequence information; sequence alignment - pairwise, multiple; phylogenetics; *in silico* identification of protein motifs and domains; structural bioinformatics of proteins and RNAs including protein modeling and prediction of their interactions with other proteins and small molecules; identification of genes and promoter regions within genomes; networks; strategies for whole genome sequencing and assembly.

## **RECOMMENDED DATA BASES AND TOOLS**

1. NCBI, PDB, EcoCyc, DDBJ, EXPASY, SWISS-PROT, UNI-PROT, TIGR, KEGG etc.
2. DS viewer, Swiss PDB viewer, RasMol, Modeller, Ligplot, Autodock.
3. Bioedit, Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0, DNA Dragon etc.

## **RECOMMENDED BOOKS:**

1. Claverie JM and Notredame C, 2006. Bioinformatics for Dummies. 2<sup>nd</sup> Edition; Wiley Publishing.
2. Xiong J, 2006. Essential Bioinformatics. 1<sup>st</sup> Edition; Cambridge University Press.
3. Xia X, 2007. Bioinformatics and the Cell: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics. 1<sup>st</sup> Edition. Springer
4. Mathura V and Kanguane P, 2009. Bioinformatics: A Concept-Based Introduction. Springer
5. Mount DW, 2004. Bioinformatics Sequence and Genome Analysis. Second Edition; Cold Spring Harbor Laboratory Press.
6. Sperschneider V, 2008. Bioinformatics: Problem Solving Paradigms. Springer.

## **IMMUNOLOGY (3+0)**

### **COURSE OBJECTIVES:**

To acquaint students with the basic principles of innate and adaptive immune systems.

### **COURSE CONTENTS:**

Overview of the immune system as the body's main defense mechanism; elements of innate and acquired immunity; cells and organs of the immune system; properties of antibodies and antigens together with their structure, function and interactions; genetics of antibody structure and diversity; expression of immunoglobulin genes; VDJ recombination; antigen processing and presentation; major histocompatibility complex; monoclonal and polyclonal antibodies; T-cell receptors, maturation, activation, and differentiation; B-cell generation, activation, and differentiation; complement system, hypersensitivity, cytokines, resistance and immune response to infectious diseases, cell-mediated effector response, leukocyte migration and inflammation, vaccines, diseases of the immune system - autoimmunity, transplantation immunology.

### **RECOMMENDED BOOKS:**

1. Kuby J, 2007. Immunology. 6<sup>th</sup> Edition; WH Freeman, New York.

2. Janeway et al., 2001. Immunobiology The immune system in health and disease. 5<sup>th</sup> Edition; Garland Science Publisher, New York.
3. Anderson WL, 1999. Immunology. 1<sup>st</sup> Edition; Wiley-Blackwell.
4. Delves PJ et al., 2012. Roitt's Essential Immunology. 12<sup>th</sup> Edition. Wiley-Blackwell
5. Abbas AK and Lichtman AH, 2010. Basic Immunology: Functions and Disorders of the Immune System. 3<sup>rd</sup> illustrated Edition; Saunders Publisher.
6. Harlow E and David L, 1988. Antibodies, A laboratory Manual. 1<sup>st</sup> Edition; Cold Spring Harbor laboratory Press.

## **BIOTECHNOLOGY**

**(3+0)**

### **COURSE OBJECTIVES:**

To acquaint students with the basic concepts, significance and applications of biotechnology as it stands today.

### **COURSE OUTLINES:**

Biotechnology definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture, food, livestock, fisheries, algae, fungi, etc.; Plant growth promoting bacteria: nitrogen fixation (nitrogenase, hydrogenase, nodulation, biocontrol of pathogens, growth promotion by free-living bacteria. Microbial insecticides: Insecticidal toxins of *Bacillus thuringiensis*, baculovirus as biocontrol agents. Large scale production of proteins from recombinant microorganisms. Microbial production of therapeutic agents: pharmaceuticals, enzymes, monoclonal antibodies as therapeutic agents, production of antibodies in *E. coli*, HIV therapeutic agents. Vaccines. Synthesis of commercial products by recombinant microorganisms: antibiotics and biopolymers. Bioremediation and biomass utilization: microbial degradation of xenobiotics. Transgenic plants and animals. Gene therapy. Stem cells and their application.

### **RECOMMENDED BOOKS:**

1. Daugherty E, 2012. Biotechnology: Science for the New Millennium. 1<sup>st</sup> Edition, Revised; Paradigm Publication.
2. Smith JE, 2009. Biotechnology. 5<sup>th</sup> Edition; Cambridge University Press.
3. Nicholl TSD, 2004. An Introduction to Genetic Engineering. 2<sup>nd</sup> Edition; Cambridge University Press, UK.
4. Purohit SS, 2005. Biotechnology Fundamentals & Application. 4<sup>th</sup> Edition; Agro Bios, India.
5. Ratlegde C and Kristiansen B, 2006. Basic Biotechnology. 2<sup>nd</sup> Edition; Cambridge University Press, UK.
6. Thomas JA and Fuchs RL, 2002. Biotechnology and Safety Assessment. 3<sup>rd</sup> Edition; Academic Press, UK.

## **METHODS IN MOLECULAR BIOLOGY**

(2+1)

### **COURSE OBJECTIVES:**

To acquaint students with the experimental aspects of molecular biology

### **COURSE CONTENTS:**

Introduction to recombinant DNA technology; restriction and modifying enzymes; cloning and expression vectors and their types; expression of recombinant proteins and their purification by affinity chromatography; polymerase chain reaction (PCR) - types; (inverse, touch-down, nested, hemi-nested, pit stop, multiplex, reverse transcriptase, RACE, real-time) and its applications; detection of mutations and/or SNPs; DNA fingerprinting; analysis of nucleic acids by gel electrophoresis – horizontal, vertical, pulse field, denaturing gradient gel electrophoresis; analysis of proteins by native and SDS-PAGE; 2-D gels; generation of antibodies and their uses; enzyme-linked immunosorbant assay; Southern, Western, Northern blotting.

### **PRACTICAL:**

Preparation of stock and working solutions; isolation of nucleic acids and their quantification; restriction digestion of DNA and preparation of restriction maps; gel electrophoresis; polymerase chain reaction (PCR); detection of mutations by restriction fragment length polymorphism; preparation of chemically competent cells; transformation of bacteria with plasmid DNA; analysis of proteins by SDS-PAGE

### **RECOMMENDED BOOKS:**

1. Ausubel FM, 2005. Short Protocols in Molecular Biology (2 volume set). 5<sup>th</sup> Edition; John Wiley and Son.
2. Green MR and Sambrook J, 2001. Molecular Cloning: A Laboratory Manual. 3<sup>rd</sup> Edition; Cold Spring Harbor Laboratory Press.
3. Primrose SB and Twyman R, 2006. Principles of Gene Manipulation and Genomics. 7<sup>th</sup> Edition; Wiley- Blackwell.
4. Wilson K and Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Edition; Cambridge University Press.
5. Walker JM and Rapley, 2008. Molecular Biomethods Handbook (Methods in Molecular Biology). 2<sup>nd</sup> Edition; Humana Press.

## **BIOCHEMICAL TECHNIQUES**

(1+2)

### **COURSE OBJECTIVES:**

This course provides the information of principles & mechanism of different equipment and analysis of Biochemical and Biological samples.

### **COURSE OUTLINES:**

Homogenization, centrifugation, ultra centrifugation, paper, TLC, and column chromatography, Gel filtration, ion exchange chromatography, affinity



chromatography, HPLC, lyophilization, electrophoresis, flame photometry, atomic absorption spectro-photometry, spectro-fluorimetry, UV / visible spectrophotometry and use of radioisotopes.

### **PRACTICAL:**

Preparation of sample for mineral analysis by ashing method; Wet digestion procedure of sample preparation for mineral analysis; Mineral analysis of plant tissues using atomic absorption spectrophotometer. Separation of Biomolecules by affinity chromatography identification of sugars, proteins etc. by uv/vis spectrophotometer. Determination of sodium and potassium content in blood serum by flame photometer. Separation of amino acids by amino acid analyzer. Gel chromatography and ion exchange chromatography. Determination of molecular weight of a given protein by gel filtration. Separation of Hb and serum proteins by electrophoresis. Disk-gel electrophoresis of proteins. Separation of proteins by isoelectric focusing.

### **RECOMMENDED BOOKS:**

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) by David Freifelder, W. H. Freeman.
2. Introduction to Modern liquid chromatography (1979) by L. L. Snyder & J.J Kirkland. John Wiley & Sons
3. Tools of Biochemistry (1977) T. G. Cooper & T. C. Cooper John Wiley & Sons
4. Centrifugation. A practical approach. (1987) Ed. D. Rickwood, Oxford: IRL press England.
5. Varley's Practical Clinical Biochemistry (1991) 5<sup>th</sup> Edition by A. H. Gowenlock and M. Bell. CBS Publishers & Distributors.
6. Hawk's Physiological chemistry Mc Graw-Hill publishing company
7. Tietz Textbook of Clinical Chemistry (1999) by C.A. Burtis, Ashwood & N.W. Tietz (Eds) W. B. Saunders Co.
8. Principles and Techniques of Biochemistry and Molecular Biology 6<sup>th</sup> Edition. Edited by K. Wilson & J. Walker.

## **CLINICAL BIOCHEMISTRY (2+1)**

### **COURSE OBJECTIVES:**

Provide students with advanced understanding and applied knowledge in the theory and practice of Clinical Biochemistry and equip them with a critical understanding of how biochemical investigations are employed to develop a clinical diagnosis. Emphasis will also be placed on understanding the biochemical basis of human disease.

### **COURSE CONTENTS:**

Diagnostically important Plasma Enzymes & Proteins: Identification and treatment of enzyme deficiencies, Assessment of cell damage, Factors affecting results of plasma enzyme assays. Abnormal plasma enzymes

activities: isoenzymes in plasma (lactate dehydrogenase, creatine kinase, Amylase); Abnormalities of proteins in plasma: immunoglobins deficiencies, Disorders of carbohydrate metabolisms and Clinical correlations: Diabetes mellitus, Fructose intolerance, Lactic acidosis, Hypoglycemia, Galactosaemia; Glycogen storage Diseases (enzyme defect in different forms of glycogen storage diseases); Disorders of Lipid Metabolism (lipoproteins, classification of lipoproteins, hyperlipidemia, cholesterol and cardiovascular diseases); Disorders of purine and pyrimidine metabolism (Gout, Arthritis); Metabolic Bone Diseases (Calcium balance, Biological functions of calcium, phosphate and magnesium metabolism); Liver Diseases (cirrhosis, specific liver diseases); Hemoglobinopathies, Disorders of Iron and porphyrin metabolism. Cancer and its consequences- tumor progression, tumor markers, oncogenes, local effects of tumor, cancer cachexia, Ectopic hormone production, consequences of cancer treatment.

### **PRACTICAL:**

Phelobotmy (blood sampling), serum/plasma isolation procedure, Complete blood count, isolation of tissues samples and storage; Total protein determination in serum and plasma; Blood glucose test, Glucose tolerance test for diabetes mellitus, Glycation (HbA1c); Liver function tests, Renal Function tests, Cardiac enzymes, Albumin determination; Determination of lipid profile, serum and urine electrolytes.

### **RECOMMENDED BOOKS:**

1. Clinical Chemistry: Principles, Procedures, Correlations by Michael L. Bishop, Edward P. Fody, Larry E. Schoeff Publisher: Lippincott Williams & Wilkins; 5<sup>th</sup> Edition (July 6, 2004)
2. Tietz Fundamentals of Clinical Chemistry by Carl A. Burtis, Edward R. Ashwood. Publisher: W.B. Saunders Company; 5<sup>th</sup> Edition (January 15, 2001).
3. Lecture Notes on Clinical Biochemistry, Alistaire F Smith, Geoffrey Beckett, Simon Walker, Peter Rae 6<sup>th</sup> Edition, John Wiley & Sons, 1998.

## **ENVIRONMENTAL BIOCHEMISTRY**

(2)

### **COURSE OBJECTIVES:**

The objective of this course is to impart essential concepts in the field of environmental biochemistry. This course also aims to develop a focused assessment of issues in environmental health, building on information from assigned materials, experiences and insights obtained in class.

### **COURSE CONTENTS:**

- ❖ Air Pollution: This session will include a class discussion of global climate change. Particulate matter, compounds of carbon, sulfur, nitrogen and

their interactions, methods for their estimation, their effects on atmosphere.

- ❖ Solid and Hazardous waste: Sources and types of wastes and pollutants, Hazards from wastes and pollutants, management of solid waste and clean-up of hazardous wastes.
- ❖ Water Pollution: Types of water and their general characteristics. Pollution of groundwater, surface water and drinking water with emphasis on community pollution issues. Effects of pollutants on plants and animals.
- ❖ Biodegradation and Bioremediation: Hazards and xenobiotic compounds, Biodegradation of xenobiotic compounds, microbial bioremediation, phytoremediation.
- ❖ Waste Water Treatment.
- ❖ Radiation Hazards. Workshops to learn how biomarkers are used to assess environmental exposures.

## **RECOMMENDED BOOKS**

1. Environmental Biochemistry Vol-3 Neelima Rajvaidya, Dilip Kumar Markandey, APH Publishing, 2005.
2. Understanding Environmental Pollution, Hill, M.K., 2<sup>nd</sup> Edition. Cambridge University Press, 2005.
3. Environmental Pollution and Control. Peiece, J.J., Weiner, R. F., and Vesilaind, P.A. 4<sup>th</sup> Edition, Butterworth-Heinemann, (Elsevier) USA, 1998.
4. Environmental Contaminants: Assessment & Control, Dairel, A.V., Academic Press, USA, 2005.
5. Handbook of Industrial Waste Treatment, Lawrance K.W., Marcel Dekkar, 1992.
6. Standard Methods for the Examination of Water & Wastewater. American Public Health Association (APHA), 2003.
7. An Air That Kills Andrew Schneider and David McCumber Berkley Publishing (Penguin Group) January 2005
8. An Inconvenient Truth: The planetary emergency of global warming and what we can do about it. Al Gore, Rodale (paperback) 2005
9. Our Stolen Future: How we are threatening our fertility, intelligence, and survival Theo Colborn, Dianne Dumanoski, John Peter Meyers, Plume (Penguin Group) 1997.

## **PLANT BIOCHEMISTRY**

**(2+1)**

### **COURSE OBJECTIVES:**

The objective of this course is to cover the key concepts of plant biochemistry. Topics to be covered are plant pigments, photosynthetic systems and pathways as well as phyto-hormones and related naturally occurring compounds.

## **COURSE OUTLINES:**

Structure and functions of plant cell. Plant cell wall. Photosynthesis; structure of chlorophyll, absorption of light energy, photosynthetic pigments, photosystem-I, photo system-II. Hill's reaction, electron transport chain, ATP-C3, C4 and CAM photosynthetic pathways, CO<sub>2</sub> fixation (Calvin Benson cycle). Hatch Slack pathway and photorespiration. Conversion of nitrogen into ammonia and other nitrogenous compounds. Biosynthesis of Alkaloids and their biological functions. Terpenes and Terpenoids. Phenolics and related compounds. Phyto-hormones and related compounds.

## **PRACTICAL:**

Extraction and qualitative analysis of chlorophyll, starch, lipids, enzymes, auxins, alkaloids, phenolics and flavonoids

## **RECOMMENDED BOOKS:**

1. Biochemistry and Molecular Biology of Plant Hormones. (1999). Edited by P. J. J., Haykaas, M. A. Hall, & K.R. Libbenga, Science Pub. Co.
2. Lehninger, A. L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5<sup>th</sup> Edition.
3. Plant Biochemistry by T. Wood & Mercer.

## **BIOENERGETICS**

(2+0)

## **COURSE OBJECTIVES:**

This course provides insights into energy, its production and regulation in living system.

## **COURSE OUTLINE:**

Introduction; basic thermodynamic concepts of energy and free energy, enthalpy, entropy and their relationships; endothermic and exothermic reactions; biological oxidation and reduction; high energy compounds; coupling mechanisms: substrate level phosphorylation, electron transport chain, oxidative and photo phosphorylation; autoregulation of energy production.

## **RECOMMENDED BOOKS:**

1. Text Book of Biochemistry (1971) by B. Harrow and A. Mazur W.B.Saunders Company.
2. Harper's Illustrated Biochemistry, 27th Ed. By R.K. Murray, D.K. Grannar, V.W. Rodwell. McGraw Hill.
3. Physical Chemistry (2002) 7th Edition by P.W. Atkins Oxford University Press
4. Physical Chemistry (2004) 4th Edition by R.J. Sibley, R.A. Alberty & M.G. Bawendi J.Wiley & Sons

## **BIOMEMBRANES AND CELL SIGNALING**

**(3+0)**

### **COURSE OBJECTIVES:**

The aim of this course is to equip students with understanding the structures of biological membranes as well as signal transduction pathways. Topics to be covered include membrane structure and functions, membrane transport, and signal transduction networks and how they communicate with each other and impact gene expression.

### **COURSE OUTLINES:**

Introduction; chemical composition and structure of membranes; transmembrane proteins; membrane junctions, receptor-ligand interactions; protein-protein interactions; interaction of proteins with other molecules; second messengers; DAG, calcium, Cyclic AMP, Cyclic GMP, Inositol 3 Phosphate; cell signaling pathways and networks: their activation and impact on gene expression; G-protein and G-protein coupled receptors. Neurotransmitters.

### **RECOMMENDED BOOKS:**

1. Molecular Cell Biology (2007) 6<sup>th</sup> Edition. H. Lodish, C.A. Kaiser, M. Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H. Freeman.
2. Biochemistry (2007) 6<sup>th</sup> edition by J.M. Berg, J.L. Tymoczko & L. Stryer W.H. Freeman & Co.
3. Molecular Biology of the Cell, (2008) 5<sup>th</sup> Edition .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter 5<sup>th</sup> Edition Garland Sciences, Taylor and Francis
4. Molecular Cell Biology (2007) 6<sup>th</sup> Edition. H. Lodish, C.A. Kaiser, M. Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H. Freeman.
5. Cell and Molecular Biology: Concepts and Experiments (2008) by G. Karp John Wiley & Sons

## **NUTRITIONAL BIOCHEMISTRY**

**(2+1)**

### **COURSE OBJECTIVES:**

This course covers key concepts of nutrition and human health and the essential components of a balanced diet.

### **COURSE OUTLINES:**

Food selection and meal planning for healthy individuals. Balanced diet; recommended dietary allowances for different categories of the human beings. Measurement of energy of foods and expenditure. Direct and indirect calorimetric measurement. Basal metabolism. , Obesity and Factors affecting BMR. Respiratory quotient, Food borne diseases, Nutritional aspects and

dietetic treatment of a few important primary nutritional and general diseases, Fasting, Starvation and anorexia nervosa, Endemic goiter, Idiosyncrasies, Food intolerance and food allergies, Clinical surveys, Physical examination, Anthropometry, Laboratory examinations, Dietary surveys, FAO global information and early warning system for food and agriculture. Micronutrients: Sources, Daily allowance, Deficiency diseases, Biological role of the water and fat soluble Vitamins; Biological importance of minerals. Nutrigenomics.

### **PRACTICAL:**

Assessment and surveillance: Clinical surveys; physical examination, anthropometry, laboratory examinations, dietary surveys; calculations of energy values of food; calculation of recommended daily allowance (RDA); calculation of basal energy expenditure (BEE) & basal metabolic rate (BMR); BMI, estimation of vitamins, sodium, potassium, phosphorus etc. by different methods from plant & animal sources..

### **RECOMMENDED BOOKS:**

1. Krause's Food, Nutrition and Diet Therapy L. Kathleen Mahan Sylvia Escott-Stump(2009) 11<sup>th</sup> Ed. Saunders
2. Understanding Nutrition. E. N. Whitney & S. R. Rolfes (2002) 9<sup>th</sup> edition Wads worth / Thomson learning: New York, 2002
3. Nutritional Biochemistry, Tom Brody (1999) 2<sup>nd</sup> edition Academic Press: New York.
4. Nutrition & Dietetics. S.A. Joshi 2<sup>nd</sup> Ed. 2002, Tata McGraw Hill Publishers
5. Nutrition Health Promotion Approach. Webb (2008) 3<sup>rd</sup> Ed. Oxford University Press.
6. Robinson's Basic Nutrition & diet therapy. (1997) by E. S. Weigley, D. H. Mueller & C. H. Robinson Prentice Hall.
7. Fundamentals of Biochemistry. by J. I. Jain (2008) S. Chand & Co. India
8. Biochemistry, 3<sup>rd</sup> edition by U. Satayanarayna & U. Chakarapani (2006) Books and Allied: Kolkata

## **RESEARCH PLANNING & REPORT WRITING (2+1)**

### **COURSE OBJECTIVES:**

The goal of this course is to enhance awareness of students for how modern day biochemical studies are carried out using state-of-the-art instruments, how data is generated, critically evaluated and analyzed. The course also prepares students in report writing, preparing and making scientific presentations and surveying of literature.

### **COURSE OUTLINES:**

Involves extensive reading of modern day biochemistry literature, designing experiments as well as projects, and critical evaluation of literature. Three key areas to be covered are:

- ❖ **RESEARCH PROCESS, DESIGN & METHODOLOGY:** Project selection and its development, role of students & supervisor, experimental design and investigation, methodology, control, sampling methods replicating & data processing, results interpretation, primary and secondary sources, scientific research, scientific record keeping;
- ❖ **WRITING, PRESENTATION AND PUBLISHING SCIENTIFIC PAPERS:** Importance of research report, thesis and scientific paper. Report writing and its presentation: Role of P value in decision making, conflict of interests, ownership of data, consent form, publication of the research paper: selection of journal, instructions to authors, letter to editor, acknowledgement, Referee's comments and suggestions, sending a revised manuscript and acceptance letter.
- ❖ **REVIEW & SYNOPSIS:** The student in consultation with the supervisor will prepare an extensive review and design a research plan in the area of interest, based on introduction, literature survey, problem statement, objectives, methodology, significance and limitations.

### **PRACTICAL:**

A variety of activities including seminars on assigned topic, written essays, poster presentation, presentation of research publications, etc will be undertaken throughout the semester. Reference indexing. Similarity index and Plagiarism Checking

### **RECOMMENDED BOOKS**

1. Graduate research: A guide for students in the science (1998) 3 Rev Sub edition by Robert V. Smith University of Washington Press.
2. Writing, Reading & Research Clifford (1985) by R. Veit, and J. Clifford Bobbs-Merrill Educational Publications.
3. Practical Research: Planning & Design (2009) by P.D. Leedy and J.F., Ormrod Publishers: Merrill.
4. Research methods: A process of Inquiry by Grazinao & Ranlin (2006)
5. Conducting Research Literature Reviews: From the Internet to Paper (2004) by A. G. Fink. Saga Publications.

## **CURRENT TRENDS IN BIOCHEMISTRY (3+0)**

### **COURSE OBJECTIVES**

This course provides the information about the latest developments and revolutions in the biochemistry.

### **COURSE OUTLINE:**

Latest developments in areas of current interest will be covered. Course content will be based on recent reviews and research publications in top-tier journals

**COURSE OBJECTIVES:**

This course provides information about how large-scale biochemistry is done in multinational companies and academic labs. The focus of this course will be on how locally available inexpensive raw materials may be used to develop products with good commercial value.

**COURSE OUTLINES:**

Introduction; extraction of oil from oil seeds; purification refining of oils; preparation of soap and detergents; effect of acidic species and hard water on soap; extraction of sugar from different sources; preparation of jams, jellies and chocolates; manufacture of starch from rice, corn, potato, wheat and its industrial applications; fermentation and its applications; production of antibiotics, acetic acid, citric acid and ethanol by microorganisms.

**PRACTICAL:**

- ❖ Extraction of oil by Soxhlet method
- ❖ Determination of Acid value
- ❖ Determination of Iodine value
- ❖ Purification of oil by column chromatography
- ❖ Separation of phospholipids by TLC
- ❖ Determination of ethanol percentage in the fermentation broth
- ❖ Determination of citric acid by titration method in the fermentation medium
- ❖ Preservation of food by UV-radiation / chemical method
- ❖ Estimation of total proteins, reducing sugar, total sugar from extract of seasonal fruits.

**RECOMMENDED BOOKS:**

1. Shreve's chemical process industries (1998) 5<sup>th</sup> Edition by G.T. Austin Publishers: McGraw-Hill
2. Kent and Riegel's Hand Book of Industrial Chemistry and Biotechnology (2007) 11<sup>th</sup> Edition by J.A. Kent. Springer.
3. Introduction to Cane Sugar Technology. by G.H. Jenkins Elsevier
4. British pharmacopoeia.
5. Comprehensive Biotechnology (1985) Edited by M. Moo-Yong & C.L. Cooney, Pergamon Press,



## DETAIL OF ELECTIVE COURSES

### LIST OF ELECTIVE COURSES:

- Cancer Biology
- Genomics
- Proteomics
- General Virology
- Cell and tissue culture
- Pharmacology
- Antimicrobials and Chemotherapeutics
- Functional Genomics
- Structural Biology
- Drug Development
- Fermentation Biotechnology
- Neurochemistry
- Toxicology
- Biodiversity
- Research Projects
- Any other course(s) recommended by an Institution's Board of Studies

### **CANCER BIOLOGY** (3+0)

#### **COURSE OBJECTIVES;**

This course will teach the students to be conversant on issues related to cancer, its etiology, development, carcinogenic agents, treatment and prevention. The main aim and objective of this course is to educate the students on various genetic and molecular changes in normal cells that undergo during transformation into malignant cells.

#### **COURSE OUTLINES:**

Cell cycle, Check Points, M.Phase Kinase, Regulatory activities in S and M. Phase (Heterokaryon experiments), Oncogenes: Growth factors, Receptors, Signal Transducer, Transcriptional Factors and Cell Cycle Genes. Tumor Suppressing genes: (Rb and P53 etc.), Tumor inducing DNA Virus, Tumor inducing RNA Virus, Human Colon Cancer, Breast Cancer, cervical Cancer, Lung cancer, Hepatic carcinoma, Cancer Epidemiology and Prevention, Risk factors and Carcinogenic agent: Chemicals and Radiations, Tumor Invasion and Metastasis, Role of Nutrients, Hormones and Gene Interaction in Carcinogenesis, Cancer Therapy.

#### **PRACTICAL (if lab facilities available)**

Heterokaryon experiments; study of DNA damage by physical and chemical methods; Ames test for identification of mutagenic agent; case study of chromosomal abnormalities in human and agricultural specimen.

## **RECOMMENDED BOOKS:**

- 1 The Biology of Cancer by Robert A Weinberg.
- 2 Cancer Biology by Raymond W. Ruddon, latest edition, Oxford University Press.
- 3 Wintrobe's Clinical Haematology by Maxwell, M. Wintrobe, G. Richard Lee, Williams and Wilking Publishers, New York.

## **GENOMICS (3+0)**

### **COURSE OBJECTIVES**

The overarching goal of this course is to provide students with a thorough overview of both the theoretical and experimental aspects of structural and functional genomics.

### **COURSE CONTENTS:**

Organization and structure of genomes; genetic mapping (RFLP, microsatellite, SNP); high-resolution physical mapping (STS, EST); flow cytometry; somatic cell and radiation hybrids; artificial chromosomes in bacteria and yeast; hierarchical and whole genome shotgun sequencing; DNA sequencing strategies - manual and automated sequencing, pyrosequencing, Solexa, Helicos, Roche 454, real-time and nanopore sequencing; sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs, integrated gene-finding software packages; structural variation in the genome and its applications; microarray and RNA interference.

## **RECOMMENDED BOOKS:**

1. Strachan T and Read AP, 2010. Human Molecular Genetics. 4<sup>th</sup> Edition; Garland Science.
2. Saccone C and Pesole G, 2003. Handbook of Comparative Genomics: Principles and Methodology. 1<sup>st</sup> Edition; Wiley-Liss.
3. Town C, 2002. Functional Genomics. 1<sup>st</sup> Edition; Springer.
4. Krebs et al., 2010. Lewin Genes X. 10<sup>th</sup> Edition; Jones and Bartlett Publishers.
5. Al-Rubeai M and Fussenegger M, 2010. Systems Biology (Cell Engineering). 1<sup>st</sup> Edition; Springer

## **PROTEOMICS (3+0)**

### **COURSE OBJECTIVES:**

The course will provide fundamental information about: Proteins at molecular level, Posttranslational modifications, Protein-protein interactions, Integral membrane proteins, Advance techniques used in proteomics.

## **COURSE OUTLINES:**

Molecular Biology of Proteins (types, structure, synthesis, translation), Posttranslational modifications (glycosylation, phosphorylation, methylation, etc.), Molecular mechanisms of cellular communication/signaling pathways, Bioinformatic tools (genomics, proteomics, metabolomics). Protein-Protein Interactions, receptor identification and characterization, Integral Membrane Proteins and Ion Channels, Peptide Models of Transmembrane Domains, Membrane Fusion and Membrane Binding Proteins, Apolipoproteins. Proteomics Strategy, Protein extraction and sample preparation Advance techniques used in proteomics including, capillary and 2D Gel Electrophoresis, Mass Spectrometry, MALDI TOF, MS/MS, LC/MSMS, Protein arrays etc. Online search engines for data analysis.

## **RECOMMENDED BOOKS:**

1. Principles of Proteomics by R. M. Twyman (2004). BIOS Scientific Publishers
2. Proteomics in Practice: A Guide to Successful Experimental Design (2008) 2<sup>nd</sup> Edition by R. Westermeier, T. Naven, and Hans-Rudolf. J.Wiley & Sons
3. Molecular Biology of the Cell, (2008) 5<sup>th</sup> Edition .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter 5<sup>th</sup> Edition Garland Sciences, Taylor and Francis
4. Biochemistry (2007) 6<sup>th</sup> Edition by J.M. Berg, J.L. Tymoczko & L. Stryer W.H. Freeman & Co.
5. Introduction to Proteomics. Edited by Daniel C. Liebler (2002). Humana Press. ISBN 0-8960-3992-7.
6. Proteomics in Practice – A Lab Manual of Proteome Analysis. Reiner Westermeier and Tom Naven. (2002). Wiley-VCH Verlag. ISBN 3-527-30354-5
7. Introduction to Proteomics: Tools for the New Biology (2001) by Daniel C. Liebler

## **GENERAL VIROLOGY**

**(3+0)**

### **COURSE OBJECTIVES:**

This course will provide fundamental concepts of history, shape and diversity of virus and its classification. The main aim of this course is to understand the replication of viruses, infections and diseases caused by them.

### **COURSE OUTLINE:**

General concepts of virus, history, diversity, shapes, sizes and components of genomes; Isolation and purification of viruses and components; Classification of viruses and nomenclature: positive strand RNA viruses - Picornavirus, Flavivirus, West Nile virus, Dengue virus, Coronavirus and SARS pathogenesis. Negative strand RNA viruses: Paramyxovirus,

Orthomyxovirus, Influenza pathogenesis and Bird flu. Rabies pathogenesis; double-stranded RNA viruses: Reoviruses, Retroviruses: Structure, classification, life cycle, Reverse transcription, HIV, Viral pathogenesis and AIDS. Small DNA viruses: Parvo and polyomaviruses, Large DNA viruses: Herpes-Adeno and poxviruses, Nanoviruses, Miscellaneous viruses.

### **PRACTICALS** (if lab facilities available)

Isolation of bacteriophage from sewage samples; extraction of DNA from virus; study of the effect of organic solvent/detergent in enveloped virus; SDS-gel electrophoretic analysis of viral proteins (SDS-PAGE); identification of phages from various sources.

### **RECOMMENDED BOOKS:**

- 1 Principles Of Virology; Molecular Biology, Pathogenesis, by Krug, R., Racaniello, V., and Lynn, W. E, ASM Press.
- 2 Principles of Molecular Virology by Cann, A. J. 2001, Academic Press.
- 3 Basic Virology by Wanger, E. K and Hewlett, M., 1999, Blackwell Science, Inc.
- 4 Medical Virology 4<sup>th</sup> Edition by David, O. White and Frank. J. Fenner.
- 5 Fields Virology 2<sup>nd</sup> Edition, by Bernard Fields Knipe and Peter Howley.

## **CELL AND TISSUE CULTURE (2+1)**

### **COURSE OBJECTIVES:**

The aim of this course is to provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences.

### **COURSE OUTLINES:**

**Plant cell and tissue culture:** requirements for *in vitro* cultures; culture facilities; sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, organ culture; meristem culture for virus elimination; embryo culture and embryo rescue; regeneration of plants and micropropagation; somaclonal variation; industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology.

**Mammalian cell culture:** origin and principles of cell culture; qualitative characteristics of cell cultures; cell counting and analysis; cryopreservation; cell banking and subculture (variety of different systems); primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants; animal cells for bioassays and bioproducts; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

## **RECOMMENDED BOOKS:**

1. Setlow JK, 2000. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
2. Nicholl DST, 2002. An Introduction to Genetic Engineering. 2<sup>nd</sup> Edition; Cambridge University Press.
3. Gale YL, 2002. Genetic Engineering.
4. Razdan MK, 2003. Introduction to Plant Tissue Culture. 2<sup>nd</sup> Edition; Intercept, New York, USA.
5. Lanza et al., 2000. Principles of Tissue Engineering. 2<sup>nd</sup> Edition; Academic Press, California.
6. Ignacimutu S, 1997. Plant Biotechnology. Oxford IBH Publisher.
7. Punia MS, 1999. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers.

## **PHARMACOLOGY**

**(3+0)**

### **COURSE OBJECTIVES:**

This course provides fundamental concepts in Pharmacology, which focuses upon the mechanism, factors affecting the actions of drug and different types of drug.

### **COURSE OUTLINES:**

Definition of Pharmacology, definition of drug and drug nomenclature, pharmacopoeias, formularies, Branches of Pharmacology, Sources of drugs, Dosage forms and doses of drugs. Drug administration. Absorption of drugs and processes involved in drug absorption Factors modifying absorption of drugs. Bioavailability, clinical significance and factors affecting bioavailability. Drugs reservoirs, distribution and redistribution of drugs, plasma protein binding. Pro-drug, Biotransformation of drugs, Plasma half-life of drugs, steady state concentration, its clinical importance and factors affecting it. Excretion of drugs. Mechanism of drug action. Dose response curves, structure-activity relationship. Factors modifying action and doses of drugs. Drug-drug interactions. Locally Acting Drugs (Demulcents, Emollients, Irritants,), Drugs Acting on Gastrointestinal Tract (Anti Emetics, Drugs affecting motility of GIT, Ulcer Healing drugs, Laxatives), Cardiovascular Drugs(Anti-arrhythmic Drugs, Inotropic Drugs, Anti-hypertensive Drugs, Anti-anginal Drugs, Thrombolytics, Anti-hyperlipidemic Drugs), Diuretics, Autocoids, Drugs Acting on Autonomic Nervous System (Cholinergic Drugs, Anti-cholinergic Drugs, Adrenergic Drugs, Antiadrenergics, Adrenergic, Neurone Blockers, Autonomic Ganglionic Blockers, Skeletal Muscle Relaxants, Central Nerves System(Sedative-Hypnotics, Antiepileptics, Anaesthetics, Anxiolytics), Analgesics (Opioids, Non-Steroidal Anti-Inflammatory Drugs).

## **RECOMMENDED BOOKS:**

1. Goodman Gilman, Pharmacological basis of Therapeutics. 11<sup>th</sup> Ed McGraw-Hill Book Company, New York, 2008.
2. Winguard and Brody's, Human Pharmacology, Mosby Year Book, Boston, 1991.
3. James M Ritter and Lionel De Levis, A Text book of Clinical Pharmacology, 5<sup>th</sup> Ed Oxford University Press, New York, 2008.
4. R S Satorkar and S D Bhandarkar, Pharmacology and Pharmacotherapeutics, 19<sup>th</sup> Ed, Popular Prakashan, Bomby, 1998.
5. J D Tripathy, Essential of Medical Pharmacology, Japees Brother, New Delhi, 6<sup>th</sup> Ed., 2008.
7. Katzung B G, Basic and Clinical Pharmacology, McGraw-Hill Medical Publishers, New York, 11th Ed., 2009.
8. Lippincott, Pharmacology, 4<sup>th</sup> Ed, Lippincott William & Wilkins, USA, 2008.
9. Manuchair Ebadi, Pharmacology, Little Brown & Company, London, 1993
10. Prof Dr A Qayum, Fundamentals of Experimental Pharmacology.
11. Bertram G K, Basic and Clinical Pharmacology, Paramount Publishing Business & Professional Group, USA, 10<sup>th</sup> Ed., 2007.
12. William F Ganong, W F, Review of Medical physiology, 22<sup>nd</sup> Ed, 2005 Prentice Hall International Inc, New Jersey.
13. Qayum A, Fundamentals of Experimental Pharmacology. Ghandhara University, Peshawar, 2004.
14. Humphrey P. Rang, Rang & Dale's Pharmacology, 6<sup>th</sup> Ed, 2007.

## **ANTIMICROBIALS AND CHEMOTHERAPEUTICS (3+0)**

### **COURSE OBJECTIVES:**

To introduce the basic principles of chemotherapy of cancer and infectious disease; to equip students with an understanding of the basic concepts of selective toxicity and resistance; to provide an understanding of the molecular mechanisms behind the action of anticancer and anti-infective drugs.

### **COURSE CONTENTS:**

Introduction to chemotherapy, chemotherapeutic agents and antimicrobial therapy. Classification of antimicrobials: Antibacterial, anti-viral, anti-malarial and antifungal. Classification of Antibacterial agents based on their mode of action: Cell Wall Synthesis inhibitors ( $\beta$ -lactum antibiotics), Protein synthesis inhibitors (Aminoglycosides and Chloramphenicol etc), DNA Synthesis Inhibitors (Fluoroquinolones), RNA synthesis inhibitors (Rifampin), Folic Acid inhibitor (Sulfonamides & Trimethoprim) and Mycolic acid synthesis inhibitors (Isoniazid). Chemistry, mode of action and structure activity relationship of antibiotics. Selective toxicity, spectrum of activity and side effects. Antiviral chemotherapy. Malaria and its treatment. Antifungal agents. Antibiotic resistance mechanism and synergism. Minimum inhibitory concentration

(MIC), minimum bactericidal concentration (MBC) and LC50.

Cancer Chemotherapy: DNA alkylating/Crosslinking drugs, Antimetabolites (5-fluorouracil, 6-mercaptopurine (6-MP etc)), DNA Topoisomerase inhibitors and DNA Repair Enzymes and Mitotic poisons (often plant alkaloids).

## **REFERENCES:**

1. Bertram G. Katzung, Susan B. Masters, Anthony J. Trevor, Basic & Clinical Pharmacology. The McGraw-Hill Companies, 12<sup>th</sup> Ed. 2012.
2. Michelle A. Clark. et al. Lippincott's Illustrated Reviews: Pharmacology. Lippincott Williams & Wilkins China, 5<sup>th</sup> Ed. 2012.
3. Laurence L. Brunton, John S Lazo, Keith L. Parker. Goodman & Gilman's The Pharmacological basis of Therapeutics. The McGraw-Hill Companies, Inc. 11<sup>th</sup> Ed. (2006).
4. P. N. Bennett, M. J. Brown, Clinical Pharmacology. Churchill livingstone. Edinburgh London. 9<sup>th</sup> Ed. 2003.

## **FUNCTIONAL GENOMICS**

**(3+0)**

### **COURSE OBJECTIVE:**

The student will be familiar with most aspects of functional genomics. The student will learn how knowledge of functional genomics can be exploited for understanding bacterial physiology and pathogenesis, as well as for development of new antibacterials and other biotechnological purposes.

### **COURSE OUTLINE:**

Course introduction & Objectives, a large-scale analysis of the function of different gene products within an organism. Bioinformatics, working with single genes and annotation work flow, Gene annotation with Artemis, DNA microarray overview and principles, Functional vs Comparative Genomics, Genome Mapping and organization, Genome Sequencing projects, Assembling genome sequences, Sequence polymorphisms in genomes and SNPs, Differential Display, Gene Discovery - Expressed Sequencing Tags (ESTs); Serial Analysis of Gene Expression (SAGE), Transcriptome analysis: cDNA microarrays, oligonucleotide microarrays, Regulation of Gene Expression, Metabolomics, Forward and Reverse Genetics, RNAi-mediated Gene Silencing, Gene Knockouts, Micro-RNAs and Small RNAs, Site-directed mutagenesis, Genomics as a systems biology, two-hybrid systems; Applications of genomics to medicine, agriculture, forensics and population studies. In vivo technologies for assessing gene expression, analysis/visualization and issues with imaging. Quantitative RT-PCR analysis, Integration of proteomic, microarray, and other functional genomics techniques.

## **RECOMMENDED BOOKS:**

1. Functional Genomics (Methods in Molecular Biology). (2010) by Michael J. Brownstein and Arkady Khodursky. Humana Press; Soft cover reprint of hardcover.
2. Functional Genomics: Methods and Protocols (Methods in Molecular Biology). (2011). 2<sup>nd</sup> Ed. Humana Press.
3. Functional Genomics. (2002) by Chris Town. Springer.
4. Functional Genomics of Human Ion Channels. (2010). 1<sup>st</sup> Ed. by Edited by Zhiguo Wang and Zhiguo Wang (Jun 1, 2010). Transworld Research Network.
5. Plant Functional Genomics: Methods and Protocols (Methods in Molecular Biology). (2010). 1<sup>st</sup> Ed. by Erich Grotewold (Dec 1, 2010), Publisher: Humana Press.

## **STRUCTURAL BIOLOGY (3+0)**

### **COURSE OBJECTIVE:**

The purpose of the course is to provide the student with a profound knowledge of advanced aspects of macromolecular structure and train the ability to analyze and assess published literature. In addition, applications of structural analysis for research projects in molecular biology and biochemistry is discussed.

### **COURSE OUTLINES:**

Structural biology is a foundation of biochemistry and molecular biology, methods that used to determine the structure of different bio-molecule, Crystallography and X-ray diffraction, NMR, use to determine their structures aspects of structural biology from primary to quaternary structure and deals with the 3D structure of proteins, nucleic acids, carbohydrates, and lipids, the structural mechanism of enzymes and catalysis; protein-nucleic acid interactions; protein synthesis, RNA structure, and the ribosome; membrane proteins; The enzyme section deals with Kinetics, mechanism and drug design. Macromolecular assemblies and higher order structures include oligomers, viruses, molecular machines, metalloproteins, membrane proteins and biological complexity. Homology modeling and molecular docking are also covered with various lectures and hands-on practicals, Interpretation and assessment of published research in structural biology.

## **RECOMMENDED BOOKS:**

1. Foundations of Structural Biology. (2000). 1<sup>st</sup> Ed. by Leonard J. Banaszak. Academic Press.
2. Structural Biology: Practical NMR Applications. (2012). 2<sup>nd</sup> Ed. by Quincy Teng. Springer.
3. Textbook of Structural Biology. (2009). Pap/Cdr edition. by Anders Liljas, Lars Liljas, Jure Piskur and GÅran Lindblom. World Scientific Publishing



- Company.
4. Membrane Structural Biology: With Biochemical and Biophysical Foundations. (2008). 1<sup>st</sup> Ed. by Mary Luckey, Publisher: Cambridge University Press.
  5. Structural Biology of Bacterial Pathogenesis. (2005). 1<sup>st</sup> Ed. by Gabriel Waksman, Michael Caparon and Scott Hultgren Amer Society for Microbiology.
  6. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology. (2009). 1<sup>st</sup> Ed. by Bernhard Rupp. Garland Science.

## **DRUG DEVELOPMENT (3+0)**

### **COURSE OBJECTIVES:**

This course acquaints the students in related fields of pharmaceutical sciences, clinical trial and evidence based medicine with the necessary study design concepts and statistical practice to allow them to understand how drug developers plan and evaluate their drug development.

### **COURSE OUTLINES:**

Introduction to drug development, the regulatory environment for new drug development: the food and drug administration, sponsor and regulatory agency responsibilities, the new drug applications, Drug discovery and non clinical research (pre clinical research and development):overview of pharmacokinetics, pharmaceutics and pharmacodynamics, toxicological studies, methodology analysis, design and methodology in clinical trials(clinical research and development): ethical aspects of design and methodology, clinical study protocols, monitoring clinical trials, statistical analysis, types of clinical data, descriptive and inferential statistics, employment of hypothesis testing (statistical significance), employment of confidence intervals (clinical significance), sample size estimation, safety assessment in clinical trials, efficacy assessment in clinical trials, pharmaceutical and biopharmaceutical drug manufacture (post marketing phase).

### **RECOMMENDED BOOKS:**

1. New drug development by J. Rick Turner
2. Drug discovery and development by R. Hill
3. The drug development process by Peter.g.welling

## **FERMENTATION BIOTECHNOLOGY (3+0)**

### **COURSE OBJECTIVES:**

This course will cover the historical background and the advancement in fermentation Biotechnology, Basic knowledge on microbial metabolism, screening and genetic modification of microorganisms. Besides to learn the

rules of fermentation biotechnology, relationship of microbiology to Industrial fermentation, the types and operation of bioreactors, equipment and tools used in the control of fermentation. Moreover the course permits to know the different phases in relation to the production of biomass or different microbial metabolites.

### **COURSE OUTLINES:**

Fermentation and Microorganisms, different types of fermentation, industrial fermentation, chronological review and perspectives in fermentation biotechnology, microbial metabolism, main pathways of carbon and nitrogen metabolism and its regulations, respiro-fermentative metabolism of yeasts, metabolic regulation, screening and selection of industrial cultures; genetic manipulations of industrial strains, the maintenance of the cultures, fermentation technology, raw materials and the composition of substrate of fermentation. Fermentation process, batch, extended batch, batch with cell recycle, continuous process; kinetic of microbial growth and fermentation products; principal parameters of fermentation process. Fermentation technology upscaling, bioreactors: agitation and aeration technology, measurements and regulations of principal fermentation parameters; fermentation plant (fundamental and auxiliary equipments, modality of sterilization and product recovery). Downstream processing, Brief discussion about recent advances in fermentation biotechnology.

### **RECOMMENDED BOOKS:**

1. Microbiology: An Introduction. By Gerard J. Tortora, Berdell R. Funke, Christine L. Case. Publisher: Benjamin Cummings; 11<sup>th</sup> Edition (January 6, 2012)
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood, Chris Woolverton, Publisher: McGraw-Hill Science/Engineering/Math; 8<sup>th</sup> Edition (February 3, 2010).
3. Lehninger Principles of Biochemistry. (2012) 6<sup>th</sup> Ed. By David L. Nelson, Michael M. Cox. W.H. Freeman; 6<sup>th</sup> Edition (November 21, 2012).
4. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain and A.R. Allman. Publisher: CRC Press; 3<sup>rd</sup> Edition (December 12, 2011).
5. Yeast: The Practical Guide to Beer Fermentation (Brewing Elements Series) by Jamil Zainasheff and Chris White. Publisher: Brewers Publications (October 16, 2010)
6. Fermentation and Biochemical Engineering Handbook, 2<sup>nd</sup> Ed., Principles, Process Design and Equipment by Henry C. Vogel, Celeste C. Todaro. Publisher: William Andrew; 2<sup>nd</sup> Edition (December 17, 2007).
7. Fermentation Biotechnology. By Achrekar Jayanto. Publisher: Wisdom Press (2012).

## **NEUROCHEMISTRY (3+0)**

### **COURSE OBJECTIVES:**

The course is designed to study the neurons and neurotransmitters and the phenomenon of their mechanism of action to understand the biochemical basis of neurological diseases.

### **COURSE OUTLINES:**

- ❖ Neuroanatomy: Gross appearance, Fluid compartments, Microscopic appearance, Neurons, Glial cells. The synapses.
- ❖ Brain composition: Central and peripheral nervous system, Lipids, Myelin and membranes, structure of Myelin, Function of Myelin, Electrolytes, Proteins (structure and Properties).
- ❖ Neurotransmission: Resting potential, sodium pump, Action potential and nerve conduction, Chemical events at synapses, Identification and occurrence of neurotransmitters, Quantum hypothesis, Origin of synaptic vesicles, postsynaptic events, involvement of C-AMP Receptors, Neuron-axonal transport in exoplasmic flow, Mechanism of transport in exoplasmic flow, Neurotransmitters and Neuropeptides, Inhibitory and excitatory synapse, GABA and other inhibitory transmitters, Mechanism of action of dopamine, Enkephlines and endorphins, Opiate receptors, cyclic nucleotides.
- ❖ Nourishment of the brain: Nutritional factors and the CNS, Development of the brain and nutritional effects on maturation, Chemical and enzymatic make-up of the brain during development, cerebral metabolism.
- ❖ Brain Functions: Adaptive processes in the brain, inducible enzymes, Adaptation to specific substrates, Adaptation to product of an alternate pathway, Adaptation involving coenzymes, Adaptation in response to hormone.
- ❖ Adaptation to Environment: Light, The pineal gland, Learning and memory as adaptive processes.
- ❖ Biochemistry of Neurological disorders: Genetic and metabolic disorders, Metabolic basis of Tay-sachs, Lesch-Nyhan, Schizophrenia, Epilepsy, Other psychiatric disorders including Dyskinesia, Myelin diseases, Multiple Sclerosis, Parkinsons disease, Myasthenia Gravis.

### **RECOMMENDED BOOKS:**

1. Basic Neurochemistry, Molecular, Cellular, and Medical Aspects by George J. Siegel 6<sup>th</sup> Edition, 2005.
2. Handbook of Neurochemistry and Molecular Neurobiology Editor-in-chief: Lajtha, Abel, 2010.
3. Essentials of Neurochemistry, Gaynor C. Wild, Edward C. Benzel, Jones and Bartlett Publishers, 1994.

## **TOXICOLOGY**

**(3+0)**

### **COURSE OBJECTIVES:**

- ❖ To understand the molecular, cellular and pathophysiological responses resulting from exposure to chemical agents relevant to human health.
- ❖ Students will learn how to interpret and integrate a broad range of toxicological information. In addition, course also addresses the toxicological assessment of a number of important chemical poisons, including heavy metals and pesticides.

### **COURSE OUTLINES:**

- ❖ Introduction to toxicology and toxicological substances, Metabolism of Xenobiotics, Absorption, Distribution, and Excretion of Toxicants.
- ❖ Air Toxicants: Effects of ozone and benzene, NO, CO, aldehyde exposure in humans, sources of benzene exposure, toxicokinetics and toxicodynamics of benzene. Toxic effects of radiation and radioactive materials, pesticides, hydrocarbons and alcohols.
- ❖ Food-Borne Toxicants and Prevention in Toxicology, Role of mycotoxins as environmental toxins impact on human health, role of metabolism in the toxicity of the mycotoxin aflatoxin, Proposed means to prevent aflatoxin-induced liver cancer in high-risk populations and apply knowledge to other environmental carcinogens.
- ❖ Metal & Drugs Toxicology: Overview of metals in the environment and heavy metal toxicity, Ways in which we can protect ourselves from metal poisoning, both through man-made agents and natural chelates of heavy metals, Heavy metals that have an important impact on human health e.g. mercury and cadmium, lead and arsenic. Therapeutic drug monitoring, poisonous plants and herbal medicines.

### **RECOMMENDED BOOKS:**

1. HODGSON, E. and SMART, R.C: Introduction to Biochemical Toxicology. Wiley and Sons, New York, Hardcover: 902 pages, Publisher: Wiley; 4<sup>th</sup> Edition (August 18, 2008)
2. CASARETT AND DOULL's Toxicology: The Basic Science of Poisons. 7<sup>th</sup> edition (November 20, 2007), McGraw-Hill, New York, pp. 1280. Edited by Curtis D. Klaassen.

## **BIODIVERSITY**

**(3+0)**

### **COURSE OBJECTIVES:**

The course will enable the student to learn about the plant and animal diversity. Our aim is to develop a scientific way of thinking about biological diversity rather than attempting to memorize the history of living things

## **COURSE OUTLINES:**

Biosphere and biological resources. Evolution of biosphere: Definition, Origin, concept and chemical basis of life, protocell formation, unicellularity, multicellularity and tissue levels of organization, evolutionary perspective: relationship to other animals, metamerism and tagmatization. Origin of metabolism. protobionts, Origin of prokaryotic and eukaryotic cells. Classification of organisms, evolutionary relationships and tree diagrams, patterns of organization. Evolutionary perspective, life within a single plasma membrane, symbiotic life styles. Life in sea, invasion of life on land, Geological time chart with biodiversity. Evolution as a force in diversity of life: Overview of earlier theories, Lamarckism, Darwinism, modern concepts. Origin of taxonomy: Origin of species, taxonomic categories and modern criteria of classification, different classification systems. Protozoan taxonomy: (upto phyla, subphyla and supper classes, wherever applicable). Structural, chemical and functional diversity of carbohydrates, lipids, proteins (polypeptides in protein diversity) and nucleic acids.

## **RECOMMENDED BOOKS:**

1. Singapore: McGraw Hill, Miller SA and Harley, JB Zoology, 5<sup>th</sup> Edition (International), 2002, Singapore; McGraw-Hill.
2. Kent, GC and Miller S. Comparative Anatomy of Vertebrates, 2001. New York: Mc Graw-Hill, Campbell, NA, Biology, 6<sup>th</sup> Edition, 2002, Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
3. Biology' Campbell, N. A. 8<sup>th</sup> Ed. The Benjamin/Cummings Publishing Company Inc. New York. USA, 2008.
4. The Biosphere, Bradbury, I. K., John Wiley and Sons. Inc. UK, 2009.

**COMPULSORY COURSES  
BS (4 YEARS) IN BASIC & SOCIAL SCIENCES**

**ENGLISH I  
(Functional English)**

**COURSE OBJECTIVES:**

Enhance language skills and develop critical thinking.

**COURSE OUTLINES:**

Basics of Grammar  
Parts of speech and use of articles  
Sentence structure, active and passive voice  
Practice in unified sentence  
Analysis of phrase, clause and sentence structure  
Transitive and intransitive verbs  
Punctuation and spelling

**COMPREHENSION:**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

**Note: Extensive reading is required for vocabulary building**

## **RECOMMENDED BOOKS:**

1. Practical English Grammar by A. J. Thomson and A.V. Martinet. Exercises 1. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. 3<sup>rd</sup> Edition. Oxford University Press. 1997. ISBN 0194313506
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
4. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

## **ENGLISH II** (Communication Skills)

### **Objectives:**

Enable the students to meet their real life communication needs.

### **Course Contents:**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

#### **Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

#### **Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

#### **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

**Note:** Documentaries to be shown for discussion and review

## **Recommended Books:**

### **Communication Skills**

#### a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. 3<sup>rd</sup> Edition. Oxford University Press 1986. ISBN 0 19 431350 6.

#### b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

#### c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 4534030.
2. Reading and Study Skills by John Langan
3. Study Skills by Richard York.

## **ENGLISH III (Technical Writing and Presentation Skills)**

### **Objectives:**

Enhance language skills and develop critical thinking

### **Course Contents:**

#### **Presentation skills**

#### **Essay writing**

Descriptive, narrative, discursive, argumentative

#### **Academic writing**

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

#### **Technical Report writing**

#### **Progress report writing**

**Note:** *Extensive reading is required for vocabulary building*



## **Recommended Books:**

### Technical Writing and Presentation Skills

#### a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3

(particularly suitable for discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.

3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

#### b) Presentation Skills

#### c) Reading

The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

# PAKISTAN STUDIES (Compulsory)

## Introduction/Objectives:

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

## Course Outlines:

### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

## Books Recommended:

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.

7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

## **ISLAMIC STUDIES (Compulsory)**

### **Objectives:**

This course is aimed at:

1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

### **Detail of Courses:**

#### **Introduction to Quranic Studies**

1. Basic Concepts of Quran
2. History of Quran
3. Uloom-ul -Quran

#### **Study of Selected Text of Holly Quran**

1. Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
2. Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3. Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4. Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5. Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

### **Study of Selected Text of Holly Quran**

1. Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
2. Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
3. Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

### **Seerat of Holy Prophet (S.A.W) I**

1. Life of Muhammad Bin Abdullah ( Before Prophet Hood)
2. Life of Holy Prophet (S.A.W) in Makkah
3. Important Lessons Derived from the life of Holy Prophet in Makkah

### **Seerat of Holy Prophet (S.A.W) II**

1. Life of Holy Prophet (S.A.W) in Madina
2. Important Events of Life Holy Prophet in Madina
3. Important Lessons Derived from the life of Holy Prophet in Madina

### **Introduction To Sunnah**

1. Basic Concepts of Hadith
2. History of Hadith
3. Kinds of Hadith
4. Uloom-ul-Hadith
5. Sunnah & Hadith
6. Legal Position of Sunnah

### **Selected Study from Text of Hadith**

### **Introduction To Islamic Law & Jurisprudence**

1. Basic Concepts of Islamic Law & Jurisprudence
2. History & Importance of Islamic Law & Jurisprudence
3. Sources of Islamic Law & Jurisprudence
4. Nature of Differences in Islamic Law
5. Islam and Sectarianism

### **Islamic Culture & Civilization**

1. Basic Concepts of Islamic Culture & Civilization
2. Historical Development of Islamic Culture & Civilization
3. Characteristics of Islamic Culture & Civilization
4. Islamic Culture & Civilization and Contemporary Issues

### **Islam & Science**

1. Basic Concepts of Islam & Science
2. Contributions of Muslims in the Development of Science
3. Quranic & Science

### **Islamic Economic System**

1. Basic Concepts of Islamic Economic System
2. Means of Distribution of wealth in Islamic Economics
3. Islamic Concept of Riba
4. Islamic Ways of Trade & Commerce

### **Political System of Islam**

1. Basic Concepts of Islamic Political System
2. Islamic Concept of Sovereignty
3. Basic Institutions of Govt. in Islam

### **Islamic History**

1. Period of Khlaft-E-Rashida
2. Period of Ummayyads
3. Period of Abbasids

### **Social System of Islam**

1. Basic Concepts of Social System of Islam
2. Elements of Family
3. Ethical Values of Islam

### **Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 1) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

**MATHEMATICS**  
**COURSES FOR BS (4 YEAR)**  
**(FOR STUDENTS NOT MAJORING IN MATHEMATICS)**

**1. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES**

Title of subject:	MATHEMATICS
Discipline	BS (Social Sciences).
Pre-requisites:	SSC (Metric) level Mathematics
Credit Hours	03 + 00
Minimum Contact Hours:	40
Assessment	Written examination;
Effective :	2008 and onward

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**Aims:**

To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

**Objectives:**

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

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

**Contents:**

**Algebra:**

Preliminaries: Real and complex numbers, Introduction to sets, set operations, functions, types of functions. Matrices: Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. Quadratic equations: Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. Sequence and Series: Arithmetic, geometric and harmonic progressions. Permutation and combinations: Introduction to permutation and combinations, Binomial Theorem: Introduction to binomial theorem. Trigonometry: Fundamentals of trigonometry, trigonometric identities. Graphs: Graph of straight line, circle and trigonometric functions.

**Statistics:** Introduction: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution:* Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram,

frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean, median and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation, mean deviation, standard deviation, variance, moments, skewness and kurtosis.

### **Recommended Books:**

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences*'

## **INTRODUCTION TO STATISTICS 3 (3-0)**

### **Unit 1. What is Statistics?**

Definition of Statistics, Population, sample, Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data. Exercises.

### **Unit 2. Presentation of Data**

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

### **Unit 3. Measures of Central Tendency**

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

### **Unit 4. Measures of Dispersion**

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

**Unit 5.** Probability and Probability Distributions.

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

**Unit 6.** Sampling and Sampling Distributions

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.

**Unit 7.** Hypothesis Testing

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

**Unit 8.** Testing of Hypothesis- Single Population

Introduction, testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

**Unit 9.** Testing of Hypotheses-Two or more Populations

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

**Unit 10.** Testing of Hypothesis-Independence of Attributes

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

**Unit 11.** Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation.  $r$  and  $R_2$ . Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

**Recommended Books:**

1. Walpole, R. E. 1982. "Introduction to Statistics", 3<sup>rd</sup> Ed., Macmillan Publishing Co., Inc. New York.
2. Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.

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**Note: General Courses from other Departments**

Details of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.



## LIST OF MS/MPhil Biochemistry Courses

1. Advanced Molecular Genetics
2. Advances in Biochemistry\*
3. Advances in Clinical Biochemistry
4. Advances in Molecular Biology\*
5. Advances in Endocrinology
6. Advances in Biotechnology
7. Advanced Biostatistics\*
8. Advanced Bioinformatics\*
9. Advanced Research Methods
10. Recent Trends in Immunology
11. Application of Techniques to Biomolecules
12. Community Nutrition
13. Protein Structure, Function and Engineering
14. Enzymes - Mechanism & Kinetics
15. Biostatistics and Biomathematics
16. DNA Techniques and Clinical Applications
17. Project Planning, Monitoring and Evaluation
18. Signal Transduction
19. Biochemistry of Metabolic Disorders
20. Natural Products Biochemistry
21. Nutrition for health promotion and disease prevention
22. Recombinant DNA Technology
23. Chemistry of Biomolecules
24. Bioanalytical Techniques
25. Research Methodology 1 & II\*
26. Research Methods in Biochemistry
27. Advanced Biochemical Techniques
28. Numerical problems in Biochemistry
29. Genomics, Proteomics and Metabolomics
30. Regulation of Gene Expression
31. Molecular Biology & Biochemistry Lab
32. Food Biochemistry
33. Vegetables Oil Technology
34. Directed Enzyme evolution
35. Renewable bioenergy Resources
36. Molecular Mechanism of Diseases
37. Molecular Evolution
38. Directed Studies in Biomolecular structure and Functions
39. Pharmaceutical Biochemistry
40. Pathogens and Pathogenicity
41. Graduate Seminar-I\*
42. Graduate Seminar with Special Problems-II\*
43. Drug Designing and metabolism

44. Medical Biochemistry
45. Forensic Biochemistry and Molecular Biology

**Note:** University may opt any other course(s) depending upon the facilities and expertise of faculty available subjected to the approval of concerned academic forum.

### **Compulsory Courses (Recommendations)**

Advances in Biochemistry  
Advanced Biostatistics  
Graduate Seminar I  
Graduate Seminar with Special Problems - II

### **Electives:**

Research Methodology  
Advanced Bioinformatics  
Advances in Molecular Biology