

**CURRICULUM**

**OF**

**MOLECULAR BIOLOGY**  
**BS 4 YEARS PROGRAMME**

**(2016)**



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

## **CURRICULUM DIVISION, HEC**

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**Composed by: Mr. Zulfiqar Ali, HEC, Islamabad**

# 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).

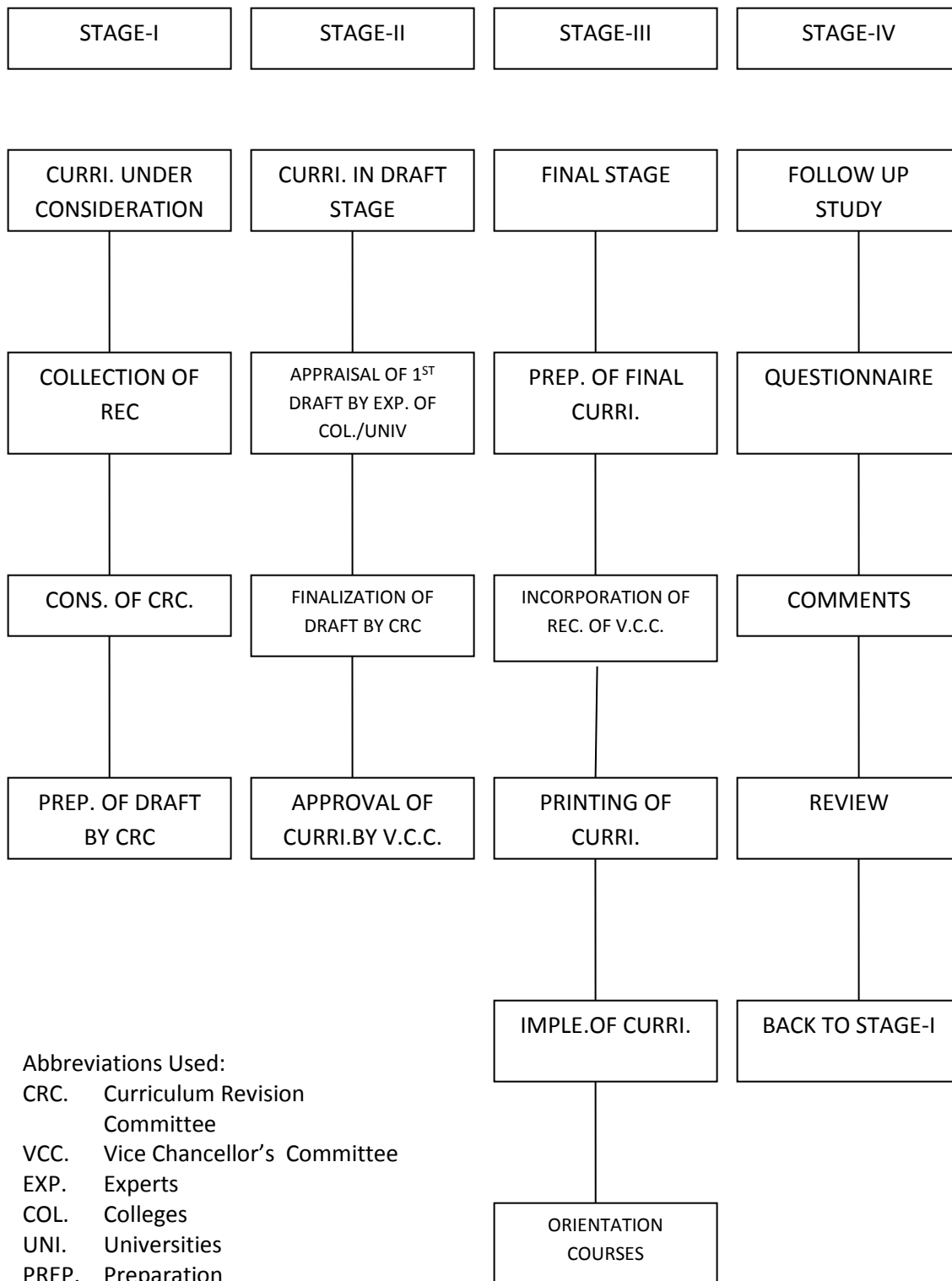
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector 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 <http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx>

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

# CURRICULUM DEVELOPMENT PROCESS



**Abbreviations Used:**

- CRC. Curriculum Revision Committee
- VCC. Vice Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations

## INTRODUCTION:

Final meeting of the National Curriculum Revision Committee (NCRC) in the discipline of Molecular Biology was held on March 14-16, 2016 at HEC Islamabad. Following members attended the meeting:

Sr. No	Name & Address	
1.	Prof. Dr. Anjum Nasim Sabri, Professor / Chairperson, Department of Microbiology and Molecular Genetics, Quaid-e-Azam Campus, University of Punjab, Lahore.	Convener
2.	Dr. Hajira Sadia (In Place of Dr. Peter John), Assistant Professor, Atta-ur-Rehman School of Applied Biosciences (ASAB), National University of Science & Technology, Sector H-12, Islamabad.	Member
3.	Dr. Muhammad Saeed, Assistant Professor, Department of Biosciences, COMSAT Institute of Information Technology, Park Road, Chak Shahzad, Islamabad.	Member
4.	Dr. Bushra Mirza, Professor & Chairperson, Department of Biochemistry, Quaid –I-Azam University, Islamabad.	Member
5.	Dr. Nosheen Masood, Assistant Professor, Department of Environmental Sciences, Fatima Jinnah Women University, Rawalpindi.	Member
6.	Dr .Wasim Shehzad, Associate Professor /Director, Institute of Biochemistry & Biotechnology, University of Veterinary and Animal Science, Syed Abdul Qadir Jillani Road, Lahore.	Member
7.	Dr. Akhtar Ali. (In Place of Prof. Dr. Masroor Ellahi Babar), Professor / Dean, Department of Molecular Biology, Virtual University of Pakistan, M. A Jinnah Road, Lahore.	Member

8.	Dr. Shahid Raza, Dean / Director, Department of Biological Sciences, University of South Asia, 47 Tufail Road, Lahore.	Member
9.	Prof. Dr. Ghulam Asghar Maka, Professor (Director), Institute of Microbiology, University of Sindh, Jamshoro.	Member
10.	Dr. Mir Muhammad Ali Talpur, Associate Professor, Department of Microbiology, Shah Abdul Latif University, Khairpur.	Member
11.	Dr. Ali Muhammad Waryah, Assistant Professor, Department of Molecular Biology & Human Genetics, Liaquat University of Medical & Health Sciences, Jamshoro, Sindh.	Member
12.	Dr. Shahid Ali, Assistant Professor, Centre for Biodiversity & Microbiology, University of Swat, G. T. Road, Odigram, Swat	Member
13.	Dr. Hamid Manzoor, Assistant Professor, Institute of Molecular Biology & Biotechnology, Bahauddin Zakariya University, Multan.	Member
14.	Dr. Bushra Rashid, Assistant Professor, Centre of Excellence in Molecular Biology (CEMB), University of the Punjab, Lahore.	Member
15.	Dr. Deeba Noreen Baig, Assistant Professor, Department of Biological Sciences, Forman Christian College, Ferozpur Road, Lahore.	Member
16.	Dr. Muhammad Qasim, Assistant Professor, Department of Microbiology, Kohat University of Science & Technology, Kohat.	Member/ Secretary

## **Objectives of the meeting:**

- To develop the draft curriculum in the discipline of Molecular Biology and to bring it par with international standards.
- To incorporate latest reading and writing material against each course.
- To bring uniformity and develop minimum baseline courses in each and every course of study.
- To make recommendations for promotion/development of the discipline.

The meeting started with the recitation of verses from the Holy Quran by Dr. Muhammad Qasim. Ms. Ghayyur Fatima (Director Curriculum) presided over the inaugural session. She welcomed the participants on behalf of HEC and thanked the participants for attending the meeting for this cause of national significance. Ms. Ghayyur Fatima also highlighted brief history of semester system implementation in Pakistan. She also briefed about the role of HEC in strengthening the curriculum of Molecular Biology and to bring it at par with international standards. Furthermore, she encourages the participants to prepare their suggestions and recommendations for HEC to bring improvement in current semester system.

The committee unanimously agreed upon selecting Prof. Dr. Anjum Nasim Sabri as Convener and Dr. Muhammad Qasim as Secretary of the NCRC in Molecular Biology. Ms. Ghayyur Fatima requested the convener of the committee to start technical session in accordance with the agenda. Prof. Dr. Anjum Nasim Sabri briefed the committee about the background of Molecular Biology degree programme and its importance in biology to meet the demand of local market. She asked the committee members to give their input in the document to be drafted at the end of the meeting. It was decided that the general courses, courses from other departments will be same with reference to contents to already approved HEC curriculum of biological sciences. It is necessary to maintain equity with reference to first two years.

The committee went through the scheme of study for 4-year BSc. (Hons) Molecular Biology programme at structural level and reviewed its courses and credit hours. Molecular Biology degree programmes of some of international universities such as Cornell, King's college, London; University of Birmingham, The University of Sheffield and Maxwell were also discussed so that our syllabi meet international standards. Following extensive brain storming and constructive criticism a list of compulsory, general, foundation, major and elective courses were prepared. These courses were then arranged in various semesters according to its relevancy and in-line sequence. Prof. Dr. Bushra raises issues related to BS (2 years) degree and courses requirement for admission in BS (4 years) Molecular Biology and it was decided that concerned body of the university will adopt its own criteria for admission and pre-requisite courses. The forum also decided to add foreign language and comparative religion as an optional compulsory course.



Most of the compulsory courses were adopted as such from already approved NCRC courses in the discipline of Biochemistry, Biotechnology, Genetics and Microbiology. To bring uniformity in the courses, it was also decided to adopt similar title of the courses which are already taught in Biochemistry, Biotechnology and Microbiology degree programmes. It was also decided that the scheme of studies must be flexible and the universities may offer courses depending upon the available faculty, expertise and infrastructure. Prof. Dr. Anjum Nasim Sabri requested all members to review the books and add latest books in these courses.

## FRAME WORK FOR BS MOLECULAR BIOLOGY (4 YEARS PROGRAMME)

Total numbers of Credit hours	136
Duration	4 years
Semester duration	16-18 weeks
Semesters	08
Course Load per Semester	15-18 Cr hr
Number of courses per semester	4-6 (not more than 3 lab / practical courses)

Compulsory courses requirements (the student has no choice)		General courses to be chosen from other departments		Discipline specific foundation Courses	
9 courses		9 courses		10-11 courses	
Subject	Cr Hr	Subject	Cr. Hr	Subject	Cr. Hr
1. English I	3	1. General Genetics	2+1	1. Molecular Biology-I	2+1
2. English II	3	2. Biodiversity of animals	2+1	2. Molecular Biology-II	2+1
3. English III / Communication skills	3	3. Biodiversity of plants	2+1	3. Molecular Genetics	2+1
4. English IV/ Foreign language	3	4. Biochemistry-I	2+1	4. *Immunology	2+1
5. Pakistan Studies	2	5. Biochemistry-II	2+1	5. **Virology	2+1
6. Islamic Studies / Ethics/ Comparative Religion	2	6. Microbiology	2+1	6. Molecular Ecology	2+1
7. Mathematics I	3	7. Cell Biology	2+1	7. Bioinformatics	2+1
8. Biostatistics/Mathematics II	3	8. Animal Physiology	2+1	8. Basic techniques in Molecular Biology	1+2
9. Introduction to Computer	2+1	9. Plant Physiology	2+1	9. Enzymology	2+1
Note*		10. Chemistry	2+1	10. Introduction to Omics	2+0
Note**		11. Ecology and Ecosystem	2+1	11. Biotechnology	2+1
		12. Developmental Biology	2+1	12. Cell and tissue Culture	2+1
		13. Endocrinology	2+1	13. Biosafety and Bioethics	2+0
		14. Sociology/Arts/ Environmental current issues/ Environmental ethics	2+0		
		15. Entrepreneurship			
		Note***			
25		23		34	

- \* University may recommend other General courses according to their available faculty and expertise.
- \*\* University may recommend any other course in lieu of Mathematics II.
- \*\*\* University may recommend other courses according to their available faculty i.e. Zoology, Botany, Biotechnology, Animal/Human/Plant Physiology, Chemistry/Biochemistry, Endocrinology, Ecology and

Ecosystem, Developmental Biology, Plant diversity and Genetics, Microbiology and Molecular Genetics.

\* General Immunology

\*\* General Virology

Major courses including research project/internship		Elective Courses within the major	
11-13 courses		4 courses	
Subject	Cr. hr	Subject	Cr. hr
1. Advanced Techniques in Molecular Biology	1+2	Elective I	2+1
2. Gene therapy	3 +0	Elective II	2+1
3. Cell signaling	3+ 0	Elective III	2+1
4. Recombinant DNA technology	2+1	Elective IV	2+1
5. Molecular Evolution	2+1		
6. Genomics	2+1		
7. Transcriptomics	2+1		
8. Proteomics	2+1		
9. Molecules to the Market	2+1		
10. Molecular Diagnostics	3+0		
11. Quantitative Biology	2+1		
12. Skills and Research Methodology	2+1		
13. Immunogenetics	3+0		
14. Molecular Toxicology	0+6		
15. Molecular Pharmacology			
16. Bionanotechnology			
17. Research Project			
46		12	

\*\*\*\* Student may take 13 courses out of the list of 17 courses in major other than Research Project.

## List of Elective Courses:

University may recommend elective courses according to facilities within the department.

1. DNA Damage and Repair
2. Biophysics and Computational Biology
3. Vaccinology
4. Epigenetics
5. Molecular Breeding
6. Human Genetics and Chromosomal Disorders
7. Neurobiology
8. Genetically Modified Organisms
9. Computer Graphics and Molecular Biology
10. Forensic Biology
11. Macromolecular Crystallography
12. Plant Molecular Genetics
13. Probiotics
14. Biodegradation & Bioremediation
15. Infectious Diseases
16. Food Preservation Technology
17. Epidemiology: Analytical and Experimental Approaches
18. Advances in Microscopy and Image Analysis
19. Biosensors
20. Biofuels and Bio-refineries
21. Antimicrobials and Chemotherapeutics
22. Drug Development
23. Stem cells and Gene Therapy Regenerative Medicine
24. Cancer Biology
25. Molecular Virology
26. Animal Molecular Biology

## SCHEME OF STUDIES FOR BS MOLECULAR BIOLOGY (4 YEARS PROGRAMME)

Semester/ year	Name of subject	Credits
First	ENGLISH-I	03
	PAKISTAN STUDIES	02
	MATH- I	03
	GENERAL-I	2 + 1
	GENERAL-II	2 + 1
	FOUNDATION-I	2 + 1
		<b>17</b>
Second	ENGLISH-II	03
	ISLAMIC STUDIES / ETHICS	02
	MATH/STAT-II / UNIV. OPTIONAL	03
	GENERAL-III	2 + 1
	GENERAL-IV	2 + 1
	FOUNDATION-II	2 + 1
		<b>17</b>
Third	COMPUTER APPLICATION	03
	ENGLISH-III/COMMUNICATION SKILLS	03
	GENERAL-V	2 + 1
	GENERAL-VI	2 + 1
	FOUNDATION-II	2 + 1
	FOUNDATION-III	2 + 1
		<b>18</b>
Fourth	ENGLISH-IV/FOREIGN LANGUAGE UNIV. OPTIONAL	03
	GENERAL-VII	2 + 1
	GENERAL-VIII	2 + 1
	FOUNDATION-IV	2 + 1
	FOUNDATION-V	2 + 1
	FOUNDATION-VI	2 + 1
		<b>18</b>
Fifth	FOUNDATION-VII	2 + 1
	FOUNDATION-VIII	2 + 1
	FOUNDATION-IX	2 + 1
	MAJOR- I	2 + 1
	MAJOR- II	2 + 1
	MAJOR- III	2 + 1
		<b>18</b>

Sixth	FOUNDATION- X	2 + 1
	MAJOR- IV	2 + 1
	MAJOR- V	2 + 1
	MAJOR- VI	2 + 1
	MAJOR- VII	2 + 1
	MAJOR-VIII	2 + 1
		<b>18</b>
Seventh	MAJOR- IX	2 + 1
	MAJOR- X	2 + 1
	ELECTIVE-I	2 + 1
	ELECTIVE-II	2 + 1
	ELECTIVE PAPER/ RESEARCH PROJECT	03
		<b>15</b>
Eighth	MAJOR- XI	2 + 1
	MAJOR-XII	2 + 1
	ELECTIVE-I	2 + 1
	ELECTIVE-II	2 + 1
	ELECTIVE PAPER /RESEARCH PROJECT	03
		<b>15</b>
	Total credit hours	<b>136</b>

### List of Compulsory Courses:

1. English I
2. English II
3. English III/ Communication skills
4. English IV/ Foreign language
5. Pakistan Studies
6. Islamic Studies / Ethics /Comparative Religion
7. Mathematics I
8. Biostatistics/Mathematics II
9. Introduction to Computer

# DETAIL OF COMPULSORY COURSES

## ENGLISH I (FUNCTIONAL ENGLISH)

Credit Hrs 3+0

**Objectives:** Enhance language skills and develop critical thinking.

### Course Contents:

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. Functional English

##### a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

##### b) Writing

- 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.

- c) **Reading/Comprehension**
  - 4. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- d) **Speaking**

## **ENGLISH II (COMMUNICATION SKILLS)**

**Credit Hrs 3+0**

**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. Third 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 019 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 453403 0.
  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. Kirsznier 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**

**Credit Hrs 3+0**

### **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 Outline:**

#### **1. Historical Perspective**

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad 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

### **RECOMMENDED BOOKS:**

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: Wm Dawson & 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

Credit Hrs 3+0

## 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-Baqara 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) Quran & 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
- 4) 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)

## 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

### Course Outline:

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression. *Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

### Recommended Books:

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)
2. Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

**LEARNING OUTCOMES:****Students will able to:**

1. Explain what is meant by statistical observation , inference, biological variance
2. Distinguish between populations and samples.
3. Distinguish between population parameters and sample statistics.
4. Compute a sample mean, sample variance, and sample standard deviation.
5. Compute a population mean, population variance, and population standard deviation.

**COURSE CONTENTS:**

Introduction to Biostatistics and its scope in Molecular biology; Collection of Primary and Secondary data; editing of data; Presentation of data: Tabulation, Classification, Visual Presentation (Diagrams and Graphs); Measures of Central Tendency: Arithmetic Mean by direct and short-cut method, Geometric Mean, Harmonic Mean, Mode, Median, ED<sub>50</sub> (LD<sub>50</sub> in detail ), Quartile; Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation by direct and short-cut method, Variance, and their Coefficient; Correlation: Simple Correlation Table, Rank Correlation, Partial and Multiple Correlation; Regression and method of least square; Probability: Concept of Probability, Laws of Probability; Permutation and Combination; Probability distributions: Binomial distribution, Poisson distribution and their fitting to observed data, Normal distribution; Sampling and Basic Design; Hypothesis Testing; Chi-square test, Student's t-test, Analysis of variance; Multivariate analysis; Knowledge of statistical software; Laboratory Experiments pertaining to the course.

**RECOMMENDED BOOKS:**

1. Fernholz, L.T, Morgenlhaler, S. and Stahel, W. 2000. *Statistics in Genetics and in Environmental Sciences*, Birkhauser Verlag, Switzerland.
2. Quinn, G., 2002. *Experimental Design and Data Analysis for Biologists*, Cambridge University Press, U.S.A.
3. Gerstman, B.B. 2014. *Basic Biostatistics: Statistics for Public Health Practice*. 2<sup>nd</sup> Edition. Jones and Bartlett learning publications. 5 wall street Burlington MA01803.
4. Glover, T. and Mitchell, K., 2015. *An Introduction to Biostatistics*, Third Edition 3<sup>rd</sup> Edition . Waveland Press, Inc. Long grove, IL,60047-9580.

**LEARNING OUTCOMES:****Students will develop:**

1. The ability to solve problems in the discipline by using computing skills
2. The ability to analyze data statistically, and carefully interpret results of experiments after drawing valid reasonable conclusions.
3. The ability to search the relevant literature and to produce a discipline specific technical document.
4. The ability to give an effective presentation using different software.

**COURSE CONTENTS:**

- Introduction to Computer and Windows.
- Word processing (Microsoft Word).
- Spread Sheets (Microsoft Excel) and other related software packages (at least two).
- Internet access and different data bases available on the Internet.

**RECOMMENDED BOOKS:**

1. Parsons, J.J., 2016. New Perspectives on Computer Concepts Introductory 18<sup>th</sup> Edition. Cengage learning 20 Channel Centre Street Boston, MA 02210, USA.
2. Randal E. Bryant, R.E. and O' Hallaron, D.R., 2015. Computer systems: A Programmer's Perspective. Pearson Education Press.
3. Mayword, A., 2016. Microsoft Office 2016: Tips and Tricks

**LIST OF GENERAL COURSES**

1. General Genetics
2. Biodiversity of animals
3. Biodiversity of plants
4. Biochemistry-I
5. Biochemistry-II
6. Microbiology
7. Cell Biology
8. Animal Physiology
9. Plant Physiology
10. Chemistry
11. Ecology and Ecosystem
12. Developmental Biology
13. Endocrinology
14. Sociology/Arts/Current Issues in Environment/Environmental Ethics
15. Entrepreneurship



## DETAIL OF GENERAL COURSES

### GENERAL GENETICS

CREDIT HOURS 2+1

#### LEARNING OUTCOMES:

##### Students will be able to:

1. Learn the classical genetics with emphasis on basic principles of inheritance and Mendelian Genetics.
2. Apply what they learn in genetics by applying this knowledge in a variety of problem-solving situations.

#### COURSE CONTENTS:

Definition and genesis (history) of genetics. Heredity and variation. Chromosomal theory of inheritance. Mendel's laws of inheritance. Gene interaction; genotypic and phenotypic ratios. Multiple alleles, Multiple factor hypothesis and use of binomial theorem. Linkage and crossing over and their calculations, gene mapping. Sex linkage, sex determination and sex linked inheritance, sex influenced, sex limited and holandric genes. Genetic material. Gene and environment: penetrance, expressivity, pleiotropism and phenocopies. Twin studies, nature and nurture. Mutations. Extra-nuclear inheritance: maternal effects and maternal inheritance. Qualitative and quantitative inheritance.

#### PRACTICALS:

1. Preparation of culture medium and maintenance of Drosophila cultures in lab.
2. Problems related to Mendelian inheritance, gene interaction, gene mapping.
3. Blood groups-ABO blood groups and Rh factors

#### RECOMMENDED BOOKS:

1. Asche, A., 2013. Recent Advances in Cloning Genetics and Stem Cell Technology. RDM.
2. Brown, T.A., 2016. Gene Cloning and DNA Analysis: An Introduction 7<sup>th</sup> Edition, John and Wiley sons Limited, UK.
3. Costa, L. G. and Eaton, D. L. 2006. Gene-Environment Interactions; Fundamentals of Ecogenetics, John Wiley and Sons, N.Y.
4. Eldon, J. G., Michael, J. S. and Snustad D. P. 6<sup>th</sup> Edition. Principles of Genetics
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doedley,J.,2015. An Introduction to Genetic Analysis 11<sup>th</sup> Edition W.H. Freeman. 41 Madison Ave, New York, NY 10010, United States.
6. James D. W. 2013. Molecular Biology of Gene. Benjamin Cumming.
7. James D. W. 2013. Molecular Biology of Gene. Benjamin Cumming.
8. Leland, H., Leroy, H. 2010. Genetics: From Gene to Genome. McGraw-Hill Sciences.

9. Philip, M., 2009. *Advanced Genetic Analysis: Genes, Genomes and Networks in Eucaryotes*. Oxford University Press.
10. Primrose, S. B. and Twyman, R. M. 2006. *Principles of Gene Manipulation and Genomics*, Blackwell Scientific Publications, U.S.A.
11. Robert, B. 2014. 5<sup>th</sup> Edition. *Genetics: Analysis and Principles*. McGraw-Hill educations.
12. Sirks M. J., 2013; *General Genetics*. Springer Science & Business Media.

## **BIODIVERSITY OF ANIMALS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES :**

#### **Students will be able to:**

1. Identify and explore examples of animal biodiversity in the World
2. Communicate with one another an understanding about the different types of animals and their habitats.

### **COURSE CONTENTS:**

Classification of Animal kingdom. Characterization, salient features and general organization of all major animal groups /Phyla. Concept of animal structure with reference to adaptations to environment and inter-relationship based on evolution.

### **PRACTICALS:**

1. Study of morphology and salient features of various major groups of animals.
2. Identification of various types mentioned from prepared slides and fresh collection.
3. Collection of specimens of animals and their identification.

### **RECOMMENDED BOOKS:**

1. Hickman, C. P. Jr., Hickman, R. L. S., Keen S. L., Larson, A. L., Eisenhour, D. J., 2014. *Animal Diversity. Volume 1*. McGraw-Hill Education.
2. Jr., Hickman, C., Keen, S., Larson, A., Eisenhour, D., l'Anson, H., Roberts, L., Keen, S., 2013. *Integrated Principles of Zoology* 16<sup>th</sup> Edition. McGraw-Hill Education.
3. Jr., Hickman, C., Larry Roberts, L., Keen, S., Larson, A., Eisenhour, D., 2014. *Animal Diversity. 7<sup>th</sup> Edition*. McGraw-Hill Education
4. Kershaw, D. R., 2012; *Animal Diversity*. Springer Science & Business Media.
5. Reece, J.B., Urry, L.A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Jackson, R. B., 2013. *Campbell Biology* .10<sup>th</sup> Edition. Benjamin Cummings.
6. Starr, C., Taggart, R., Evers, C. and Starr, L., 2015. *Diversity of Life (Biology: the Unity and Diversity of Life)* 14<sup>th</sup> Edition. Volume 3 Brooks Cole publishing.

**LEARNING OUTCOMES:****Students will be able to:**

1. Identify and explore examples of plant biodiversity in the world
2. Communicate with one another an understanding about the different types of plants and their habitats.

**COURSE CONTENTS:**

Introduction: Diversity of life. Arranging the diversity of life into Kingdoms. Major characteristics of phyla of kingdom Plant and colonization of land. Plant diversity, evolutionary history of plant kingdom, structural and reproductive adaptation for colonization of land. Plant structure and Growth: Reproduction & Development: Life cycle of plant. Control systems of Plants to cope with environmental stresses; Body plan and nutritional modes in Fungi, Classification of Fungi

**PRACTICALS:**

1. Study of morphology and reproductive structures of specimens mentioned in course outline.
2. Identification of various types mentioned from prepared slides and fresh collection.
3. Collection of specimens of plants and their identification.

**RECOMMENDED BOOKS:**

1. Britto, J., 2009; Diversity of Plants: A Molecular Approach. The Rapinat Herbarium and Centre for Molecular Systematics, St. Joseph's College.
2. Gibson, J. P., Gibson, T. R., 2007. *Plant Diversity*. Infobase Publishing.
3. Greenaway, T. 1999. *The Plant Kingdom: A Guide to Plant Classification and Biodiversity*, Raintree, U.S.A.
4. Henery, R. J., 2004. *Plant Diversity and Evolution: Genotypic and Phenotypic Variation in Higher Plants*. CABI publishers, UK.
5. Laird, S. A. 2002. *Biodiversity and Traditional Knowledge*, 1<sup>st</sup> edition, Stylus Pub. LLC, V.A.
6. Margulis, L. and Schwartz, K.V. 1996. *Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth*, 2<sup>nd</sup> Edition, W. H. Freeman, U.S.A.
7. Reece, J.B., Urry, L.A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Jackson, R. B., 2013. *Campbell Biology* .10<sup>th</sup> Edition. Benjamin Cummings. USA.
8. Starr, C., Taggart, R., Evers, C., Starr, L., 2015. *Diversity of Life (Biology: the Unity and Diversity of Life)* 14<sup>th</sup> Edition. Volume 3 Brooks Cole publishing.
9. Weisfeld L. I., Opalko, A. I., Bome, N. A., Bekuzarova, S. A., 2015. *Biological Systems, Biodiversity, and Stability of Plant Communities* .1<sup>st</sup> Edition. Apple Academic Press. Canada.

**LEARNING OUTCOMES:****The students will be able to:**

1. Importance of elements, water and other biological entities.
2. The core principles and topics of Biochemistry and their experimental basis.
3. Structure and interactions of nucleic acid, protein and carbohydrates.

**COURSE CONTENTS:**

A general introduction to the science of biochemistry; importance and the scope of biochemistry; structure, physical properties and importance of water; unique properties of carbon and other elements found in biological molecules; nature of organic matter; isomerism; biologically important organic compounds/solvents; Buffer and pH. overview of biological molecule and their structures; Amino Acids; Peptides and Protein; Enzymes: Nature and Function of enzyme, Classification and Nomenclature. Mechanism of enzyme action. Carbohydrates: Monosaccharides, Oligosaccharides, Polysaccharides, Glycoconjugates, Glycosaminoglycans, Proteoglycans, Glycoproteins; Carbohydrates as informational molecules; Nucleic Acids: Nucleosides and nucleotides, Structure and function of DNA and RNA; Lipids: Storage Lipids, Fatty acids and their types, Triacylglycerols, Structural Lipids, Phospholipids, Sphingolipid, Glycolipid, Sterols and Isoprenoids.

**PRACTICALS:**

1. Solutions.
2. Acid and Bases.
3. Electrolytes and Non Electrolytes.
4. Buffers and pH.
5. Study of hydrolysis of starch by using mineral acids.
6. Various qualitative tests for Monosaccharide, oligosaccharides and polysaccharides
7. Detection of reducing sugars in the presence of non-reducing sugars
8. Qualitative tests for different lipids.
9. Paper and thin-layer chromatography of sugars and amino acids.
10. Determination of pK values of amino acids (Glycine, Alanine) by preparation of titration curves.
11. Qualitative and quantitative analysis of proteins by colorimetric methods (Biuret and Lowry's)

**RECOMMENDED BOOKS:**

1. Berg, J. M., Tymoczko, J. L., Gatto. G. J., Stryer, L., 2015. Biochemistry 8<sup>th</sup> Edition. W. H. Freeman.
2. Cox, M. and Nelson, D. L., 2005. Lehninger Principles of Biochemistry 4<sup>th</sup> Edition, Palgrave Macmillan.
3. Denniston, S., 2006. General, Organic and Biochemistry, 5<sup>th</sup> Edition. McGraw-Hill.

4. Devlin, T. M., 2002. Textbook of Biochemistry with Clinical Correlations 5th Edition. John Wiley and Sons. Inc., New York,
5. Dharmapalan, B., 2015. Plant Biochemistry: An Introduction Alpha Science International Ltd.
6. Garrett R. H., Grisham, C. M., 2012; Biochemistry 5<sup>th</sup> Brooks/Cole Cengage Learning, USA
7. Harvey, R. A., Ferrier D. A., 2011; Lippincott's Illustrated reviews: Biochemistry, 5<sup>th</sup> Edition Lippincott Williams & Wilkins, NY
8. Lehninger A. L., Nelson D. L., Cox M. M., 2013; Lehninger Principles of Biochemistry 6<sup>th</sup> Edition. W. H. Freeman.
9. Metzler D. E., 2012. Biochemistry: The Chemical Reactions of Living Cells, Academic Press Elsevier USA
10. Murray, R., Granner, D., Mayes, P., and Rodwell, V., 2006. Harper's Illustrated Biochemistry 27<sup>th</sup> Edition. McGraw-Hill Education.
11. Voet, D., Voet, J. G. and Pratt, C. W., 2002. Fundamentals of Biochemistry; John Wiley and Sons. Inc., New York.

## **BIOCHEMISTRY-II**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **The students will be able to:**

Demonstrate advanced knowledge and understanding about the bioenergetics, biochemical thermodynamics and integration of metabolic pathways.

### **COURSE CONTENTS:**

Introduction to metabolism and basic aspects of bioenergetics and biochemical thermodynamics (endergonic and exergonic reactions); phosphoryl group transfer and ATP production; metabolism, oxidation-reduction; carbohydrate metabolism and regulation (glycolysis, glycogenolysis; gluconeogenesis; pentose phosphate pathway); citric acid cycle (reactions, energetics and control), electron transport chain, oxidative phosphorylation, shuttle mechanisms (glycerol-phosphate shunt), lipid metabolism (energy yield from fatty acid oxidation, ketone bodies, acylglycerol, compound lipids, cholesterol); photosynthesis; Calvin Cycle; metabolism of nitrogenous compounds (amino acid synthesis, catabolism, purine and pyrimidine synthesis); nucleic acid metabolism and control; urea cycle; integration of metabolism.

### **PRACTICALS:**

1. Preparation of calibration curve for glucose
2. Estimation of serum glucose by using calibration curve
3. Extraction of glycogen from liver; acid and enzymatic hydrolysis of glycogen

4. Extraction and estimation of lipids from plant tissue/seed and lipid separation from different tissues; fractionation by thin layer chromatography (TLC).
5. Extraction and salting out of proteins.
6. Quantitative analysis of proteins and nucleic acids by UV spectrophotometry
7. Extraction and quantitative analysis of amino acids

### **RECOMMENDED BOOKS:**

1. Voet, D., Voet, J. G. and Pratt, C. W., 2002. Fundamentals of Biochemistry; John Wiley and Sons. Inc., New York.
2. Berg, J. M., Tymoczko, J. L. and Stryer, L., 2002. Biochemistry 5<sup>th</sup> Edition. W.H. Freeman and Company, New York.
3. Devlin, T. M., 2002. Textbook of Biochemistry with Clinical Correlations 5<sup>th</sup> Edition. John Wiley and Sons. Inc., New York.
4. Zubay, G., 1995. Biochemistry 4<sup>th</sup> Edition. W. C. Brown Publishers, Inc., Oxford England.
5. Plummer, D. T., 1990. An Introduction to Practical Biochemistry 4<sup>th</sup> Edition. McGraw-Hill Book Company, London,
6. Wilson, K. and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> Edition. Cambridge Univ. Press, London
7. Berg, J. M., Tymoczko, J. L., Stryer, L., 2006. Biochemistry: International 6<sup>th</sup> Edition. W.H. Freeman & Co Ltd.
8. Cox, M. and Nelson, D.L., 2005. Lehninger Principles of Biochemistry 4<sup>th</sup> Edition, Palgrave MacMillan.
9. Murray, R., Granner, D., Mayes, P., and Rodwell, V., 2006. Harper's Illustrated Biochemistry 27<sup>th</sup> Edition. McGraw-Hill Education.
10. Denniston, S. 2006. General, Organic and Biochemistry, 5<sup>th</sup> Edition. McGraw-Hill.

## **MICROBIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will able to know about:**

1. The fundamentals of Prokaryotic and Eukaryotic microbial life
2. The antimicrobial resistances
3. The biogeochemical cycles, interaction/and their importance in the environment with special emphasis on the role of microbes.

### **COURSE CONTENTS:**

Overview and history of microbiology including microbial diversity (Archaea, bacteria, fungi, algae, protozoa , viruses), nutrition, growth, metabolism; cultivation; 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, seawater, potable water and waste water.

## **PRACTICALS:**

1. Laboratory safety: Containment and decontamination.
2. Preparation and sterilization of bacteriological media and glassware.
3. An introduction to microscopy.
4. Principles of Staining Procedures: Simple , Gram's , Acid-fast, cell-wall, flagellar, capsule, spore, negative staining and spirochaete staining.
5. Study of cell motility by hanging drop preparation.
6. Inoculation techniques.
7. Study of colony characteristics of microorganisms.
8. Standard plate count technique (SPC).
9. Bacterial growth curves
10. Microbiological analysis of air , soil, water
11. Biochemical tests (oxidase, catalase, Oxidation fermentation test)

## **RECOMMENDED BOOKS:**

1. Black, J. G and Black, L.J.,2015 Microbiology: Principles and Explorations 9<sup>th</sup> Edition. John Wiley and Sons Ltd.
2. Burton, G. R. W. and Engelkrik, P. G. (2000). Microbiology for the Health Sciences. Lippincott Williams & Wilkins.
3. Peleczar, M. J., Chanm, E. C. S. and Krieg, N. R. (1990). Microbiology. McGraw-Hill.
4. Johnson, T.R., G.J., Funke, B.R. and case, C.L., 2015. Microbiology: An Introduction Tortora, 12<sup>th</sup> Edition. Pearson Publisher.
5. Johnson, T.R and case, C.L., 2015. Laboratory Experiments in Microbiology 11<sup>th</sup> Edition. John Willey and Sons Ltd.
6. Willey, J., Sherwood, L., and Woolverton, C.J., 2016. Prescott's Microbiology 10<sup>th</sup> Edition. McGraw-Hill Education.
7. Tortora, G. J., Funke, B. R., & Case, C. L. 2016. Microbiology: An introduction. Pearson , Boston.

## **CELL BIOLOGY**

**CREDIT HOUR 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. The structures and need of basic components of Prokaryotic and Eukaryotic cells, especially macromolecules, membranes, and organelles
2. The cellular division i.e., mitosis and meiosis .
3. Students will apply their knowledge of cell biology to understand the reasons of changes in cell function.

### **COURSE CONTENTS:**

Introduction to cell theory, structure, chemical constituents of cell and cell organelles and their functions, separation of cell organelles, Cell membrane, its molecular organization and functional role, The concept of the unit membrane, membrane structure, the fluid mosaic model, membrane

receptors and transport mechanisms. Cell to cell communication, Endoplasmic Reticulum. Lysosome, Micro-bodies, Mitochondrial ultra-structure and function, Chloroplast ultra-structure and the mechanism of photosynthesis, Cell movements, structure and function of cytoskeleton, centriole, cilia and flagella, the mitotic apparatus, The nucleus, structure and function of chromosomes, the cell cycle, mitosis, meiosis., apoptosis , necrosis.

### **PRACTICALS:**

1. Microscopy and staining techniques
2. Study of prokaryotic and eukaryotic cells
3. Study of plant and animals cells
4. Study of the cell structure in the staminal hair of *Tradescantia*
5. Study of different types of plastids
6. Mitosis: smear/squash preparation of onion roots.

### **RECOMMENDED BOOKS:**

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K. and Walter, P. 2013. Essential Cell Biology; 4<sup>th</sup> Edition, Garland Sciences, New York, USA.
2. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. 2014. Molecular Biology of the Cell; 6<sup>th</sup> Edition, Garland Sciences, New York, USA.
3. David L. Nelson, D. L. and Cox, M. M. 2012. Lehninger Principles of Biochemistry; 6<sup>th</sup> Edition, W.H. Freeman, New York, USA.
4. Karp, J. H. 2016. Cell and Molecular Biology. John Willey and Sons, Inc. New York. USA.
5. Lodish, H. 2012. Solutions Manual for Molecular Cell Biology; 7<sup>th</sup> Edition, W.H. Freeman, New York, USA.
6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M. P. 2012. Molecular Cell Biology; 7<sup>th</sup> Edition. W.H. Freeman, New York, USA.
7. Nelson, D. L and Cox, M. M., Lehninger, A. 2013. Absolute Ultimate Guide for Lehninger Principles of Biochemistry; 6<sup>th</sup> Edition, W.H. Freeman, New York, USA.
8. Plopper, G. 2014. Principles of Cell Biology; 2<sup>nd</sup> Edition, Jones & Bartlett Learning, Burlington, USA.
9. Wilson, J. and Hunt, T., 2014. Molecular Biology of the Cell, The Problems Book; 6<sup>th</sup> Edition, Garland Sciences, New York, USA.

## **ANIMAL PHYSIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**Students will be able to:**

1. Understand and explain the basis of physiological functions in animals.



2. Explain structure-function relationships; how form follows function in animals.

### **COURSE CONTENT:**

Animals and environments: function on the ecological stages; molecules and cells in animal physiology; genomics, proteomics, and related approaches to animal physiology; physiological development and epigenetic; transport of solutes and water; nutrition, feeding, and digestion; energy metabolism: aerobic and anaerobic forms of metabolism; thermal relations; the physiology of control: neurons and endocrine cells; synaptic transmission; sensory processes; organization of sensory systems and motor systems; nervous system organization and biological clocks; endocrine and neuroendocrine physiology; reproduction; integrating systems animal navigation; control of movement: the motor bases of animal behavior; movement and muscle; the physiology of breathing; circulation: the anatomical components of circulatory systems, the heart and blood vessels function to maintain adequate perfusion of tissues; osmoregulation & excretion nutrition & digestion; gas exchange; immune system .

### **PRACTICALS:**

1. Introduction to animal physiology practical
2. Safety rules, animal handling ethics and awareness about animal handling lab equipments
3. Study of electrophysiological properties of cell membrane (patch clamping).
4. Determination of haemoglobin content, haematocrit and cell counting.
5. Preparation of blood smears.

### **RECOMMENDED BOOKS:**

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. 2014. Molecular Biology of the Cell; 6<sup>th</sup> Edition, Garland Sciences, New York, USA.
2. Hill, R. W., Gordon, A. Wyse, G. A. and Anderson, M. 2016. Animal Physiology; 4<sup>th</sup> Edition, Sinauer Associates, Inc., Sunderland, USA.
3. Lodish, H. 2012. Solutions Manual for Molecular Cell Biology; 7<sup>th</sup> Edition, W.H. Freeman, New York, USA.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M. P. 2012. Molecular Cell Biology; 7<sup>th</sup> Edition. W.H. Freeman, New York, USA.
5. Moyes, C. D. and Schulte, P. M. 2015. Principles of Animal Physiology; 3<sup>rd</sup> Edition, Pearson, London, UK.
6. Sherwood, L., Klandorf, H. and Yancey, P. 2014. Animal Physiology: From Genes to Organisms (with InfoTrac); 1<sup>st</sup> Edition, Brooks Cole, USA.
7. Wilson, J. and Hunt, T., 2014. Molecular Biology of the Cell, The Problems Book; 6<sup>th</sup> Edition, Garland Sciences, New York, USA.

**LEARNING OUTCOMES:****Students will be able to:**

1. Understand and explain the basis of physiological functions in plants.
2. Explain structure-function relationships; how form follows function in plants.

**COURSE CONTENTS:**

Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation; Mineral nutrition: Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role, deficiency, toxicity symptoms of macronutrients; Photosynthesis: Introduction, Oxygenic and non-oxygenic photosynthesis; Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle); Differences between C<sub>3</sub> and C<sub>4</sub> plants. Factors affecting this process, Products of photosynthesis; Respiration: Definition and respiratory substrates; Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients; Plant Growth Regulators: Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, Brassinosteroids, Jasmonates, and Salicylic acid

**PRACTICALS:**

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.
5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a pyrometer/cobalt chloride paper method.
6. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
7. Estimation of oxygen utilized by a respiring plant by Winkler's method.

**RECOMMENDED BOOKS:**

1. Bidlack, J. E., and Jansky, S. H. 2014. Introductory Plant Biology, 13<sup>th</sup> Edition. The McGraw-Hill Companies, New York, USA.

- Buchanan, B. B., Gruissem, W. and Jones, R. L. 2015. Biochemistry and Molecular Biology of Plants; 2<sup>nd</sup> Edition, John Wiley and Sons. New York. USA.
- Jones, R. L., Ougham, H., Thomas, H. and Waaland, S. 2012. The Molecular Life of Plants 1<sup>st</sup> Edition, Wiley-Blackwell, Oxford, UK.
- Stern, K., Bidlack, J. and Jansky, S. 2007. Introductory Plant Biology; 11<sup>th</sup> Edition. McGraw-Hill Science, New York, USA.
- Taiz, L., Zeiger, E., Møller, I. M. and Murphy, A. 2014. Plant Physiology and Development, 6<sup>th</sup> Edition, Sinauer Associates, Inc., Sunderland, USA.
- William G. Hopkins, W. G. and Hüner, N. P. A. 2008. Introduction to Plant Physiology; 4<sup>th</sup> Edition, John Wiley and Sons, Inc., New York, USA.

## **CHEMISTRY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will able to**

- Learn about the foundations in the fundamentals and applications of current chemical theories
- Understand the biological fields that are based upon chemistry

### **COURSE CONTENTS:**

Fundamental principles and concepts of physical, inorganic and organic chemistry related to biology, Basic functionality and reactions of carbon based systems (sp hybridization). Aspects related to structure and bonding (ionic, covalent and coordinate bonds), stereochemistry and representation of structure with emphasis placed on the relevance of the material to 'life systems'. Secondary metabolites

### **PRACTICALS:**

- Techniques associated with basic analytical chemistry
- Determination of sodium and potassium content in blood serum by flame photometer
- Mineral analysis of plant and animal tissues using atomic absorption spectrophotometer

### **RECOMMENDED BOOKS:**

As recommended in HEC approved curriculum of Chemistry

- John, E. M., 2012. Organic Chemistry, 8<sup>th</sup> Ed., Brooks/Cole Publishing Co, USA,
- Hill, R. H. JR and Fister, D. C., 2010 Laboratory Safety for Chemistry Students, John-Wiley & Sons, Inc.,
- Linder, B., 2011. Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd.,
- Miessler, G. L., Tarr, D. A., 2008 Inorganic Chemistry, 3<sup>rd</sup> Ed., Pearson Education, India.

## **ECOLOGY AND ECOSYSTEM**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Learn about the structure and function of ecological systems
2. Explain how ecological systems work at different spatial and temporal scales
3. List abiotic and biotic factors that affect, the distribution, dispersal, and behavior of organisms
4. Apply concepts and theories from biology with ecological examples

### **COURSE CONTENTS:**

Introduction, aims and applications of ecology. Concept, structure and components of ecology and Ecosystem; Energy flow in ecosystems and energy transformation in nature; Trophic levels, Food chain, Food webs, Food cycle, Ecological pyramids; Biogeochemical cycles (carbon, nitrogen, phosphorus); Productivity of ecosystems; human impact on ecosystem; Fundamental of population ecology.

### **PRACTICALS:**

1. Study of different methods of sampling.
2. Study of some biotic and abiotic factors of various ecosystems
3. Measurements and description of communities by different methods.

### **RECOMMENDED BOOKS:**

1. Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A Study of Interrelationships, McGraw-Hill, U.S.A.
2. Newman, E. L. 2001. Applied Ecology, Blackwell, U.K.
3. Odum, E. 2001. Ecosystem Ecologist and Environmentalist, Betty Jean Jean Craige, University of Georgia Press, Georgia.
4. Sala, O.E. and Jackson R.B. 2000. Methods in Ecosystem Science, Springer-Verlag, N.Y.
5. Weathers, K., 2012. Fundamentals of Ecosystem Science, 1<sup>st</sup> Edition. Elsevier Academic Press
6. Jørgensen, S., 2009. Ecosystem Ecology, 1<sup>st</sup> Edition, 2009, Elsevier Academic Press

## **DEVELOPMENTAL BIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. List the types of characteristics that make an organism ideal for the study of developmental biology.
2. Familiar with the events that lead up to and comprise the process of fertilization.
3. Describe the stages and cellular mechanisms

4. Know the some of the traits useful for understanding the evolutionary relationships

### **COURSE CONTENTS:**

Introduction: Principle features of development, Patterns and Processes of Becoming: A Framework for Understanding Animal Development; Cellular differentiation and its genetic and molecular control; fertilization, cleavage, and morphogenesis of plants and animals; polarity and positional information; organogenesis and development of specialized tissues; evolution and development; Hormones as mediators of development; Regeneration in vertebrates

### **PRACTICALS:**

Chick-embryo culture techniques

### **RECOMMENDED BOOKS:**

1. Scott F. Gilbert, S., F and Michael J. F. Barresi, M. J. F. 2016. 11<sup>th</sup> Edition. Sinauer Associates, Inc.
2. Slack , J.M.W., 2013. Essential Developmental Biology, 3<sup>rd</sup> Edition, 2013, Willy and Sons
3. Wolpert ,L., Tickle , C., Arias, M.A., 2011. Principles of Development, 5<sup>th</sup> Edition Oxford Press

## **ENDOCRINOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**Students will be able to:**

1. Understand the different types of hormones and their control systems
2. Learn about the effect of changes in hormone levels on the endocrine system by which a hormone is controlled and function in this system

### **COURSE CONTENTS:**

Introduction to Endocrinology, Types of glands, Hormones types (amino acids derived, peptide, lipids), General account of chemical nature, biosynthesis, transport and mechanism of hormones, conceptual account of different types of signaling and transductions, Feedback regulation of hormonal homeostasis, Physiological actions of hormones of hypothalamus, anterior and posterior pituitary glands, thyroid gland, parathyroid gland, endocrine pancreas, adrenal cortex, adrenal medulla, gonads, corpus luteum, placental and other endocrine mechanism including hormones of pineal, thymus gland, atrial natriuretic hormone, hormones related to blood formation, renal and adipose tissue, Eicosanoids and growth factors, Stress response (Fight and flight response, The resistance reaction, Exhaustion, Stress and disease).

### **PRACTICALS:**

1. Demonstration of endocrine glands location in a dissected mouse/rat.
2. Histological study of endocrine glands.

3. Introduction and principle of ELISA (Enzyme Linked Immunosorbent Assay) for different types of hormones such as proteins and steroids.

### **RECOMMENDED BOOKS:**

1. Melmed, S., Polonsky, K.S., Larsen, P.R., Henry M. Kronenberg, H.M., 2002. Williams Textbook of Endocrinology. 12<sup>th</sup> Edition Philadelphia.
2. Becker, K.L., 2001. Principles and Practice of Endocrinology and Metabolism, 3<sup>rd</sup> Edition. Lippincott Williams & Wilkins.
3. Greenspan, F. S. and Strewler, G. J. 2004. Basic and Clinical Endocrinology. Prentice-Hall, New York, 2004.
4. Molina. P.E., 2013. Endocrine Physiology. 4<sup>th</sup> Edition, McGraw-Hill, Boston.

## **ENTREPRENEURSHIP**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

Students will be able to:

1. How to start their business.
2. About the opportunities, nature and function of the entrepreneur in the successful, commercial application of innovations
3. How to explore entrepreneurial leadership and management style
4. How to identify the requirements for building an appropriate entrepreneurial team

### **COURSE CONTENTS:**

Introduction to Entrepreneurship; Entrepreneurial Process; Business Opportunity Identification; Market Assessment; Financing the Emerging Firm; New Product Innovation; Technology Commercialization; Business Plan Development; Strategy and Entrepreneurship; Managing the growing firm.

### **PRACTICALS:**

1. Entrepreneurial project
2. Market / field surveys
3. Presentation of projects.
4. Motivational technical meetings/ lectures/ sessions/ discussions about Entrepreneurship

### **RECOMMENDED BOOKS:**

- 1 Burns, P., and Hurst, J.D., 2011. Small Business and Entrepreneurship, 3<sup>rd</sup> Edition 2011,
- 2 Max, K., Tamvada, P., Audretsch, J., Sustaining ,D.B., 2009. Entrepreneurship and Economic Growth. Springer.
- 3 David B. Audretsch , D. B., Max C. Keilbach, M., Erik E. Lehmann, E.E., 2006. Entrepreneurship and Economic Growth 1<sup>st</sup> Edition, Oxford University Press.
- 4 Drucker, P.F., 2006. Innovation and Entrepreneurship. Harper Business Publishers

- 5 Shimasaki, K., 2014. *Biotechnology Entrepreneurship: Starting, managing and leading Biotech companies*. Academic Press.

## **CURRENT ISSUES IN ENVIRONMENT CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

**Students will be able to:**

1. It will provide a framework with which students will understand environmental issues, environmental systems and their management .
2. Explain how environmental issues and management can be used as environmental protection

### **COURSE CONTENTS:**

The Atmosphere: Composition, Minor and major gases, Water in atmosphere, Aerosols, Global circulation pattern; Human Population: Population trends, Causes of population growth, Biological reasons, Social reasons, Increasing population and Anticipated changes; Drought and Famine: Types, Human responses to drought, Seasonal drought, Drought and Famine in different regions, Desertification; Pollution: Air pollution, Water pollution, Land pollution, Thermal pollution, Radiation pollution, Noise pollution; Acid Rain: Nature and Development, Source, Acid rain and Geology; Effects of Acid Rain on: Aquatic environment, Terrestrial environment, Built environment, Human health; Climate Change: Green House Effect and Global Warming; Global chilling, Green house effect, Green house gases, Changes in CO<sub>2</sub>- Carbon Cycle, Changes in temperature, Socioeconomic effect, Environmental effects; Ozone Depletion: Ozone-structure, Properties/Significances, Ozone destroying catalysts, Natural, Anthropogenic, Antarctic zone hole, Changing ozone Level, Impact on biosphere; Natural Resources and Reserves: Use, Renewable and Nonrenewable, Depletion and Management; Waste: Type, Disposal and Management; Biodiversity: Concept and Significance, Causes of extinction, Conservation practices, Biodiversity and Climate changes, Introduced species and their effects; Deforestation: Causes, Effects, Reforestation; Genetically Engineered Foods: Safety, Benefits, Public concerns, Food patents; Cloning, Use and Misuse, Threat to environment, Ethical and Religious reasoning; Natural Disasters: Earthquakes, Volcanoes, Lava, Cyclones, Tornadoes, Asian disasters (Tsunami disaster, Earthquake etc.)

### **RECOMMENDED BOOKS:**

1. Andrew, L., Stephen, H. and Paul, A. 2004. *Ecological Genetics*, Blackwell Publishing, M.A.
2. Aston, A., Harris, S. and Lowe, A. 2004. *Ecological Genetics: Planning and Application*, Blackwell Science, U.K.
3. Baker, A. J. 2000. *Molecular Methods in Ecology*, Blackwell Science, M.A.
4. Bradshaw, V. 2006. *The Building Environment: Active and Passive Control Systems*, 3<sup>rd</sup> Edition. John-Wiley and Sons Limited, N.J.

5. Cooper, G. J. 2003. *The Science of the Struggle for Existence (On the Foundation of Ecology)*, Cambridge University Press, U.K.
6. Costa, L. G. and Eaton, D. L. 2006. *Gene-Environment Interactions: Fundamentals of Ecogenetics*, John-Wiley and Sons Limited, N.J.
7. Freeland, J. R. 2005. *Molecular Ecology*, John-Wiley and Sons Limited, N.J.
8. Light, A. and Rolston, H., 2005. *Environmental Ethics*, Blackwell Publishers Ltd. U.S.A.
9. Louis, P. and Pojman, L. P. 2004. *Environmental Ethics: Readings in Theory and Application*, 4<sup>th</sup> Edition. Wadsworth Publishing, C.A.
10. Nico, M., Straalen, V. and Roelofs, D. 2006. *An Introduction to Ecological Genomics*, Oxford University Press, N.Y.
11. Raven, P. H. and Berg, L. R. 2005. *Environment*, 5<sup>th</sup> Edition, John-Willey and Sons Limited, N.J.
12. Wenz, P. S. 2001. *Environmental Ethics Today*, Oxford University Press, N.Y.

## **SOCIOLOGY**

**CREDIT HOURS 2+0**

### **LEARNING OUTCOMES:**

#### **The Student will be able to:**

1. Understand topics relevant to Sociology.
2. Understand causes for different behaviour in society and social institutions.
3. Understand how her/his role in society influences her/his own beliefs and behaviors
4. Learn about the ways in which social structures impose social control
5. Identify theories of society, and apply social theories to explain why social events occur

### **COURSE CONTENTS:**

Introduction: Sociology, the Science of Society, Scope and significance, Fields of Sociology, Sociology and other Social Sciences; Social interaction and social structure, Social Interaction, the Nature and Basis of Social Interaction; Social Processes, Social Structure, Status, Roles, Power and Authority and Role Allocation; Culture, Meaning and nature of culture, Elements of culture, Norms, values, beliefs, sanctions, and customs; Culture and Socialization Formal and non-formal socialization, and Transmission of Culture; Cultural Lag. Cultural Variation, Cultural Integration, Cultural Evolution, Cultural Pluralism Culture and personality; Deviance and social control, Deviance and conformity, Mechanism and techniques of social control, Agencies of social control; organization, Social organization-Definition, meaning and forms, Social groups — Types and functions of groups, Social Institutions: forms, nature and inter-relationship; Community: definition and forms (Urban and rural); Social change, Processes of social change, Social change and conflict, Social change and social problems,



Resistance to social change; Human ecology, Ecological processes, Ecological problems of Pakistan

## **RECOMMENDED BOOKS:**

As per HEC approved curriculum of sociology

## **LIST OF FOUNDATION COURSES**

1. Molecular Biology-I
2. Molecular Biology-II
3. Molecular Genetics
4. Immunology
5. Virology
6. Molecular Ecology
7. Bioinformatics
8. Basic techniques in molecular Biology
9. Enzymology
10. Introduction to omics
11. Biotechnology
12. Cell and tissue culture
13. Biosafety and Bioethics

## **DETAIL OF FOUNDATION COURSES**

### **MOLECULAR BIOLOGY-I**

**CREDIT HOURS 2+1**

#### **LEARNING OUTCOMES:**

**Students will be able to:**

1. Recognize the comparison of prokaryotic and eukaryotic genes and genomes.
2. Know about molecular genetics and how DNA and RNA work

#### **COURSE CONTENTS:**

Introduction to molecular biology and history; Chemical and physical properties of nucleic acids, The structure and function of DNA, RNA and Proteins; prokaryotic and Eukaryotic genes and genome, DNA packaging in chromatin and regulation of chromatin structure; Structure of chromosomes; Evolution of genomes (nuclear and organelle genome); Central dogma of molecular biology; DNA replication; Transcription; Translation; DNA repair including description of types of DNA damage, various DNA polymerases and different types of repair; DNA recombination; Transposable DNA elements.

#### **PRACTICALS:**

1. Extraction and purification of nucleic acids from different sources (bacteria, blood, plants, animal tissues) etc.
2. Qualitative and quantitative analysis of nucleic acids

## **RECOMMENDED BOOKS:**

1. Allison, L.A., 2011. Fundamental Molecular Biology. 2<sup>nd</sup> Edition. Wiley Sons.
2. Gerald Karp, G., Janet Iwasa, J., Wallace Marshall, W., 2016. Karp's Cell and Molecular Biology, 8<sup>th</sup> Edition .John Willey and Sons, Inc.
3. Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: **InTech** Janeza Trdine 951000 Rijeka, Croatia - European Union.
4. Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: In Tech Janeza Trdine 951000 Rijeka, Croatia - European Union.
5. Larramendy, M.L., and Soloneski, S., 2016. Nucleic Acids From Basic Aspects to Laboratory Tools Publisher: In Tech, Janeza Trdine 951000 Rijeka, Croatia - European Union.
6. Lodish., H., Berk, A., Kaiser, C.A. M. Krieger, M., Bretscher, A., Ploegh, H., Martin, K., 2016. Molecular Cell Biology. 8<sup>th</sup> Edition. W.H. Freeman.
7. Old R. W. and Primrose, S.B., 1994. An Introduction to Genetic Engineering, Blackwell Scientific Publications.
8. Watson, J.D., Gann, A., Levine, M., Losicks, R., 2013. Molecular Biology of the Gene. The Benjumen Cummings Publishing Company, California
9. Wilson, J. and Hunt, T., 2015. Molecular Biology of the Cell. 6<sup>th</sup> Edition Garland Sciences, Taylor and Francis.

## **MOLECULAR BIOLOGY II**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Know about the gene regulation and gene expression.
2. Understand the processes of transcription and translation

### **COURSE CONTENTS:**

Over view of regulation of gene expression. Regulatory sequences, transcription factors, Regulation of gene expression in prokaryotes (operon systems), eukaryotic gene regulation, Transcriptional control of gene expression (RNA polymerases, regulatory sequences, activators and repressors of transcription; genetic switches, transcription initiation, molecular mechanisms of transcription repression and activation, regulation of transcription factor activity); post-transcriptional controls (processing and transport of pre-mRNA, cytoplasmic mechanisms of post-transcriptional control, processing of rRNA and tRNA); Bacterial protein synthesis and regulation; Eukaryotic protein synthesis and regulation; post translational modification; non coding RNAs

### **RECOMMENDED BOOKS:**

- 1 Allison, L.A., 2011. Fundamental Molecular Biology. 2<sup>nd</sup> Edition. Wiley Sons.

- 2 Gerald Karp, G., Janet Iwasa, J., Wallace Marshall, W., 2016. Karp's Cell and Molecular Biology, 8<sup>th</sup> Edition. John Willey and Sons, Inc.
- 3 Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: **InTech** Janeza Trdine 951000 Rijeka, Croatia - European Union.
- 4 Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: In Tech Janeza Trdine 951000 Rijeka, Croatia - European Union
- 5 Larramendy, M.L., and Soloneski, S., 2016. Nucleic Acids From Basic Aspects to Laboratory Tools Publisher: In Tech, Janeza Trdine 951000 Rijeka, Croatia EUROPEAN UNION
- 6 Lodish., H., Berk, A., Kaiser, C.A. M. Krieger, M., Bretscher, A., Ploegh, H., Martin, K., 2016. Molecular Cell Biology. 8<sup>th</sup> Edition. W.H. Freeman.
- 7 Old R. W. and Primrose, S.B., An Introduction to Genetic Engineering, Blackwell Scientific Publications.
- 8 Watson, J.D., Gann, A., Levine, M., Losicks, R., 2013. Molecular Biology of the Gene. The Benjumen Cummings Publishing Company, California
- 9 Wilson, J. and Hunt, T., 2015. . Molecular Biology of the Cell. 6<sup>th</sup> Edition Garland Sciences, Taylor and Francis.

## **MOLECULAR ECOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Understand the scientific methods and specific applications of molecular ecology, covering phylogeography, behavioural ecology and conservation genetics
2. Develop a generalized molecular knowledge in ecological, geological, chemical and biological concepts related to the environment.

### **COURSE CONTENTS:**

Molecular Markers: Marker types, new marker development, advantages and disadvantages of specific markers; Genome Evolution: Components of genomes, whole genome duplications, chromosome rearrangements, repetitive sequence evolution; Population Genetics: Population migrations and phylogeography, Understanding patterns of geographical variation within species; rates and patterns of dispersal and migration; responses to climate change; Measures of genetic diversity, inbreeding, quantitative traits; Speciation and Hybrid Zones :Hybridization, dispersal and gene flow; Tracing of evolutionary patterns and phylogeny; Molecular Approaches in Behavioural Ecology: Mating systems and mate choice, Recognising kin, Genes of ecological importance; Conservation Genetics: An outline of the ways in which genetic data (QTLs and marker loci) can contribute to conservation biology. Examples: cheetahs, Asiatic lions, red wolf, whales, turtles, birds, brown bears, mahogany, primroses and orchids; Environmental Genomics,

## **PRACTICALS:**

1. Use of PCR based methodology for identification of molecular markers
2. Phylogenetic analysis
3. *In silico* estimate of population genetic structure to the use of DNA-based phylogenies in conservation genetics

## **RECOMMENDED BOOKS:**

- 1 Collin, S. 2013. The Race to Commercialize Biotechnology: Molecules, Market and the State in Japan and the US. Routledge, USA.
- 2 Mehta, S., S. 2011. Commercializing Successful Biomedical Technologies Basic Principles for the Development of Drugs, Diagnostics and Devices, Cambridge University Press.
- 3 Tapash, K., Ghosh, T. K., and Pfister, W. R. 2005. Drug Delivery to the Oral Cavity: Molecules to Market (Drugs and the Pharmaceutical Sciences), Taylor and Francis group, LLC.

## **GENERAL VIROLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Major components of viruses, System of traits used for classification of viruses.
2. How viruses interact with cells.
3. Ways that viruses persist in host cells.

### **COURSE CONTENTS:**

Principles of electron microscopy; Origin and evolution of viruses; Nature of animal and plant viruses; Classification: structural and functional groups; Cell culture: various types of cell lines (plants and animals); Replication of viruses (RNA & DNA); Principles of viral diagnostic procedures; Introduction to bacterial viruses; Receptors for bacteriophages, somatic, non-somatic viruses and sex specific viruses. Adsorption sites and mode of replication. Transducing viruses of eukaryotes and cross-phylogenetic transfer; Prion and viroid; Origin of life and Evolution.

### **PRACTICALS:**

1. Molecular detection and quantification of viruses.
2. Heme-agglutination Inhibition assays.
3. Chick embryo for propagation of virus and titration.
4. Plaque assay.
5. Transmission electron microscopy (virtual presentation, field trip).
6. Sample preparation for electron microscopy.
7. Isolation and identification of phages from various sources.

### **RECOMMENDED BOOKS:**

1. Brian, W., Mahy, B. and Mahy, W. 2001. A Dictionary of Virology, Academic Press, U.S.A.

2. Burrell, C.J., Howard, C.R., Murphy, F.A., 2016. Fenner and White's Medical virology. Publishers. Academic Press.
3. Cann, A. J. 2000. Virus Culture: A Practical Approach, Oxford University Press, N.Y.
4. Cann, A. J. 2012. Principles of Molecular Virology, Elsevier Science & Technology Book.
5. Carter, J., Venetia A. Saunders, V.A., 2007. Virology: Principles and Applications .John Wiley and Sons, N.Y.
6. Dimmock, N.J., Easton, A.J., Leppard, K.N., 2015. Introduction to Modern Virology. John Wiley and Sons, N.Y.
7. Edward, K. W., Martinez, J. H., David, C. B., David, C. Basic Virology. 3<sup>rd</sup> Edition. Blackwell Science.
8. Flint, S. J., Enquist, L. W., Racaniello, V. R. and Skalka, A. M. 2003. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. 2<sup>nd</sup> Edition, American Society for Microbiology, Washington, D.C.
9. Griffin, R., Martin, M.A, Straus, H., Griffin, D.E., Robert, G., Lamb, A., Howley, P.M., Roizman ,B., Straus, S. E. and David, M. 2001. Fundamental Virology, Lippincot Williams and Wilkins, M.D.
10. Howley, P. M., Roizman, B., Straus, S. E., Martin, M. A. and Griffin, D. E. 2001. Fundamental Virology, Lippincot Williams and Wilkins, M.D.
11. Hull, R., 2014. Plant Virology. Elsevier Science & Technology Book
12. Krug, R., Racaniello, V., Lynn W. E, Vincent Racaniello, R., Enquist, L.W. and Flint S.J. 1999. Principles of Virology: Molecular Biology, Pathogenesis and Control, American Society for Microbiology, Washington, D.C.
13. Nigel, J. J., Dimmock, K. L. and Andrew, E. 2001. 6<sup>th</sup> Edition. Introduction to Modern Virology, Blackwell Science, Inc. U.S.A.
14. Wagner, E. K. and Hewlett, M.J. 2003. Basic Virology, Blackwell Publishers, U.S.A.
15. Zuckerman, A.J., Banatvala, J.E., Pattison, J.R., Griffiths, P. and Schoub, B. 2004. Principles and Practice of Clinical Virology, 5<sup>th</sup> Edition. John Wiley and Sons, N.Y.

## **GENERAL IMMUNOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. To provide a greater understanding of the role of the immune system in preventing human disease and to focus on how deficiencies in immunity can result in disease susceptibility
2. To understand basis of immunity and cells and organs involved in acquired immunity.
3. To understand the role of antibodies and induction of antibody response to antigens.

## **COURSE CONTENTS:**

Introduction: chronological development and scope of immunology; Immunity and immune responses: Definitions and types (specific and non-specific). Humoral and cellular immunity; Introduction to complement system; Cells and tissues of immune system; The antigens: structure (simple and complex molecules, proteins and polysaccharides) and immunogenicity; Tissue antigens: the Allo- and heterophile antigens. The ABO and RH blood group systems, their chemical basis, inheritance & clinical significance. Immunoglobulin: structure and function; classes, subclasses, types and subtypes; immunoglobulin genetics; Immune response to an antigen; Introduction to antigen-antibody reactions: methods for detecting antigens and antibodies (agglutination, precipitation, complement fixation, EIA, etc.); Introduction to HLA & MHC and its role in immune response, disease and its significance in tissue transplantation; Immune-regulation and tolerance; Introduction to Cancer immunology; introduction to immunopathology: hypersensitivity reactions; autoimmune diseases and immunodeficiencies; Immunization (methods of immunization, vaccines and adjuvants).

## **PRACTICALS:**

1. Total and Differential leukocyte count.
2. Blood grouping (ABO & Rh).
3. Immuno-diagnostic Methods.
4. Agglutination test (Widal test).
5. Precipitation tests.
6. Gel diffusion test.
7. ICT Test.

## **RECOMMENDED BOOKS:**

1. Abbas, A. K., Lichtman, A. H. and Pillai, S. 2007. Cellular and Molecular Immunology, Elsevier Health Sciences, N.Y.
2. Abbas, A. K., Lichtman, A. H. and Pillai, S. 2012. Basic Immunology Functions and Disorders of the Immune System. 4<sup>th</sup> Edition.
3. Chen, E. R. and Kasturi, S. 2006. Deja Review: Microbiology and Immunology, McGraw-Hill Companies, N.Y.
4. Janeway, C., Travers, P., Walport, M. and Shlomchik, M. 2004. Immunobiology: The Immune System in Health and Disease, Taylor & Francis Inc., London.
5. Johnson, A. G. G., Ziegler, R. J., Lukasewycz, O. A. and Lukasewycz, O. A. Microbiology and Immunology: Board Review Series, Lippincot Williams and Wilkins, M.D.
6. Lichtman, A. H. 2007. Basic Immunology. Elsevier Health Sciences, N.Y.
7. Murphy, K., and Weaver, C., 2016. Janeway's Immunobiology. Garland Science.
8. Parham, P., 2015. The Immune System, 4<sup>th</sup> Edition. Garland Science.
9. Paul, W.E. 2013. Fundamental Immunology, 6<sup>th</sup> Edition. Lippincot Williams and Wilkins, M.D.

10. Thomas, J. K., Richard, A. G., Barbara, A., O., Janis, K., 2013. Kuby Immunology. 7<sup>th</sup> Edition.
11. Emon, V. M. 2006. Immunoassay and Other Bioanalytical Techniques, CRC Press, F.L.

## **BIOINFORMATICS**

**CREDIT HOURS (1+2)**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

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

### **COURSE CONTENTS:**

Introduction; 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.

### **PRACTICALS:**

1. NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc.
2. Bioedit, Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer 3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0 etc.

### **RECOMMENDED BOOKS:**

1. Egelhofer, V., 2016. Textbook Bioinformatics; Volume 1, Herstellung und virlag BoD Norderstedt, Germany.
2. Claverie, J.M. and Notredame, C., 2006. Bioinformatics for Dummies; 2<sup>nd</sup> Edition; Wiley Publishing, USA.
3. Xiong, J., 2006. Essential Bioinformatics; 1<sup>st</sup> Edition; Cambridge University Press, UK.
4. Xia, X., 2007. Bioinformatics and the Cell: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics; 1<sup>st</sup> Edition, Springer, USA.
5. Mathura, V. and Kanguane, P., 2009. Bioinformatics: A Concept-Based Introduction; Springer, USA.
6. Mount, D.W., 2004. Bioinformatics Sequence and Genome Analysis. 2<sup>nd</sup> Edition, Cold Spring Harbor Laboratory Press.
7. Sperschneider, V., 2008. Bioinformatics: Problem Solving Paradigms; Springer, USA.

8. Loging, W.T., 2016. Bioinformatics and Computational Biology in Drug Discovery and Development; 1<sup>st</sup> Edition, Cambridge university press UK.
9. Setubal, J.C. and Almeida, N.F., 2010. Introduction to Bioinformatics Using Bacterial Genomics; 1<sup>st</sup> Edition, Springer, USA.
10. Jopp, F., Lange, C. and Goesmann, A., 2017. Computational Biology; 1<sup>st</sup> Edition, Springer Spektrum, Berlin Heidelberg

## **ENZYMOLGY**

**CREDIT HOURS 2+1**

### **LEARNING OBJECTIVES:**

#### **Students will be able to:**

1. Gain knowledge about the classification of enzymes.
2. Understand the mechanism of action of enzymes, the construction and purpose of the important parts of the enzyme molecule.
3. Understand the basics of enzyme kinetics, pathways , mechanisms of their control and the importance of the parameters describing the kinetics.

### **COURSE CONTENTS:**

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, multi-enzyme system and bi-substrate reactions, catalytic mechanisms, regulatory enzymes, immobilized enzyme and enzyme assays; Chromatography (gel filtration, ion exchange)

### **PRACTICALS:**

1. Extraction and estimation of enzymes from different sources.
2. Acid and enzymatic hydrolysis of glycogen and starch.
3. Biosynthesis of enzymes by fungi and bacteria.
4. Effect of Temperature on enzymes stability and activity.
5. Effect of Substrate concentration on enzyme activity.
6. Effect of Enzyme concentration on enzyme activity.
7. Effect of pH on enzyme activity.

### **RECOMMENDED BOOKS:**

1. Bisswange, H., 2011. Practical Enzymology. Wiley-VCH. Publishers.
2. Bowden, A.C., 2012. Fundamentals of Enzyme Kinetics 4<sup>th</sup> Edition. Wiley-Blackwell.
3. Okotore, R.O., 2015. Essentials of Enzymology. publisher XLIBRIS.
4. Sauro, M.H., 2012. Enzyme Kinetics for Systems Biology Ambrosius Publishing
5. Voet, D., Voet, J. G. and Pratt, C. W., 2002. Fundamentals of Biochemistry; John Willey and Sons. Inc., New York.



**LEARNING OUTCOMES:****Students will be able to:**

1. Learn how to develop micro-environment and which factor will affect tissue culture outcomes.
2. Describe/practice sterile methods to avoid microbial contaminations.
3. Gain knowledge of organogenesis and embryogenesis protocols and differences between them.

**COURSE CONTENTS:**

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.

**PRACTICALS:**

1. Culture media preparation.
2. Starting a primary culture (tissue digestion, cell count and cell culture).
3. Maintenance of a cell line.
4. Cryopreservation of cell line.
5. Plant cell culture (callus induction , suspension culture)
6. Vital staining.
7. Organ culture.

**RECOMMENDED BOOKS:**

1. Al-Rubeai, M. 2014. Animal cell culture. Cham : Springer.
2. Barnum, S. 2004. Biotechnology: An Introduction, Brooks Cole, U.S.A.
3. Christou, P. and Harry, K. H. 2004. Handbook of Plant Biotechnology, John Wiley and Sons, N.Y.
4. Doyle, A. and Griffiths, J. B. 1998. Cells and Tissue Culture: Laboratory Procedures in Biotechnology, John Willey and Sons, N.Y.
5. Freshney, I. I. 2000. Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, N.Y.
6. Gayatri, M. C., & Kavyashree, R. 2015. Plant tissue culture: Protocols in plant biotechnology. Oxford: Alpha Science Intl.
7. Jennie, P. M. and Penelope, E. R. Introduction to Cell and Tissue Culture; Theory and Technique.1998. Plenum Press, New York.

8. Nelson, C. M. 2015. Tissue morphogenesis: Methods and protocols. Humana Press. New York.
9. Sharma, V., and Alam, A. 2015. Plant tissue culture. I K International Publish. New Delhi .

## **BIOSAFETY AND BIOETHICS**

**CREDIT HOURS 2+0**

### **LEARNING OUTCOME:**

#### **Students will be able to:**

1. The concepts, principles, and elements of bioethics related to molecular biology
2. Good laboratory procedures and practices.
3. The standard operating procedures for biotechnology research and assign Biosafety levels
4. Design confinement facilities at different biosafety levels
5. Intellectual property right to modern biotechnological innovations.

### **COURSE CONTENTS:**

Introduction to Biosafety risks related to genetically modified organisms (GMO) and biohazards; Concepts of Biosafety Environment: Terrestrial, Marine, Atmosphere; good laboratory practices; Designing of labs based on Biosafety and Biological Containment parameters; Details of Biological Containment: Plants, Animals, Microbes; Bioethical issues related to Biosafety; biosafety guidelines from a national perspective; Introduction to Bioethics definition, concept, uses and abuses of genetic information; ethical issues related to Molecular Biology; Role of national bioethics committees; international rules and regulations for biosafety and bioethics. Intellectual property right.

### **RECOMMENDED BOOKS:**

1. Altman, A and Hasegawa P.M, 2012. Plant Biotechnology and Agriculture: Prospects for the 21<sup>st</sup> Century. 1<sup>st</sup> Edition; Academic Press.
2. Deepa, G. 2013. IPR, Biosafety and Bioethics. Pearson publishing, NY United States of America.
3. Katherine, H. M and Peter, S., 2008 Agrobacterium from biology to biotechnology Chapter: The Bioethics and Biosafety of gene transfer. Publisher Springer, NY USA
4. Raj M. J., 2006. Biosafety and Bioethics published by Isha Books/Gyan Books Pvt Ltd, India.
5. Sateesh M .K., 2009. Bioethics and Biosafety published. IK International Publishing House Pvt Ltv. India.
6. Sree, K. V., 2007. Bioethics and Biosafety in Biotechnology. New Afe International Publisher, India.
7. Ramamurthi, R., & Geethabali, 2016. Bioethics and biosafety. APH Publishing Corporation. New Delhi.

## INTRODUCTION TO OMICS

CREDIT HOURS 3+0

### LEARNING OUTCOMES:

#### Students will be able to:

1. Specific scientific methods within post-genomic molecular life.
2. Tools and databases used in *Omics*

### COURSE CONTENTS:

Introduction to omes, Basis, principles and application of various omics disciplines: genomics, transcriptomics, metabolomics, proteomics, overview of major techniques in omics with special emphasis on metabolomics (GCMS, NMR, LCMS). *In silico* methods in omics analysis.

### RECOMMENDED BOOKS:

1. Barh, D., Khan, M. S., & Davies, E. 2015. Plant Omics: The omics of plant science: Springer.
2. Kahl, G., & Kahl, G. (2009). The dictionary of genomics, transcriptomics and proteomics. Weinheim: Wiley-VCH.
3. Primrose, S. B., & Twyman, R. 2011. Principles of Gene Manipulation and Genomics, 8<sup>th</sup> Edition. John Willey & Sons.
4. Thangadurai, D., & Sangeetha, J. 2015. Genomics and proteomics: Principles, technologies, and applications.
5. Twyman, R. M. 2004. Principles of proteomics. New York: BIOS Scientific Publishers.

## BIOTECHNOLOGY

CREDIT HOURS 2+1

### LEARNING OUTCOMES:

#### Students will be able to:

1. About the conventional and modern biotechnology
2. How to apply these techniques in bioprocessing

### COURSE CONTENTS:

Concepts, historical background, conventional and modern biotechnology: kinds of biotechnology, Plant biotechnology: plant tissue culture and GM Crops. Animal biotechnology; Environmental Biotechnology: Bioremediation. Biological control. Industrial biotechnology: fermentation techniques, bio products, (enzymes, amino acids etc). Medical biotechnology: diagnostic tools, health care products. Aquatic biotechnology: aqua culture, and sea food resources. Bioprocessing. Economic perspectives of biotechnology. Biotech COs and Bio Industries. Future challenges in biotechnology.

### PRACTICALS:

1. Screening of lipase, protease, amylase producing bacteria
2. Different aqua culture techniques
3. Plant/animal tissue culture technology
4. Bio degradation, toxic chemicals especially aromatics (pesticides & crude oil components)

5. Bio accumulation/Bio absorption of heavy metals by bacteria, fungi, protozoa, and plants.
6. Solubilization of insoluble metal complexes.
7. Production of bio polymers.

### **RECOMMENDED BOOKS:**

1. Thiemann, W. J., Palladino, M. A., 2012; Introduction to biotechnology 3<sup>rd</sup> Ed, Benjamin Pearson publishers.
2. Khan, F. A. 2016. Biotechnology fundamentals. CRC Press, Taylor & Francis Group, CRC Press
3. Stevens, H. 2016. Biotechnology and society: An introduction . University of Chicago Press. Chicago.
4. Phillips, P. W. B., Castle, D., & Smyth, S. J. 2016. Biotechnology, agriculture and development. A Cheltenham: Edward Elgar Publishing
5. Okafor, N. 2016. Modern Industrial Microbiology and Biotechnology. CRC Press

## **BASIC TECHNIQUES IN MOLECULAR BIOLOGY**

**CREDIT HOURS 1+2**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Learn about the skills necessary in the Molecular biology
2. Apply research-based theories to solve problems related to molecular biology
3. Know about centrifugation, electrophoresis, blotting techniques

### **COURSE CONTENTS:**

Different types of centrifugations. Different techniques used for gene amplification; Primer designing polymerase chain reaction (PCR) types; (inverse, touchdown, nested, hemi nested, pit stop, multiplex, reverse transcriptase) and its applications; detection of mutations and/or SNPs; restriction fragment length polymorphism ; analysis of nucleic acids by gel electrophoresis horizontal, vertical, pulse field, denaturing gradient gel electrophoresis; analysis of proteins by native and SDS gels; generation of antibodies and their uses; enzyme-linked immunosorbant assay; Southern, Western, Northern blotting, Protein purification by different chromatographic techniques, Sanger sequencing.

### **PRACTICALS:**

1. Preparation of stock and working solutions
2. Isolation of nucleic acids and their quantification
3. Gel electrophoresis
4. Polymerase chain reaction (PCR)
5. Detection of mutations by restriction fragment length polymorphism and SSCP
6. Preparation of chemically competent cells
7. Transformation of bacteria with plasmid DNA

## 8. Analysis of proteins by SDS-PAGE

### **RECOMMENDED BOOKS:**

1. Allison, L.A., 2011. *Fundamental Molecular Biology*. 2<sup>nd</sup> Edition. Wiley Sons.
2. Arora, D. K., Das, S., & Sukumar, M. (2013). *Analyzing microbes: Manual of molecular biology techniques*. Berlin: Springer.
3. Arora, D.K., Das, S. and Sukumar, M., 2013. *Analyzing Microbes, Manual of Molecular Biology Techniques*; Springer-Verlag Berlin Heidelberg.
4. Carson, S., Miller, H. B., & Witherow, D. S. 2012. *Molecular biology techniques: A classroom laboratory manual*. Amsterdam: Elsevier /Academic Press.
5. Espina, V. and Liotta, L., 2012. *Molecular Profiling: Methods and Protocols*; Volume 823, Springer Science+Business Media, LLC.
6. Gerald Karp, G., Janet Iwasa, J., Wallace Marshall, W., 2016. *Karp's Cell and Molecular Biology*, 8<sup>th</sup> Edition . John Willey and Sons, Inc.
7. Gupta, V.K., Tuohy, M., Turner, K.M. and O'Donovan, A., 2013. *Laboratory Protocols in Fungal Biology*; Springer-Verlag New York.
8. Kormann, M.S.D., 2016. *Modern Tools for Genetic Engineering*. Publisher: **InTech** Janeza Trdine 951000 Rijeka, Croatia - European Union.
9. Kormann, M.S.D., 2016. *Modern Tools for Genetic Engineering*. Publisher: In Tech Janeza Trdine 951000 Rijeka, Croatia European Union
10. Larramendy, M.L., and Soloneski, S., 2016. *Nucleic Acids From Basic Aspects to Laboratory Tools* Publisher: In Tech, Janeza Trdine 951000 Rijeka, Croatia - European Union
11. Lodish., H., Berk, A., Kaiser, C.A. M. Krieger, M., Bretscher, A., Ploegh, H., Martin, K., 2016. *Molecular Cell Biology*. 8<sup>th</sup> Edition. W.H. Freeman.
12. Old R. W. and Primrose, S.B.,1994. *An Introduction to Genetic Engineering*, Blackwell Scientific Publications.
13. Seymour, G.J., Cullinan, M.P. and Heng, N.C., 2010. *Oral Biology; Molecular Techniques and Applications*; 1<sup>st</sup> Edition, Humana Press.
14. Surzycki, S. (2000). *Basic Techniques in Molecular Biology*. Berlin: Springer.
15. Walker, J.M. and Gaastra, W., 1987. *Techniques in Molecular Biology*; Volume 2, Springer US.
16. Watson, J.D., Gann, A., Levine, M., Losicks, R., 2013. *Molecular Biology of the Gene*. The Benjumen Cummings Publishing Company, California
17. Wilson, J. and Hunt, T., 2015. *Molecular Biology of the Cell*. 6<sup>th</sup> Edition Garland Sciences, Taylor and Francis.

## **LIST OF MAJOR COURSES**

1. Advanced Techniques in Molecular Biology
2. Gene Therapy
3. Cell Signaling
4. Recombinant DNA Technology
5. Molecular Evolution
6. Genomics
7. Transcriptomics
8. Proteomics
9. Molecules to the Market
10. Molecular Diagnostics
11. Quantitative Biology
12. Skills and Research Methodology
13. Immunogenetics
14. Molecular Toxicology
15. Molecular Pharmacology
16. Bionanotechnology
17. Research Project/Internship

## **DETAIL OF MAJOR COURSES**

### **ADVANCE TECHNIQUES IN MOLECULAR BIOLOGY**

**CREDIT HOURS 1+2**

#### **LEARNING OUTCOME:**

**Students will be able to:**

1. The advance skills necessary in the Molecular biology.
2. How to construct cDNA libraries

#### **COURSE CONTENTS:**

RNA extraction and quantification, cDNA synthesis and library, expressed sequence tag, quantitative Real time PCR, DNA fingerprinting, genotyping, ISH, FISH, Microarray, laser capture microdissection, immune - histochemistry, immune-precipitation, 2D gel, ChIP on Chip, Chip sequencing, NGS, CRISPR, Flow cytometry; Somatic cell and radiation hybrids; artificial chromosomes in bacteria and yeast. High resolution melting analysis.

#### **PRACTICALS:**

1. RNA isolation and quantification
2. cDNA synthesis by Reverse transcriptase
3. Real time PCR
4. DNA Finger printing techniques

#### **RECOMMENDED BOOKS:**

1. Arora, D. K., Das, S., & Sukumar, M. 2013. Analyzing microbes: Manual of molecular biology techniques. Berlin: Springer.

2. Arora, D.K., Das, S. and Sukumar, M., 2013. Analyzing Microbes, Manual of Molecular Biology Techniques; Springer-Verlag Berlin Heidelberg.
3. Carson, S., Miller, H. B., & Witherow, D. S. 2012. Molecular biology techniques: A classroom laboratory manual. Amsterdam: Elsevier /Academic Press.
4. Espina, V. and Liotta, L., 2012. Molecular Profiling: Methods and Protocols; Volume 823, Springer Science+Business Media, LLC.
5. Gerald Karp, G., Janet Iwasa, J., Wallace Marshall, W., 2016. Karp's Cell and Molecular Biology, 8<sup>th</sup> Edition . John Willey and Sons, Inc.
6. Gupta, V.K., Tuohy, M., Turner, K.M. and O'Donovan, A., 2013. Laboratory Protocols in Fungal Biology; Springer-Verlag New York.
7. Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: Janeza Trdine 951000 Rijeka, Croatia European Union.
8. Kormann, M.S.D., 2016. Modern Tools for Genetic Engineering. Publisher: In Tech Janeza Trdine 951000 Rijeka, Croatia - European Union
9. Larramendy, M.L., and Soloneski, S., 2016. Nucleic Acids From Basic Aspects to Laboratory Tools Publisher: In Tech, Janeza Trdine 951000 Rijeka, Croatia European Union
10. Lodish., H., Berk, A., Kaiser, C.A. M. Krieger, M., Bretscher, A., Ploegh, H., Martin, K., 2016. Molecular Cell Biology. 8<sup>th</sup> Edition. W.H. Freeman.
11. Old R. W. and Primrose, S.B., 1994. An Introduction to Genetic Engineering, Blackwell Scientific Publications.
12. Seymour, G.J., Cullinan, M.P. and Heng, N.C., 2010. Oral Biology; Molecular Techniques and Applications; 1<sup>st</sup> Edition, Humana Press.
13. Surzycki, S. (2000). Basic techniques in molecular biology. Berlin: Springer.
14. Walker, J.M. and Gaastra, W., 1987. Techniques in Molecular Biology; Volume 2, Springer US.
15. Watson, J.D., Gann, A., Levine, M., Losicks, R., 2013. Molecular Biology of the Gene. The Benjumen Cummings Publishing Company, California
16. Wilson, J. and Hunt, T., 2015. Molecular Biology of the Cell. 6<sup>th</sup> Edition Garland Sciences, Taylor and Francis

## **GENE THERAPY**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. About disease that might be treatable by gene therapy
2. The differences between somatic and germline gene therapy and some of the problems involved in these potential treatments

### **COURSE CONTENTS:**

Introduction, therapeutic nucleic acids, Germ line gene therapy, somatic gene therapy, Viral and non-viral systems used for therapy. Clinical applications of

gene therapy (Cystic fibrosis, familial hypercholesterolemia, cancer, infectious diseases, ADA deficiency) human trials of gene therapy. Ethical and regulatory considerations. Future prospects.

### **RECOMMENDED BOOKS:**

1. Nancy, S. T. 2015. Gene and cell therapy: Therapeutic Mechanisms and strategies, 4<sup>th</sup> Edition. CRC Press, United States of America.
2. Sherman, D. 2014. Gene Transfer, Gene therapy and genetic pharmacology: Principles, delivery and pharmacological and biomedical applications, National Scientific Research Centre (CNSR) ICP Text Books France
3. Joseph P. P. 2014. Gene therapy: treating disease by repairing genes. Info Base Publishing. United Kingdom.
4. Perin, E. C., Miller, L. W., Taylor, D. A., & Willerson, J. T. 2016. Stem cell and gene therapy for cardiovascular disease. Waltham, MA : Academic Press

## **CELL SIGNALING**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

**Students will be able to:**

1. Describe the major mechanisms of cell-cell signaling.
2. Identify the major receptor types, their localization and function in response to the signaling molecules.
3. List the molecular events which occur within the cell in response to the major groups of signaling molecules and their overall physiological outcomes.

### **COURSE CONTENTS:**

General principles of cell communication (Ligands and Receptors, Cellular Junctions and direct cell to cell communication, Specificity of ligands and receptors and signal amplification, Feedback loops), Signaling through G-Protein-Coupled receptors, Signaling through enzyme-coupled cell surface receptors (Receptor Tyrosine Kinases, Ras family of G-proteins, MAP Kinase signaling, PI3K signaling, Rho family of GTPases, JAK-STAT signaling, TGF- $\beta$  superfamily), Signaling pathways dependent upon regulated proteolysis of distinct proteins (Notch Signaling, Wnt- $\beta$ -Catenin, Hedgehog-Smoothed signaling, NF- $\kappa$ B-Dependent signaling pathway), Role of secondary messenger in signaling (Ca, Nitrous oxide, ROS), and Signaling in plants.

### **RECOMMENDED BOOKS:**

1. Karp, J. H. 2016. Cell and Molecular Biology. John Willey and Sons, Inc. New York. USA.
2. Kramer, I. M., 2015. Signal Transduction. Elsevier Science, Academy Press, London.
3. Cantley, L. C., Hunter, T., Sever, R. and Thorner, J. W., 2014. Signal Transduction: Principles, Pathways, and Processes. Cold Spring Harbor Laboratory Press, New York, USA.



4. Gomperts, B. D., Kramer, I. M. and Tatham, P. E. R., 2009. Signal Transduction; Elsevier Science. Academy Press, London, UK.
5. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P. 2014. Molecular Biology of the Cell; 6<sup>th</sup> Edition, Garland Sciences, New York, USA.
6. Wilson, J. and Hunt, T., 2014. Molecular Biology of the Cell, 6<sup>th</sup> Edition, Garland Sciences, New York, USA.
7. Marks, F., Klingm-Uller, U. and Müller-Decker, K., 2008. Cellular signal processing: An Introduction to the Molecular Mechanisms of Signal Transduction. Garland Science, New York, USA.
8. Cooper, G. M., & Hausman, R. E. 2013. The cell: A molecular approach. Sunderland, MA: Sinauer Associates.
9. Botella, J. R., & Botella, M. A. 2016. Plant signal transduction: Methods and protocols. New York: Humana Press.

## **RECOMBINANT DNA TECHNOLOGY      CREDIT HOURS 2+1**

### **LEARNING OUTCOME:**

#### **Students will able to:**

1. Understand basic principles of recombinant DNA technology.
2. Explore applications of recombinant DNA technology in medical and industrial settings.

### **COURSE CONTENTS:**

Introduction and scope; Restriction and modification system, Properties of restriction endonucleases, their occurrence and recognition sequences, Assay procedures for restriction endonucleases and slab gel electrophoresis; In vitro genetic engineering; cloning vehicles: plasmids, cosmids and phagemids, YAC and BAC etc; Cloning strategies: Labeling methods of probes, Construction of genomic libraries; Methods for screening the clones; PCR and its application in cloning; prokaryotes and Eukaryotes Expression systems; DNA sequencing; Genetic Transformation system; Gene Knock down, Knock out and knock in.

### **PRACTICALS:**

1. Methods of nucleic acid isolation (DNA & RNA).
2. Slab gel electrophoresis.
3. Restriction enzyme digestion of DNA.
4. Transformation systems
5. Electro blotting.

### **RECOMMENDED BOOKS:**

1. Brown, T. A., 2016. Gene Cloning and DNA Analysis: An Introduction; 7<sup>th</sup> Edition, John Wiley and Sons Ltd., Chicester, UK.
2. Glick, B. R., Pasternak, J. J. and Cheryl L. Patten, C. L. 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA; 4<sup>th</sup> Edition, ASM Press, Washington, USA.

3. Green, M. R. and Sambrook, J. 2012. Molecular Cloning: A Laboratory Manual; 4<sup>th</sup> Edition, Cold Spring Harbor Laboratory Press, New York, USA.
4. Howe, H. 2007. Gene Cloning and Manipulation, Cambridge University Press, New York, USA.
5. Jeremy W. Dale, J. W., Malcolm von Schantz, M. V. and Plant, N. 2011. From Genes to Genomes: Concepts and Applications of DNA Technology; 3<sup>rd</sup> Edition, John Wiley and Sons Ltd., Chichester, UK.
6. Nicholl, D. S. T. 2008. An Introduction to Genetic Engineering; 3<sup>rd</sup> Edition. Cambridge University Press, Singapore.
7. Old, R. W. and Primrose, S. B. 2009. Principles of Gene Manipulation, an Introduction to Genetic Engineering, 5<sup>th</sup> Edition, Blackwell Scientific Publications, USA.
8. Primrose, S. B. and Twyman, R. M. 2015. Principles of Gene Manipulation and Genomics; 8<sup>th</sup> Edition, Wiley-Blackwell, Oxford, UK.
9. Watson, J. D., Meyers, R. M., Caudy, A. A. and Witkowski, J. A. 2007. Recombinant DNA: Genes and Genomes - A Short Course; 3<sup>rd</sup> Edition, Cold Spring Harbor Laboratory Press, New York, USA.
10. Watson, R. R., & Preedy, V. R. 2016. Genetically modified organisms in food: Production, safety, regulation and public health. Amsterdam: Elsevier Science.

## **GENOMICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Define organization and structure of genomes.
2. Distinguish between genetic and physical maps.
3. Describe the different techniques used for sequencing a genome.

### **COURSE CONTENTS:**

Organization and structure of genomes; genome sequencing genetic mapping (RFLP, microsatellite, SNP) high resolution physical mapping (STS, EST); comparative genomics and genome evolution, hierarchical and whole genome shotgun sequencing; DNA sequencing strategies, Manual and automated sequencing, different platforms used for next generation 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, DNA microarray.

### **PRACTICAL:**

1. *In silico* analysis and comparison of different genomes

### **RECOMMENDED BOOKS:**

1. Field, D., & Davies, N. 2015. Biocode: The new age of genomics. Oxford University Press

2. Kulkarni, S., & In Pfeifer, J. D. 2015. Clinical genomics. Amsterdam: Elsevier/Academic Press
3. Pevsner, J. 2015. Bioinformatics and functional genomics. 3<sup>rd</sup> Edition. John Willey and Sons, New Jersey.
4. Zayed, A., 2016. Genomics. Elsevier science

## **PROTEOMICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. How proteomics application in molecular biology research can be helpful in solving the complex biological and biochemical processes
2. Experience to investigate if only one protein of the interest as well as whole proteome.

### **COURSE CONTENTS:**

Expression, structural and functional proteomics; top down and bottom up strategies; 2 D gel, densitometry using software, affinity purification, tandem affinity purification (TAP) tagging, fluorescence resonance energy transfer (FRET) and co immune precipitation; Protein- protein interactions, Protein-DNA interaction, protein adducts, validation by two hybrid system (yeast) , mass spectrometry (APMS, MALDI TOF, FPLC, MALDI imaging), Protein microarray.

### **PRACTICALS:**

1. Differential proteome analysis by 2D gel electrophoresis
2. *In silico* analysis and comparison of different proteomes

### **RECOMMENDED BOOKS:**

1. Alexander, N G, and . Hiroshi. N. 2007. Microbial Biotechnology. Ch. The world of Omics: Genomics, Transcriptomics, Proteomics and Metabolomics pp147-168. Springer
2. Guenter, K. 2015. The Dictionary of Genomics, Transcriptomics and Proteomics and Proteomics 5<sup>th</sup> Edition. Published by Wiley Blackwell.
3. Hon-Chiu, E. W. L. 2012. Integrative Proteomics. Intech publishing. Germany.
4. Jung, K. 2016. Statistical analysis in proteomics. New York: Humana Press
5. Reinders, J. 2016. Proteomics in systems biology: Methods and protocols. New York: Humana Press.
6. Sechi, S. 2016. Quantitative proteomics by mass spectrometry. New York: Humana Press
7. Twyman. R. M. 2004. Principles of Proteomics. Taylor and Francis

## TRANSCRIPTOMICS

CREDIT HOURS 2+1

### LEARNING OUTCOMES:

#### Students will be able to:

1. The methods relevant to transcriptomic studies.
2. Applications and methods of sequencing approaches in transcriptomics.

### COURSE CONTENTS:

Overview of transcriptome and transcriptomics, Traditional techniques for mRNA expression analysis, Global expression analysis of mRNA by microarray, different types of microarray, Application of expression profiling in human diseases, Expression sequence tag (EST), Serial analysis of gene expression (SAGE), Cap analysis of gene expression (CAGE), Massively parallel signature sequencing (MPSS), *In silico* analysis and comparison of different transcriptomes.

### PRACTICALS:

1. *In silico* analysis and comparison of different transcriptomes
2. Gene expression profiling by conventional PCR/ Qubit Fluormeter

### RECOMMENDED BOOKS:

1. Alexander N G. Hiroshi. N. 2007. Microbial Biotechnology. Ch. The world of Omics: Genomics, Transcriptomics, Proteomics and Metabolomics pp147-168. Springer, NY USA.
2. Detrich, H. William, III, Zon, Leonard, & Westerfield, Monte. 2016. The Zebrafish: Genetics, Genomics, and Transcriptomics. Academic Pr.
3. Guenter K. 2015. The Dictionary of Genomics, Transcriptomics and Proteomics and Proteomics. 5<sup>th</sup> Edition. Published by Wiley Blackwell.
4. Passo. G. A. 2014. Transcriptomics in Health and Disease. Springer, NY USA.
5. Virendra G. Somath T. 2009. Tanscriptomics: Expression pattern analysis VDM Verlag, Germany
6. Wu, J. 2016. Transcriptomics and gene regulation. Dordrecht: Springer

## BIOMOLECULES TO THE MARKET

CREDIT HOURS 3+0

### LEARNING OUTCOMES:

#### Students will be able to:

1. Start their business.
2. The opportunities, nature and function of the biologicistic studies for commercial application of innovative molecules
3. Identify the requirements for building an appropriate business

### COURSE CONTENTS:

Introduction to commercialization and validation of Bio science ideas; model for virtual business; management and performance standards; product trials, trials reforms, Pre-market submissions; facility information; product labelling;

good manufacturing practices (GMP); establishment licensing, patent filing and rights; comparison with imported products; cost recovery; lot release; documentation; market analysis and planning; advertising and codes of practice.

### **RECOMMENDED BOOKS:**

1. Collin, S. 2013. *The Race to Commercialize Biotechnology: Molecules, Market and the State in Japan and the US*. Routledge, USA.
2. Chan, L., & Liu, D. 2016. *Policy Planning to Support Technological Innovation in the Pharmaceutical Industry*.
3. Ghosh, T. K., & Pfister, W. R. 2005. *Drug delivery to the oral cavity: Molecules to market*. Boca Raton: Taylor & Francis.
4. Lanjouw, J. O., & National Bureau of Economic Research. (2005). *Patents, price controls, and access to new drugs: How policy affects global market entry*. Cambridge, MA: National Bureau of Economic Research
5. Lindblat, L., Ramsden, R., & Longyear, J. 2014. Commercialization. 346-365. Wiley online Library
6. Mehta, S., S. 2011. *Commercializing Successful Biomedical Technologies Basic Principles for the Development of Drugs, Diagnostics and Devices*. Cambridge University Press.
7. Bas, T. G. 2013. Dual Market(ing) in “Bio-Engineering High Technology” New Products: The Risk of Uncertainty and Failure. *International Journal of Measurement Technologies and Instrumentation Engineering* 3, 2, 63-74

## **MOLECULAR DIAGNOSTICS**

**CREDIT HOURS 1+2**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Apply theoretical knowledge of DNA and RNA to molecular diagnostic procedures.
2. Identify the important parameters in the design of a quality system for molecular analyses.
3. Technically become good in handling techniques required to perform the most commonly used molecular diagnostics protocols.
4. Develop critical thinking skills to trouble shoot problems

### **COURSE CONTENTS:**

Molecular Cytogenetics (FISH, ISH *etc*), DNA Microarrays and Genetic Testing, Mass Spectrographic Methods to Identify Disease Processes, Microorganism detection, High throughput sequencing, PCR Variants: Asymmetric PCR, multiplex PCR, degenerated primers, mutant primer, iPCR, RT-PCR. RAPD, AP-PCR, DAF, AFLP, cDNA-AFLP, (semi) quantitative PCR, Applications in microbiology, medicine, breeding, criminology, Protein-analysis techniques, Protein extraction, SDS-PAGE, Iso-electric focusing, 2D-gel electrophoresis, Western-analysis, ELISA, Immunolocalisation (incl,

Detection techniques), RNA-extraction, Northern-analysis, Dot-blot, macro-en micro-arrays, In situ mRNA hybridization, DNA-hybridisation (Southern blotting, probe technology), RNA-analysis techniques, Light Cycler technology.

### **PRACTICALS:**

1. All techniques can be practiced subject to the availability of facilities.
2. Visits to various diagnostic, pathology laboratories and/or research institutes.

### **RECOMMENDED BOOKS:**

1. Buckingham et al., 2007. Molecular Diagnostics Fundamentals, Methods, and Clinical Applications. 1<sup>st</sup> Edition. FA Davis Publisher.
2. Cook, N., D'Agostino, M., & Thompson, K. C. (2015). Molecular microbial diagnostic methods: Pathways to implementation for the food and water industries. London, UK: Academic Press is an imprint of Elsevier
3. Debnath, M., Prasad, G. B. K. S., & Bisen, P. S. 2010. Introduction to Molecular Diagnostics. SpringerLink
4. Debnath, M., Prasad, G. B. K. S., & Bisen, P. S. 2010. Molecular diagnostics: Promises and possibilities. New York: Springer
5. Deniese D Wilson, 2008. Manual of Laboratory and diagnostic tests. McGraw Hills publisher.
6. Fischbach, F. T., & In Dunning, M. B. (2015). A manual of laboratory and diagnostic tests. Philadelphia : Wolters Kluwer Health
7. Lippincott. 2015. Carpenito Nursing Diagnosis + Fischbach a Manual of Laboratory and Diagnostic Tests, North American Ed. + Lippincott Nursing 2016 Drug Handbook. Lippincott Williams & Wilkins

## **QUANTITATIVE BIOLOGY**

**CREDIT HOUR 2+1**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Learn skills of quantitative and system biology.
2. Develop the ability to gather and integrate large amount of quantitative data.

### **COURSE CONTENTS:**

An introduction to the fields of mathematical and quantitative biology; Continuous and discrete mathematical models of biological processes and their analytical and computational solutions; Differential equations, population growth, logistic model, Verhulst model, bifurcation diagrams, chaos, equations with delay, physiological mechanisms of drug elimination, infectious diseases, epidemic models, predator-prey interaction: Lotka-Volterra model; population genetics: Hardy-Weinberg law of genetic equilibrium, mutations, variation in populations, quantitative genetics, discrete/continuous random variables, probability distributions, statistical tests, hypothesis testing, cell signaling, gene regulation, Applications in

physiology, systems biology, epidemiology, cancer biology, ecology, evolution, and spatiotemporal dynamics.

### **PRACTICALS:**

1. Problem solving related to course contents
2. *In silico* studies of quantitative biology

### **RECOMMENDED BOOKS:**

1. De, K. H. J. 2016. Quantitative ecology and evolutionary biology. Place of publication not identified: Oxford Univ Press.
2. Fenyó, D. 2010. Computational biology. New York: Humana Press.
3. Milo, R., Phillips, R., & Orme, N. 2016. Cell biology by the numbers. New York, NY : Garland Science

## **SKILLS AND RESEARCH METHODOLOGIES**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. How to apply theoretical knowledge towards scientific writing
2. Code of ethics of scientific writing
3. The students will develop critical thinking skills to trouble shoot problems

### **COURSE CONTENTS:**

Role of a student and a supervisor in a research project; Overview of scientific research; improvement through research; nature of scientific inquiry; reviewing the literature; primary and secondary sources and selection; development of a research project; designing and investigation of a research project; identifying the level within investigation; deciding on techniques to be employed; analyses of results; control, samples and replications; applications of research in industry, scientific record keeping; use of microorganisms, animals, plants and humans in experimentation; use of pathogens in experiments; ethical considerations, conflict of interests; ownership of data; Scientific report writing, presentation and publishing the scientific papers.

### **RECOMMENDED BOOKS:**

1. Allison, B., Hilton, A. O'Sullivan, T., Owen, A., & Rothwell, A. 2016. Research Skills for Students. London: Taylor and France.
2. Dawson, C., 2002. Practical Research Methods. Newtec Place, Magdalen Road, Oxford OX4 1RE, United Kingdom.
3. Jacobsen, K., 2012. Introduction to Health Research methods, A practical guide. Jones & Barlett Learning International, UK.
4. Maxwell, J. A., 2012. Qualitative Research Design: An Interactive Approach, SAGE Publications, USA
5. Nickoson, L., & Sheridan, M. P. 2012. Writing studies research in practice: Methods and methodologies. Carbondale: Southern Illinois University Press

6. Walliman, N., 2010. Research methods, The Basics. Taylor & Francis.

## **IMMUNOGENETICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Knowledge of the basic physiological mechanisms that regulate the functioning of the immune system
2. Understanding of the different types of immune responses and their biological significance.

### **COURSE CONTENTS:**

Introduction to components of immune system, antibody response; nature of antibodies, structure and heterogeneity of immunoglobulin, allelic exclusion; monoclonal antibodies. Inheritance of immune response capacities; Immune tolerance; specific immune response variations, human IR genes, antigenic variation: genetic pathways for synthesis of A, B & O antigens, secretor loci, Rh factor, other blood groups. Compatibility of blood antigens. Histo compatibility: transplantation: HLA complex, HLA haplotypes, MHC/HLA and diseases, Immunological diseases: immune deficiency diseases, AIDS, autoimmune diseases, inherited abnormalities of complement system

### **PRACTICALS:**

1. HLA typing
2. A, B & O antigens
3. Problems/ case studies related to autoimmune diseases.
4. Problems/ case studies related to inherited abnormalities.
5. Visit to health organizations for diagnosis of different allergens

### **RECOMMENDED BOOKS:**

1. Abbas, A. K., Lichtman, A. H. and Pober, J. S. 2000. Cellular and Molecular Immunology, 4<sup>th</sup> Edition. Elsevier Saunders, Co. P.A.
2. Christiansen, F. T., & Tait, B. D. 2012. Immunogenetics: Methods and applications in clinical practice. New York: Humana Press
3. Cuturi, M. C., & In Aneon, I. 2016. Suppression and Regulation of Immune Responses: Methods and Protocols. New York, NY : Springer New York : Imprint: Humana Press
4. Dixon, F. J., Alt, F. and Austen, K. F. 2000. Advances in Immunology, Academic Press Inc., U.S.A.
5. Jackson, A. 2015. Immune systems. Transit Lounge Publishing. Melbourne.
6. Lesage, S. 2010. Immunogenetics: Tolerance and autoimmunity. New York: Nova Science Publishers.
7. Roitt, I. and Delves, P. J. 2001. Roitts Essential Immunology, 10<sup>th</sup> Edition, Blackwell Science, M.A.



**LEARNING OUTCOMES:****Students will be able to gain:**

1. knowledge of current understanding, emerging issues and trends within the fields of molecular toxicology

**COURSE CONTENTS:**

History and basic concepts of toxicology, molecular and forensic basis of toxicology and its applications. Toxicological effects of various drugs of abuse and their action of mechanism. Sampling techniques and methodologies used to identify various toxicants. Insight of different types of poisons and toxicants, classification and their management, Identification of drugs in the body, Toxicity of pharmaceutical materials, non-medicinal agents and industrial pollutants, Targeted organ toxicity (Blood, Immune system, Heart, Liver, Kidney, Respiratory System, Nervous system, Ocular visual system, Endocrine system). Multiplicity and properties of drug-metabolizing enzymes (cytochrome P450, glutathione S-transferases and others), clinical and toxicological consequences of genetic polymorphisms of drug metabolizing enzymes, chemical and biological properties of reactive intermediates responsible for toxicity, mechanisms underlying idiosyncratic drug reactions (Identifying genetic risk factors for serious adverse drug reactions: current progress and challenges).

**PRACTICALS:**

1. Study of effect of various toxins in animal models
2. Study of effect of various toxins on DNA
3. Effect of toxins on different pathway (oxidative stress)
4. In-silico or computational approaches to predict drug metabolism and toxicity

**RECOMMENDED BOOKS:**

1. Dell'Omo, G., 2002. Behavioural Ecotoxicology. John-Willey and Son Limited.
2. Fishbein, J. C. 2012. Advances in Molecular Toxicology. Burlington: Elsevier Science
3. Fowler, B. A. 2016. Molecular biological markers for toxicology and risk assessment. S.I.: Elsevier Academic Press.
4. Hodgson, E. A Textbook of Modern Toxicology. 2011. 4<sup>th</sup> Edition. Wiley.
5. Josephy, P. D. and Mannervik, B., 2006. Molecular Toxicology, 2<sup>nd</sup> Edition, Oxford University Press. ISBN: 9780195176209.
6. Keohavong, P. and Grant, S.G., 2005. Molecular Toxicology Protocols, 2<sup>nd</sup> Edition.. DOI:10.1007/978-1-62703-739-6, ISBN: 978-1-62703-738-9. Publisher: Humana.
7. Phouthone, K., and Grant, S, G.2016. Molecular Toxicology Protocols. Hamnna Press.

**LEARNING OUTCOMES:****The students will be able to:**

1. About general principles, methodology, application and techniques of pharmacology
2. The molecular pharmacology of receptors.

**COURSE CONTENTS:**

Introduction, history and its classification of pharmacology, drugs and their sources, routes of drugs administration, advantages and disadvantages of enteral routes, parenteral routes, topical routes, pharmacokinetics, drug solubility and passage of drugs across the body membranes, plasma concentration of drugs and various factors affecting its absorption and factors influencing the rate of absorption, GIT and other routes of drugs, distribution and factors influencing the rate of distribution of drugs, biotransformation and factors influencing the rate of biotransformation of drugs, excretion, channels of excretion and factors influencing the rate of excretion of drugs, definition of bioavailability and bioequivalence, therapeutic index, plasma half-life ( $t_{1/2}$ ), dose-response curve, volume of distribution, pharmacodynamics, drug receptors and theories, mechanisms of drug action, specificity of drug action and factors modifying the action and dosage of drugs. Genetic variability in drug action, protein structure-activity relationships, receptor-ligand interactions, signal transduction, biochemical and molecular aspects of G-protein coupled receptors and their signaling mechanisms.

**PRACTICALS:**

1. To study the effect of neostigmine, adrenaline, acetylcholine on skeletal muscle contraction.
2. To perform the screening test for paracetamol and phenothiazine in body's fluids
3. To demonstrate the duke bleeding time method in rabbit
4. To observe the effect of warfarin and heparin on bleeding time in rabbit
5. To study the effects of drugs on rabbit eye pupil diameter
6. To study the effect of acetylcholine, atropine, adrenaline on cardiac muscles.
7. To observe the effect of central nervous system depressants and stimulants in animal models.
8. To study the effect of hypoglycemic drugs in rabbit
9. In silico tool to predict drug pharmacokinetics (PK) and effects on ADME (absorption, distribution, metabolism and excretion) processes

**RECOMMENDED BOOKS:**

1. Rho, J.P., and Louie, S.G., 2003. Handbook of Pharmaceutical Biotechnology. Haworth Press, Incorporated
2. Bryant, B. J. 2015. Pharmacology for health professionals. Chatswood, New South Wales : Mosby

3. Clementi, F., & Fumagalli, G. 2015. General and molecular pharmacology: Principles of drug action. John Wiley & Sons, Inc
4. Dean J. A. Crommelin, D.J.A., Daan J. A. Crommelin, D.J.A., and Robert D. Sindelar, R.D., 2002. Pharmaceutical Biotechnology : An Introduction for Pharmacists and Pharmaceutical Scientists, 2<sup>nd</sup> Edition. CRC Prentice, Licence
5. Dickenson, J., Freeman, F., Mills, C.L., Thode, C. and Sivasubramaniam, S., 2012. Molecular Pharmacology: From DNA to Drug Design. ISBN: 978-0-470-68443-6. Wiley-Blackwell
6. Kayser, O., Muller, R.H., and (Editor), Müller, R.H., 2005. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications. Wiley, John & Sons, Incorporated.
7. Klefenz, H., 2002. Industrial Pharmaceutical Biotechnology, Wiley-VCH Verlag GmbH.
8. Michael A. Santoro, Thomas M. Gorrie, 2005. Ethics and the Pharmaceutical Industry, Cambridge University Press
9. Rang, H. P., Ritter, J., Flower, R. J., & Henderson, G. 2016. Rang & Dale's pharmacology. Elsevier/Churchill Livingstone

## **BIONANOTECHNOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Know about the biomaterials, approaches and applications of nanotechnology in living systems

### **COURSE CONTENTS:**

Biomaterials: 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> generation biomaterials: their historical overview and current directions; nanobiotechnology, nanoscience and nanotechnology; top down and bottom up approaches to analyze nanoscopic properties; nanoparticles and nanoscale materials; cellular nano and microstructures; nanocarbon tubes, abalone shells; nanomanipulation via different types of microminipulators; nanoprobes and probe array; DNA nanotechnology and DNA-modified surfaces; applications of nanobiotechnology in living systems.

### **PRACTICALS:**

1. Construction of silver nanoparticles.
2. Construction of Zinc quantum dots.
3. Study of antimicrobial activity of nanoparticles
4. Biofilm formation and bioluminous determination.
5. Quorum sensing in biofilms in the presence of nanoparticles

### **RECOMMENDED BOOKS:**

1. Greco, R. S., Prinz, F. B., Smith, R. I. and Prinz, F. B. 2004. Nanoscale Technology in Biological Systems, CRC Press, Boca Raton.

2. Hormes, J., Challa, S. S. R. K. and Leuschner, C. 2005. Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact, John Willey and Sons, N.Y.
3. Kelsall, R., Hamley, I. W. and Geoghegan, M., 2005. Nanoscale Science and Technology, John Willey and Sons, N.Y.
4. Kumar, N., & Kumbhat, S. 2016. Essentials in nanoscience and nanotechnology. New Jersey : Wiley
5. Mansoori, G. A. 2005. Principles of Nanotechnology: Molecular-Based Study of Condensed Matter in Small Systems, World Scientific Publishing Company, N.J.
6. Nanobiotechnology for sensing applications: From lab to field. (2016). Place of publication not identified: Apple Academic Press.
7. Scherge, M., Gorb, S. N. and Stanislav, S. N. G. 2001. Biological Micro- and Nanotribology, Springer-Verlag, N.Y.
8. Sipper, M. 2002. Machine Nature: The Coming Age of Bio-Inspired Computing, McGraw-Hill Companies, N.Y.
9. Slingerland, J. 2016. Nanotechnology. Essential Library, an imprint of Abdo Publishing.

## DETAIL OF ELECTIVE COURSES

### DNA DAMAGE AND REPAIR

CREDIT HOURS 2+1

#### LEARNING OUTCOMES:

The students will be able to:

1. The types of DNA damages and their repair theories
2. The DNA damage as a key factor in the development and evolution of cancer cells

#### COURSE CONTENTS:

Introduction; Radiation (ionizing and non-ionizing) as damage inducing agents. DNA, the critical site for damage and interaction. Biological consequences of damage. Inactivation of biological systems: bacterial cells and bacteriophages by UV radiations. Post-irradiation macromolecular system. Chemicals and biological agents as damage inducers. Exogeneously and endogeneously induced base modifications and their biological consequences. Repair and Restoration of DNA damages: photo-enzymatic restoration and dealkylation, excision repair processes, mismatch repair, tolerance mechanism, conditioned repair phenomenon (phenomenology and genetic control of SOS functions, adaptive responses to DNA alkylation and oxidative stress. Environmental and physiological factors influencing recovery phenomenon viz. Liquid holding recovery, thermal and UV reactivation. Relevance of inducible repair to carcinogenesis.

#### PRACTICALS:

1. Screening of mutagenic agents by AMES test and comet assay
2. To determine the effect of radiation on prokaryotes and eukaryotes
3. Screening of carcinogenic agents by use of indicator cell lines

#### RECOMMENDED BOOKS:

1. Hanaoka, F., & In Sugasawa, K. 2016. DNA replication, recombination, and repair: Molecular mechanisms and pathology. Tokyo : Springer
2. Hausen, H. Z. 2006. Infections Causing Human Cancer, John Willey and Sons, N.Y.
3. Holland, E.C. 2004. Mouse Models of Human Cancer, John Wiley and Sons, N.Y.
4. Howe, H. 2007. Gene Cloning and Manipulation, Cambridge University Press, N.Y.
5. Kornberg, A. and Baker, T. A. 2005. DNA Replication, 2<sup>nd</sup> Edition, University Science Books, Sausalito, C.A.
6. Kumar, M. 2015. Senescence, DNA damage and repair in COPD. Saarbrücken: LAP LAMBERT Academic Publishing.
7. Nickoloff, J. A. and Hoekstra, M. F. 1998. DNA Damage and Repair : DNA Repair in Prokaryotes and Lower Eukaryotes, Humana Press, N.J.
8. Nickoloff, J. A. and Hoekstra, M. F. 2001. DNA Damage and Repair: Advances from Phage to Humans, Humana Press, N.J.

9. Simic, M. G., Grossman, L. and Upton, A. D. 1986. Mechanisms of DNA Damage and Repair: Implications for Carcinogenesis and Risk Assessment, Plenum Press, N.Y.
10. Tamarin, R. H. 2002. Principles of Genetics, McGraw-Hill Companies, N.Y.
11. Thomas, A. E. 2010. DNA damage repair, repair mechanisms, and aging. Hauppauge, N.Y: Nova Science Publisher's.
12. Vaughan, P. 2000. DNA Repair Protocols: Prokaryotic Systems, Humana Press, N.J.

## **BIOPHYSICS AND COMPUTATIONAL BIOLOGY**

**CREDIT HOUR 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. About the 3D structures and properties of macromolecules by molecular simulations.
2. Methods in structural biology and related software databases.

### **COURSE CONTENTS:**

Architecture and Physical Properties of Proteins, Introduction: Governor of biological phenomena, Protein, Variety and similarity in protein architecture, 3D structure prediction, Symmetry in supramolecules, Membrane protein structure, Protein folding and the physical principles, Protein dynamic features: Complex and dynamic system, protein. Observation of dynamic properties by molecular simulation, Dynamics from protein crystallography, Solution X-ray and neutron scattering, Molecular motions monitored by NMR spectroscopy. Behaviors of genes-dynamic DNAs, Methods in Structural Biology and Software Databases - NIH resource, at UIUC Bioinformatics software Biocatalog - at EBI.

### **PRACTICALS:**

1. Data base analysis
2. Data retrieving
3. Bioinformatic software regarding crystallography

### **RECOMMENDED BOOKS:**

1. Kinter, M. and Sherman, N. E. 2000. Protein Sequencing and Identification Using Tandem Mass Spectrometry, John Willey and Sons, N.Y.
2. Liebler, D. C. 2001. Introduction to Proteomics, Tools for the New Biology, Humana Press, N.J.
3. Meksem, K. and Kahl, G. 2005. The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, John Willey and Sons, N.Y.
4. Nakamura, H. and Arisaka, F. 2005. Architecture and Physical Properties of Proteins, Biophysical Society of Japan, Japan.
5. Nelson, P. 2003. Biological Physics: Energy, Information, Life, W. H. Freeman, U.S.A.

6. Sensen, C. W. 2005. Handbook of Genome Research: Genomics, Proteomics, Metabolomics, Bioinformatics, Ethical and Legal Issues, John Willey and Sons, N.Y.
7. Wong, K-C. 2016. Computational Biology and Bioinformatics: Gene Regulation. CRC Press, Taylor and Francis Group.
8. Tu, J., Inthavong, K., & Wong, K. K. L. 2015. Computational thermodynamics - Theory, Modelling and Applications. Dordrecht: Springer Netherlands George Church, G., 2016 Biophysics Genomics and Computational Biology. Springer.

## **VACCINOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **The students will be able to:**

1. Know about the methods of vaccine preparation
2. gain the Knowledge that how vaccines work immunologically and epidemiologically
3. Know the different types of vaccines and guidelines for current vaccination practices
4. critically discuss the advantages and disadvantages of vaccines

### **COURSE CONTENTS:**

Introduction to vaccinology, the history of vaccine development (Small pox, Measles, Tetanus, polio, rabies, hepatitis), Concept and scope of vaccines. Principles of Vaccines design, Strategies to stimulate innate immunity, Antigen processing and major histocompatibility complex, Mucosal Immune system and Mucosal Vaccine design, utility of animal models in vaccine design, Antigen Engineering, Attenuated bacterial vaccines, Recombinant MVA vaccines, Recombinant Adenoviruses and Avipox viruses for vaccination, Nucleic acid vaccination. Applications of vaccines, infectious diseases, cancer specific antigens, prophylactic cancer vaccines. Vaccine Delivery Systems, Transcutaneous immunization, Needle free jet injection, Oral vaccines, Biodegradable particles, Co-stimulatory Moieties, Vaccine safety and ethics.

### **PRACTICALS:**

1. Preparation of attenuated cultures
2. Chick embryo inoculation for vaccine development
3. Effect of different available vaccines in animal models
4. Antibody titre for different antigenic vaccines

### **RECOMMENDED BOOKS:**

1. Centlivre, Mireille, & Combadière, Béhazine. 2015. New challenges in modern vaccinology. (BioMed Central Ltd.) BioMed Central Ltd.
2. Giese, M. 2016. Introduction to molecular vaccinology. Cham : Springer
3. Milligan, G. N., & Barrett, A. D. T. 2015. Vaccinology: An essential guide. NJ : Wiley Blackwell
4. Stanley, P., 2014. Vaccinia, Vaccination, and Vaccinology. Springer Verlag.

# EPIGENETICS

CREDIT HOURS 2+1

## LEARNING OUTCOME:

Students will be able to :

1. Have an insight into the genetic regulation.
2. Learn heritable changes in gene expression and cellular phenotypes.
3. Learn about changes in phenotypes other than changes in underlying DNA sequences

## COURSE CONTENTS:

Over view of epigenetics; Genome organization of eukaryotes; Heterochromatin and euchromatin; Levels of chromatin organization; Histone modifications, histone code hypothesis; Genetic modulation by CpG Island, DNA methylation and its implication on gene expression; Types of methylases, DNA/RNA and protein methylation, and its implication on gene expression; Types of acetylases and acetylation of histones; Book marking, cellular memory and Imprinting, Maternal effects, Paramutation, X-chromosome inactivation, Position effect variegation, Gene silencing, Transvection and Reprogramming; epigenetic regulation of gene expression, cellular differentiation and signal transduction; Role of epigenetics in various diseases

## PRACTICALS:

1. Visualization of heterochromatin by different techniques
2. Detection of CpG motifs by restriction enzymes.
3. Detection of CpG motif by PCR. Bi sulphite PCR
4. Detection of methylated sites on DNA

## RECOMMENDED BOOKS:

1. Allis, C. D., Caparros, M.-L., Jenuwein, T., & Reinberg, D. 2015. Epigenetics. New York: CSH Press, Cold Spring Harbor Laboratory Press
2. Benedikt, H. and Brian, K. H. 2011. Epigenetics: Linking Genotype and Phenotype
3. Development and Evolution. University of California Press.
4. Dincer, Y. 2016. Epigenetics: Mechanisms and clinical perspectives. New York: Nova Science Publisher's, Inc.
5. Nessa Carey. 2012. The Epigenetic Revolution. Columbia University Press.
6. Richard C. F. 2012. Epigenetics. W. W. Norton & Company.
7. Su, L. J., & Chiang, T.-C. 2015. Environmental epigenetics. Humna Press. London.
8. Tollefbol, T.O., 2010. Handbook of Epigenetics. Academic Press.
9. Tollefsbol, T. O. 2015. Personalized epigenetics. Amsterdam: Elsevier Ltd.



## **MOLECULAR BREEDING**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Interpret structural and regulatory differences and use this information to choose appropriate molecular breeding technologies
2. Choose appropriate molecular marker assisted breeding strategies

### **COURSE CONTENTS:**

History of breeding and classical breeding systems, Marker assisted breeding (Molecular marker genotyping: SSR, SNP), Marker trait associations analyses for qualitative and quantitative traits, Principles of linkage mapping, Hands-on experience with linkage mapping software, Principles of association/QTL mapping, Hands-on experience with association /QTL mapping software, What DNA markers can do for breeders – examples of marker assisted breeding applications, Gene flow for breed improvements (horizontal and vertical gene transfer)

### **PRACTICALS:**

1. Genotyping using different molecular markers
2. Hands-on experience with association/QTL mapping software

### **RECOMMENDED BOOKS:**

1. Al-Khayri, J. M., Jain, S. M., & Johnson, D. V. 2016. Advances in Plant Breeding Strategies. Cham: Springer International Publishing.
2. Boopathi, N. M. 2013. Genetic mapping and marker assisted selection: Basics, practice and benefits. Springer.
3. Broman, K. W. 2011. Guide to QTL mapping with r/ql. S.I: Springer-Verlag New York.
4. Tian, J., Chen, J., Chen, G., Wu, P., Zhang, H., & Zhao, Y. 2015. Genetic analyses of wheat and molecular marker-assisted breeding: Volume 2. Science Press ; Dordrecht : Springer
5. Xu, Y., 2012. Molecular Plant Breeding. CABI.

## **HUMAN GENETICS AND CHROMOSOMAL DISORDERS**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Aware of patterns and ways of transmission of genetic disorders.
2. Familiar with the importance and limitations of genetic testing, genetic screening and prenatal diagnosis.

### **COURSE CONTENTS:**

Pattern of transmission of single gene traits; pedigree analysis with criteria for identifications of various modes of inheritance. Genetic defects in prenatal development; normal chromosome picture, congenital malformations, metabolic variation and diseases: In-born error in amino acid, carbohydrates, lipids and nucleic acid metabolism. Errors in transport system. Inherited

variations, genetic linkage. Family mated, somatic hybridization, deletion mapping and duplication mapping, Genetic counseling, eugenics, twin studies. Autosomal reciprocal translocations. Sex chromosomes translocations. Robertsonian translocation, centromere fissions, insertions, inversion etc. Parental sex chromosome and aneuploidy, fragile X syndromes, down syndrome, XY female, XX male, true hermaphrodite, pregnancy loss and infertility, parental age counseling and screening for fetal trisomy, prenatal diagnostic procedures, chromosome abnormalities detected at prenatal diagnosis.

### **RECOMMENDED BOOKS:**

1. Gardner, R. J. M. and Sutherland, G. R. 1996. Chromosome Abnormalities and Genetic Counseling, Oxford University Press, N.Y.
2. Gerdes, L. I. 2014. Human genetics. Farmington Hills, Mich : Greenhaven Press.
3. Lewis, R. 2015. Human genetics: Concepts and applications. McGraw-Hill.
4. Strachan, T., Goodship, J., & Chinnery, P. F. 2015. Genetics and genomics in medicine. New York : Garland Science/Taylor & Francis Group.
5. Wolfe, J. 2016. Genetic testing and gene therapy. New York : Britannica Educational Publishing in association with Rosen Educational Services.

## **NEUROBIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

Students will be able to describe the major areas of neuroscience with a clear understanding of basic nervous system functions on a molecular, cellular and systems level .

### **COURSE CONTENTS:**

Organization of nervous system, sympathetic and parasympathetic nervous system, motor nervous system, brain cells, structure of neurons, glial cells and its types, blood brain barrier, signaling in the brain, action potential, resting membrane potential, synapse, synaptic events, neuroreceptors and signaling in the brain, signal transduction, excitation and inhibition in neurotransmitters , neurotransmitters in cognitive functions, diseases associated with the malfunctioning of these neurotransmitters, neuropeptides and modulators, neuroreceptors and drug targets.

### **PRACTICALS:**

1. Dissection of model animals for nervous system study
2. Effect of different neurotoxic substances on nervous system of model animals

## **RECOMMENDED BOOKS:**

1. Hickok, G., & In Small, S. L. 2016. *Neurobiology of language*. Amsterdam: Academic Press
2. Luo, L. 2016. *Principles of neurobiology*. New York, NY : Garland Science.
3. Striedter, G. F. 2016. *Neurobiology: A functional approach*. Oxford : Oxford University Press.

## **GENETICALLY MODIFIED ORGANISMS      CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Know about mechanisms/ development of Genetically Modified Organisms
2. Learn the importance of GMOs to improve the desirable traits
3. Get awareness regarding the ethical concerns of GMOs.

### **COURSE CONTENTS:**

Introduction to Genetically Modified Organisms (GMOs). Historical Background and Scientific foundations. Techniques for generation of GMOs, genetic transformation methods, nuclear and organelle transformation, selection markers, Micro-organisms (Bacteria, Yeast), Insects, Plants, Fish, mammals, Incorporation of Novel genes for tolerance against Biotic and Abiotic stresses, Genes for yield and quality improvement, Genes for Insect and disease Resistance. BT and RR crops and future concerns, Applications of GMOs, Bacteria-synthesized transgenic products (Insulin, Hepatitis B vaccine, Tissue plasminogen activator, Human growth hormone, Ice-minus bacteria, Interferon, BT Cotton, Ethical issues and public concerns regarding GMOs. International and national regulations for GMOs.

### **PRACTICALS:**

1. Methods of Transformation of various organisms
2. Identification of transient and stable transgenic expression

## **RECOMMENDED BOOKS:**

1. Kemp Ken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
2. Mahgoub, S. E. O. 2016. Genetically modified foods: Basics, applications, and controversy. Boca Raton : CRC Press/Taylor & Francis Group.
3. Nelson, G. C. 2001. Genetically Modified Organisms in Agriculture, Academic Press Inc., U.S.A.
4. Piguet, P., & Poindron, P. 2012. Genetically modified organisms and genetic engineering in research and therapy. Basel: Karger
5. Watson, R. R., & Preedy, V. R. 2016. Genetically modified organisms in food: Production, safety, regulation and public health. Amsterdam: Elsevier Science.

## **COMPUTER GRAPHICS AND MOLECULAR BIOLOGY**

**CREDIT HOURS 1+2**

### **LEARNING OUTCOMES:**

#### **The students will be able to:**

1. Learn about computer graphics, simulations and animations.
2. Interpret biological data in more impressive way

### **COURSE CONTENTS:**

Introduction to computer graphics, Graphic hardware and software, two and three dimensional graphics, hidden lines and hidden surfaces, graphical representation of biological data, reconstruction methods for cell system, image capture and image analysis, molecular graphics, simulation and animation.

### **PRACTICALS:**

1. Graphical representation of biological data
2. Image capture and analysis by different software.

### **RECOMMENDED BOOKS:**

1. Davis, M. J. (2011). Computer graphics. New York: Nova Science Publishers
2. Fletterick, R. J., Zoller, M., & Cold Spring Harbor Laboratory. 1995. Computer graphics and molecular modeling. New York: Cold Spring Harbor Laboratory.
3. Janke, S. J. (2015). Mathematical structures for computer graphics. Hoboken, New Jersey: Wiley
4. Ransom, R., & Matela, R. J. 1986. Computer graphics in biology. London: Croom Helm.
5. Tavares, J. M. R. S., & In Jorge, R. M. N. 2015. Developments in medical image processing and computational vision. Springer.

## **FORENSIC BIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Understand and appreciate the scope of forensic biology.
2. Mainly focus on the fundamental procedures of molecular biology as it applies to forensic settings.

### **COURSE CONTENTS:**

Introduction, history and principles of forensic biology and its sub-disciplines (molecular anthropology, forensic botany, forensic odontology, forensic serology, forensic DNA Typing); the role and functions of a forensic molecular biologist; organizational strategies of a forensic DNA laboratory; the nature, collection, documentation, examination and preservation of forensic DNA evidence; the use of alternative light sources and serological tests to detect biological stains on crime scene evidence; microscopy for the analysis of evidence; extraction and quantification of human DNA, compare, contrast

and explain the genetic and technical differences between various DNA typing techniques (RFLP, STR, sequence-based, mtDNA, nDNA, Y-chromosome); various statistical analysis of DNA profiles.

### **PRACTICES:**

1. Methods of Sampling at Crime Scene
2. Microscopy for the analysis of evidence
3. Serological tests to detect biological strains on crime scene
4. Forensic DNA Typing.

### **RECOMMENDED BOOKS:**

1. Bertino, A. J., & Bertino, P. N. (2016). Forensic Science: Fundamentals & investigations. Boston, MA: Cengage Learning.
2. Brown, R. M., & Davenport, J. S. (2016). Forensic science: Advanced investigations. Boston, MA: Cengage Learning
3. Katz, E., & Halamek, J. (2016). Forensic Science: Chemistry, Physics, Biology and Engineering. Wiley.
4. Siegel, J. A. (2016). Forensic Science: A beginner's guide. Oxford : Oneworld Publications,
5. Taylor, D., Abaro, D., Rowe, E., Taylor, D., Abaro, D., Rowe, E., & Rask-Nielsen, L. (July 01, 2016). Observations of DNA transfer within an operational Forensic Biology Laboratory. Forensic Science International: Genetics, 23, 33-49.

## **MACROMOLECULAR CRYSTALLOGRAPHY**

**CREDIT HOURS 3 +0**

### **LEARNING OUTCOMES:**

**Students will be able to:**

1. Understand the fundamentals of macromolecular crystallography
2. Learn about crystallization, data collection and data processing
3. Learn about structure elucidation and interpretation

### **COURSE CONTENTS:**

Introduction and brief history of macromolecular crystallography; Crystallization of macromolecules; The fundamentals of macromolecular X-ray crystallography and focus on methods for determining the three-dimensional structures of macromolecules. data collection, phasing methods, model building, refinement, structure validation and structure interpretation.

### **RECOMMENDED BOOKS:**

1. Carter, C.W., M. Sweet, R.M., 2003. Macromolecular Crystallography. Elsevier Academic Press USA.
2. Girolami, G.S., 2016. X-ray crystallography. University science books. California
3. McPherson, A., 2015. Introduction to Macromolecular Crystallography 2<sup>nd</sup> Edition . John Willey and Sons Inc. New Jersey.

## **PLANT MOLECULAR GENETICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Know about cloning and gene manipulation techniques in plants
2. Do genome mapping

### **COURSE CONTENTS:**

The use of comparative genome mapping in the identification, cloning and gene manipulation of important plant genes, molecular marker in plant conservation, identifying links between genotype and phenotype using marker loci and candidate gene. Economic importance of plant molecular genetics. Arabidopsis and its importance in recent molecular genetic studies. Arabidopsis genome project: achievements and future prospects. Other plant genome projects.

### **PRACTICALS:**

1. Determination of molecular marker for plant biotechnology
2. Identification of genes for phenotypic and genotype expression of plants
3. Plant transformation techniques
4. Determination of recombinant products.
5. Arabgen, lplant and lclouds with reference to molecular biology of plants.

### **RECOMMENDED BOOKS:**

1. Bahadur, B., In Rajam, M. V., In Sahijram, L., & In Krishnamurthy, K. V. 2015. Plant biology and biotechnology: Volume II, Springer.
2. Buchanan, B. B., In Gruissem, W., & In Jones, R. L. 2015. Biochemistry & molecular biology of plants. West Sussex ; Hoboken, NJ : Wiley Blackwell
3. Clark, M. S. 2014. Plant Molecular Biology. Springer Verlag
4. Gelvin, Stanton B., Schilperoort, Robbert A., & Verma, Desh Pal S. 2014. Plant Molecular Biology Manual. Springer Verlag

## **PROBIOTICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Know the basics regarding probiotics
2. Develop a command over the use of different organisms as a probiotics

### **COURSE CONTENTS:**

Introduction and historical background of probiotics. The intestinal flora, development of probiotics, probiotic usage, mechanism of working. Immune system regulation by probiotics. Industrial importance of probiotics. Commercially available probiotics. Economic importance of probiotics. Application and practical aspects of probiotic.

## **PRACTICALS:**

1. Isolation, characterization and identification of intestinal flora
2. Study of reaction produced by probiotics
3. Different methods for development of probiotics

## **RECOMMENDED BOOKS:**

1. Foerst, P., & In Santivarangkna, C. 2016. Advances in Probiotic Technology. Boca Raton, FL : CRC Press.
2. Parks, R. 2015. Handbook of probiotics NY : Hayle Medical.
3. Parks, R. 2015. Probiotics: Modern insights. Place of publication not identified: Hayle Medical
4. Trenev, N. 1998. Probiotics: Nature's Internal Healers, Avery Penguin Putnam, N.Y.
5. Venema, K., & Do, C. A. P. 2015. Probiotics and Prebiotics: Current Research and Future Trends. Portland: Caister Academic Press.
6. Watson, R. R., & In Preedy, V. R. 2016. Probiotics, prebiotics, and synbiotics: Bioactive foods in health promotion. Amsterdam : Academic Press.

## **BIODEGRADATION & BIOREMEDIATION CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **The students will able to:**

1. Which type of organisms can be used for bioremediation and biodegradation
2. About cost effective and long term solutions for environmental pollution and its eradications

### **COURSE CONTENTS:**

The environment and pollution. Environmental laws. Treatment technologies: Traditional approaches to pollution control. Bio-treatment technologies for pollution control. Biocatalyst selection and genetic modification: Enrichment and screening strategies. Design of enrichment strategies relating to the environmental sources. Microbiological techniques for enrichment and selection. Genetical approach. The carbon cycle and xenobiotic compounds: Biodegradation and Microbial technologies by microorganisms: Acclimation. Detoxification, Activation, Sorption, Bioavailability: Sequestering and complexing. Cometabolism, Environmental effects. Effects of metals and radionuclide on environment: Metal and radionuclide microbial treatment: Biotechnology for metal and radionuclide removal and recovery: Recalcitrant molecules, Phytoremediation

### **PRACTICALS:**

1. Survey of different type of pollutants present in nearby locality (especially industrial polluted localities)
2. Sampling, screening and analysis of markers for pollution treatments
3. use of treatment technologies for biodegradation and bioremediation of pollutants and polluted areas.

### **RECOMMENDED BOOKS:**

1. Alexander, M. 1999. Biodegradation and Bioremediation, Academic Press Inc., U.S.A.
2. Kumar, R., & In Sharma, A. K. 2016. Modern approaches to environmental biotechnology. New York : Nova Science Publishers, Inc.
3. Poole, R. K. and Gadd, G.M. 1989. Metal Microbe Interaction, IRL Press, U.K.
4. Ram, C. 2015. Advances in biodegradation and bioremediation of industrial waste. Boca Raton, FL : CRC Press.
5. Sánchez, M. O. 2016. Bioremediation of wastewater: Factors and treatments. Oakville, ON : Apple Academic Press.

### **INFECTIOUS DISEASES**

**CREDIT HOURS 2+1**

#### **LEARNING OUTCOMES:**

**The student will be able to know about characteristics:**

1. The infectious diseases
2. Spread, mode of infections, diagnosis and its control of infectious diseases.

#### **COURSE CONTENTS:**

Infectious disease etiology, epidemiology, pathogenesis, clinical symptoms and manifestations, diagnosis, complications, prognosis, treatment, and preventive measures; Principles of diagnostic microbiology, virology, parasitology, serology diagnosis, molecular and pathological diagnosis, anti infectious agents and immunizations. Overview of current infectious diseases.

#### **PRACTICALS:**

Diagnosis of common bacterial, viral, fungal, parasitological and other communicable diseases.

#### **RECOMMENDED BOOKS:**

1. Babita, J., & Ahmed, H. 2016. Infectious Diseases. Bpp Pub Ltd.
2. Cohen, J. 2016. Infectious diseases. S.I.: Elsevier Health Sciences.
3. Donelli, G. 2016. Advances in microbiology, infectious diseases and public health: Volume 1. Springer
4. Lu, P.-X., & In Zhou, B.-P. 2016. Diagnostic imaging of emerging infectious diseases. Springer.

### **FOOD PRESERVATION TECHNOLOGY**

**CREDIT HOURS 2+1**

#### **LEARNING OUTCOMES:**

The students will be able to know about the food processing, preservation and packing.

#### **COURSE CONTENTS:**

Principles and methods of food preservation; Bacteriology of preserved foods; Technology of food processing; Preservative agents for improving the quality,



shelf-life and organoleptic properties of foods; Neutralizers, stabilizers, firming agents, flavouring and coloring additions, value addition, coating and wrapping agents; Packaging and packaging problems. International rules for food preservation, packaging, marketing and transport. Adulterations of food, e-tagging for food products.

### **PRACTICALS:**

1. Food preservation by different synthetic and natural preservatives.
2. Effect of osmotic concentrations on food preservation.
3. Identification of food adulteration by different available tests

### **RECOMMENDED BOOKS:**

1. Nobile, M.A. and Conte, A., 2013. Packaging for Food Preservation; Springer-Verlag New York
2. Balasubramaniam, V.M., Barbosa-Cánovas, G.V. and Lelieveld, H.M., 2016. High Pressure Processing of Food; Springer-Verlag New York.
3. Galvez, A.M., Burgos, M.J., Lopez, R.L. and Pulido, R.P., 2014. Food Biopreservation; Springer-Verlag New York.
4. Rosenthal, A., Deliza, R., Barbosa-Cánovas, G.V. and Welti-Chanes, J., 2016. Fruit Preservation; Springer-Verlag New York.
5. Hernández-Sánchez, H. and Gutierrez-Lopez, G.F., 2015. Food Nanoscience and Nanotechnology; Springer International Publishing

## **EPIDEMIOLOGY: ANALYTICAL AND EXPERIMENTAL APPROACHES**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **Students will be able to:**

1. Solve epidemiological issues and suggest solutions for public health
2. Have clear concepts about communicable and non-communicable diseases
3. Guide about Environmental health and health education.

### **COURSE CONTENTS:**

Introduction to epidemiology; The historical context; Origins and Recent developments in epidemiology .Definition, scope, and uses of epidemiology; Epidemiology and public health; Causation of disease; Health status of population; Achievements in epidemiology; Measuring health and disease; Defining health and disease; Measuring disease frequency; Population at risk; Incidence and prevalence; Case fatality; Interrelationships of the different measures; Mortality; Life expectancy; Age-standardized rates; Morbidity; Disability; Health determinants, indicators, and risk factors; Comparing disease occurrence; Types of studies; Observations and experiments studies; Descriptive studies; Ecological studies; Cross-sectional studies; Case-control studies; Cohort studies; Randomized controlled trials; Field trials; Community trials; Potential errors in epidemiological studies; Confounding; Validity; Ethical issues; Summarizing data; Different types of

tables and graphs. Basic methods and tools of biostatistics and bioinformatics for assessing epidemiological problems. Epidemiology and prevention: chronic non-communicable diseases; The scope of prevention; Different methods, levels and strategies of prevention and screening; Communicable diseases: epidemiology surveillance and response; Clinical epidemiological related normality and abnormality; Environmental and occupational epidemiology; Environmental health impact assessment; Epidemiology, health policy and planning; steps in practical epidemiology.

### **PRACTICALS:**

1. Visits to different hospitals and public health centers.
2. Data analysis by different epidemiological and public health software
3. Problem based solutions of epidemiological diseases

### **RECOMMENDED BOOKS:**

1. Beaglehole, R., Bonita, R., & Kjellström, T. 1993. Basic epidemiology. Geneva: World Health Organization
2. Buettner, P., & Muller, R. (2015). Epidemiology. Sydney: Oxford University Press
3. Lawson, A., Banerjee, S., Haining, R. P., & Ugarte, M. D. 2016. Handbook of spatial epidemiology. CRC Press.
4. Magnus, M. 2016. Intermediate epidemiology: Methods that matter. Massachusetts: Jones & Bartlett Learning
5. Stewart, A. 2016. Basic statistics and epidemiology: A practical guide. Boca Raton : Taylor & Francis

## **ADVANCES IN MICROSCOPY AND IMAGE ANALYSIS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

1. To develop the concept in students about different types of microscopy and image analysis
2. To examine detailed structures of cells in different perspectives.

### **COURSE CONTENTS:**

Optical microscopy; Electron microscopy; Metallurgical microscopy: Different advances in fluorescent microscopy, immune-FRET microscopy, confocal laser microscopy, electron tunneling microscopy, Atomic force microscopy, Scanning Probe microscopy, live cell imaging, Total internal reflection fluorescence (TIRF); Microscopic image analysis by using different soft wares.

### **PRACTICALS:**

1. Sample preparation for different types of microscopy
2. Visit to different institute for hands on experience on different instruments

### **RECOMMENDED BOOKS:**

1. Albert, Remi, A., 2015. *Microscopy*. Archway Publisher

2. Dahms, T. E. S., & In Czymbek, K. J. 2015. *Advanced microscopy in mycology*. Springer
3. David C. B. and Erdman N. 2013. *Low Voltage Electron Microscopy: Principles and Application*. Wiley.
4. Eaton, P. and West, P. 2010. *Atomic Force Microscopy*, Oxford University Press, U.S.A.
5. Gabriel Popescu. 2010. *Nanobiophotonics*. McGraw-Hill.
6. Gabriel Popescu 2011. *Quantitative Phase Imaging of Cells and Tissue*. McGraw-Hill.
7. John S., Curry A. and Eyden B. 2013. *Diagnostic Electron Microscopy*. Wiley.
8. Luo, Z. (2016). *A practical guide to transmission electron microscopy: Advanced microscopy*. New York: Momentum Press
9. Michael, T., Postek, M. T., Dale, E., Newbury, D. E., Platek, F. S., David, C. and Joy, D. C. 2009. *Scanning Microscopy*, Society of Photo Optical, Belgium.
10. Reifenberger, R. G. (2016). *Fundamentals of atomic force microscopy: Part I*, NJ : World Scientific Publishing Co. Pte. Ltd.
11. Taylor, M. A. (2015). *Quantum microscopy of biological systems*. Springer
12. Verveer, P. J. 2015. *Advanced fluorescence microscopy: Methods and protocols*. Humana Press New York.
13. Vilas, M, 2014. *Microscopy: advances in scientific research and education; Vol 2*, Formatex Research Center, Spain.
14. Voigtländer, B. 2015. *Scanning probe microscopy: Atomic force microscopy and scanning tunneling microscopy Heidelberg Springer*.

## **BIOSENSORS**

**CREDIT HOURS 3+0**

### **LEARNING OUTCOMES:**

The students will be able to sense minute quantities of various individual biomolecules by using miniaturization and microsystems

### **COURSE CONTENTS:**

Introduction; miniaturization and microsystems including sensing by optical techniques, field-effect transistors, ion-selective and enzyme-sensitive electrodes; biological signals and their types; amperometric biosensors based on redox enzymes, potentiometric biosensors and enzyme field effect transistors (ENFET); thermal biosensors; optical biosensors based on redox enzymes; indirect affinity sensors; optical and electrical antibody-based biosensor; direct affinity detection using surface plasmon resonance and piezoelectric biosensors.

### **RECOMMENDED BOOKS:**

1. Yoon, J.-Y. 2016. *Introduction to biosensors: From electric circuits to immunosensors*. Springer.

2. Karunakaran, C., Bhargava, K., & Benjamin, R. 2015. Biosensors and bioelectronics. Elsevier
3. Sadana, A., Sadana, N., 2010. Handbook of Biosensors and Biosensor Kinetics; Elsevier Science & Technology.
4. Serra, P.A., 2010. Biosensors; In Tech
5. Tiwari, A., 2014. Biosensors Nanotechnology; Wiley-Scrivener
6. Russell, J. and Cohn, R., 2012. Biosensor; Book on Demand Ltd.
7. Banica, F.G., 2012. Chemical Sensors and Biosensors: Fundamentals and Applications; Wiley.

## **BIOFUELS AND BIOREFINERIES**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

#### **students will able to:**

1. Identify the organisms which can be used for biofuel production
2. Know about green biorefinery processes

### **COURSE CONTENTS:**

Biofuels introduction, types and sources; agroindustrial byproducts and biodegradable materials; genomics of biofuels; metabol; biorefineries; biobased industrial products; basics of green bio-refineries; agriculture, forestry and primary refinery raw material; ligno-cellulosic feedstock bio-refinery; whole-crop bio-refinery based on wet/dry milling and products from whole-crop bio-refinery; fundamental sugar platform and syngas platform; Biofuel production by Micro algae.

### **PRACTICALS:**

Projects related to Biofuel production, analysis and modelling

### **RECOMMENDED BOOKS:**

1. Meroehr, 2001. Biotechnology of Ethanol. Wiley-VCH
2. Vertes, A.A., Qureshi, N., Yukawa, H. and Blaschek, H.P., 2010. Biomass to Biofuels: Strategies for Global Industries. 1<sup>st</sup> Edition; Wiley.
3. Lee, S. and Shah, Y.T., 2012. Biofuels and Bioenergy: Processes and Technologies (Green Chemistry and Chemical Engineering). 1<sup>st</sup> Edition; CRC Press.
4. Jose, S. and Bhaskar, T., 2015. Biomass and Biofuels: Advanced Biorefineries for Sustainable Production and Distribution. CRC Press.
5. Zhen, F., 2013. Pretreatment Techniques for Biofuels and Biorefineries. Springer.

## **MOLECULAR VIROLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES :**

Students will able to know about the molecular basis for structure, complexity and expression of viral genomes

## **COURSE CONTENTS:**

The structure and complexity of virus genomes, Molecular genetics. virus mutants, Genetic and non-genetic interactions between viruses, single and double stranded DNA/ RNA viruses, Segmented and multipartite virus genomes, Reverse transcription and transposition, Evolution and epidemiology, Expression of genetic information, Control of prokaryote gene expression, Control of expression in bacteriophage I , Control of eukaryote gene expression, Genome coding strategies, Transcriptional control of expression, Post-transcriptional control of expression, Satellites and viroids, Prions, recombinant viruses.

## **PRACTICALS:**

1. Cell Culture Methods.
2. Life cycles of specific retroviruses,
3. Serological/Immunological methods.
4. Ultrastructural studies
5. Recombinant retroviral methods,
6. PCR techniques virus genome detection

## **RECOMMENDED BOOKS:**

1. Cann, A. 2015. Principles of molecular virology. USA: Elsevier Academic Press
2. Flint, S. J., Racaniello, V. R., Rall, G. F., Skalka, A. M., & Enquist, L. W. 2015. Principles of virology. ASM Press USA.
3. Kessler, H. H. 2014. Molecular diagnostics of infectious diseases. (Molecular diagnostics of infectious diseases.) Berlin [u.a: de Gruyter.
4. Klasse, P. J. 2015. The molecular basis of viral infection. Amsterdam : Elsevier.
5. Uyeda, I., & Masuta, C. 2014. Plant virology protocols: New approaches to detect viruses and host responses. New York: Humana Press.

## **ANTIMICROBIAL AND CHEMOTHERAPEUTICS**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will be able to:**

1. Understand the mechanisms of chemotherapy.
2. Develop general understanding of microbial control.
3. Examine various factors that influence microbial control.

## **COURSE CONTENTS:**

Nature and historical background of chemotherapy; Basic strategies for drug discovery: empirical screening, molecular targets and developing models; Range of antimicrobial targets. Chemical structure and biological activity; Molecular basis for selective action against the prokaryotes; Antimicrobial agents affecting: Cell wall synthesis, Protein Synthesis, DNA/RNA synthesis and others; Antifungal drugs affecting cell membrane and cell wall biosynthesis in fungi; Mechanism of action of antiviral drugs, antimitotic

agents, benzimidazole carbamates, alkaloids and taxol; Antiparasitic agents; Resistance mechanisms; Therapeutic implication of cytokines and vaccines; New approaches in Therapy; By the use of Blockers for: selective microbial enzymes, substrates and receptors; Blockers for biochemical processes; Action of antibiotics on biofilms, Emerging antimicrobial technology.

### **PRACTICALS:**

1. Isolation of antibiotic resistant bacteria from different sources
2. Effect of antibiotics on peptidoglycan content.
3. Effect of antibiotics on total soluble protein content.
4. Determination of extended spectrum beta lactamase in bacteria resistant to beta lactam antibiotics.
5. Determination of protein profile of antibiotic sensitive and resistant bacteria by polyacrylamide Gel Electrophoresis (PAGE).
6. Effect of antibiotic on bacteria present in biofilm.

### **RECOMMENDED BOOKS:**

1. Hauser, A. R., 2007. Antibiotic Basics for Clinicians. Wolters Kluwer Health.
2. Bobbarala, V., 2012. Antimicrobial Agents. In Tech.
3. Chakraborty, P., & Nagal, A. 2016. Software innovations in clinical drug development and safety. Hershey, PA : Medical Information Science Reference
4. Davey, P., Wilcox, M.H., Irving, W. and Thwaites, G., 2015. Antimicrobial Chemotherapy. 7<sup>th</sup> Edition. Oxford University Press.
5. Franklin, T.J. and Snow , G.A., 2010. Biochemistry and Molecular Biology of Antimicrobial Drug Action. 6<sup>th</sup> Edition. Springer-Verlag New York, LL
6. Finch, R., Davey, P., Wilcox, M.H. and Irving, W. 2012. Antimicrobial Chemotherapy. 6<sup>th</sup> Edition. Oxford University Press.
7. Greenwood, D., Finch, R., Davey, P. and Wilcox ,M., 2007. Antimicrobial Chemotherapy. Oxford University Press; 5<sup>th</sup> Rev Edition.
8. Loging, W. T. 2016. Bioinformatics and computational biology in drug discovery and development. Cambridge University Press.
9. Tran, P. L., Hamood, A. N., & Reid, T. W. 2014. Antimicrobial Coatings to Prevent Biofilm Formation on Medical Devices. Springer Link.

## **DRUG DEVELOPMENT**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will able to:**

1. Relate the fields of pharmaceutical sciences and drug designing
2. Develop clear design concepts that how to develop and evaluate drug

### **COURSE CONTENTS:**

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, pharmaceuticals 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 estimation, safety assessment in clinical trials, efficacy assessment in clinical trials, pharmaceutical and biopharmaceutical drug manufacture (post marketing phase).

### **PRACTICALS:**

1. Drug development from plants and microbes
2. In silico studies of drug designing and development

### **RECOMMENDED BOOKS:**

1. Faqi, A.S., 2012. A Comprehensive Guide to Toxicology in Preclinical Drug Development. 1<sup>st</sup> Edition. Elsevier.
2. Ganellin, R., Roberts, S.M. and Jefferies, R., 2013. Introduction to Biological and Small Molecule Drug Research and Development: Theory and Case Studies. Elsevier.
3. Hill, R.G. and Rang H.P. 2012. Drug Discovery and Development: Technology in Transition. 2<sup>nd</sup> Edition. Churchill Livingstone Elsevier.
4. Loging, W. T. 2016. Bioinformatics and computational biology in drug discovery and development. Cambridge University Press.
5. Platero, J.S. 2009. Molecular Pathology in Drug Discovery and Development. John Willey & Sons, Inc.
6. Rosier, J.A., Martens, M.A. and Thomas, J.R., 2014. Global New Drug Development: An Introduction. Wiley-Blackwell.

## **CANCER BIOLOGY**

**CREDIT HOURS 2+1**

### **LEARNING OUTCOMES:**

**The students will able to clearly demonstrate:**

1. The types of cancers and cell cycle.
2. The role of nutrients, hormones and gene Interaction in carcinogenesis

### **COURSE CONTENTS:**

Cell cycle, Check Points, Regulatory activities in S and M Phase (Heterokaryon experiments), Oncogenes: Growth factors, Receptors, Signal Transducer, Transcriptional Factors and Cell Cycle Genes. Tumor Suppressors: (Rb and P53 etc.), metastasis suppressor gene, oncoviruses, Different types of cancers, Tumor progression, Invasion and Metastasis, Cancer Epidemiology and Prevention, Risk factors and Carcinogenic agent: Chemicals and Radiations, Role of Nutrients, Hormones and Gene Interaction in Carcinogenesis, cancer diagnostics and biomarkers, Cancer Therapies.

## **PRACTICALS:**

1. Study of prepared specimens and slides of different tumors
2. Heterokaryon experiments
3. Study of DNA damage by physical and chemical methods
4. Ames test for identification of mutagenic agent
5. Case study of chromosomal abnormalities in human

## **RECOMMENDED BOOKS:**

1. Joyce, S., 2015. Cancer Biology. Kendall Hunt Pub Co.
2. Mendelsohn, J., Gray, J. W., Howley, P. M., Israel, M. A., & Thompson, C. 2015. The molecular basis of cancer. Philadelphia, PA: Saunders/Elsevier.
3. Mitchell, M. G. 2016. Cell biology: Translational impact in cancer biology and bioinformatics. London: Elsevier Science.
4. Strano, S. 2016. Cancer chemoprevention: Methods and protocols. New York: Humana Press.
5. Thiagalingam, S. 2015. Systems biology of cancer. Cambridge Press.
6. Vogelstein, B. and Kinzler, K. W. 2002. The Genetic Basis of Human Cancer, McGraw-Hill Companies, N.Y.

## **STEM CELL AND GENE THERAPY**

**CREDIT HOURS 2 +1**

### **LEARNING OUTCOMES**

#### **The students will be able to:**

1. Learn about properties of different stem cell populations, stem cell renewal and differentiation.
2. Describe the principles of underpinning stem cell and gene therapies with particular emphasis on current clinical strategies.

### **COURSE CONTENTS:**

Foundations of Biomedical Sciences, Understanding and scientific basis of Molecular Aspects of Cell and Gene Therapy, Biology of stem cells and gene delivery and the scientific basis of cell and gene therapy, Causes and genetic basis of diseases that can be treated by stem cells and gene therapy. Techniques and methods involved in the research and application of cell and gene therapy such as basic aspects of Aseptic technique, Cell culture, Cytometric analysis and sorting, Immunocytochemistry, fluorescence and confocal microscopy. Understanding of the basic mechanisms of development, Model organisms, Embryology, Cell fate determination, Differentiation, Pattern formation, Polarity, Cell migration, and cell interactions. Engineering approaches to cell-related phenomena important to cell/tissue engineering, Receptor/ligand binding. Trafficking/signaling processes. Application to cell proliferation, adhesion and motility. Cell-matrix interactions. An awareness of ethical and regulatory aspects, historical, current and future clinical trials of cell and gene therapy.



## **PRACTICALS:**

1. Laboratory Methods in Biomedical Science
2. Critical review and evaluation of scientific literature.
3. Formulate, design, execute and appraise a research plan.
4. Analysis of research results and data.
5. Students attend Stem Cell research Institute/conference/workshop/online presentations. Critical analysis and written summaries of the conferences and oral presentation.

## **RECOMMENDED BOOKS:**

1. Barranger, J. A. and Strauss, M., 1997. Concepts in Gene Therapy, Walter de Gruyter, N.Y.
2. Burdette, W. J. 2001. Basis for Gene Therapy, Charles C Thomas Publisher Limited, I.L.
3. Curiel, D. T. and Douglas, J. T. 2002. Adenoviral Vectors for Gene Therapy, Academic Press Inc., U.S.A.
4. Curiel, D. T. and Douglas, J. T., 2004. Cancer Gene Therapy. Humana Press.
5. Lanza, R. and Atala, A., 2014. Essentials of Stem Cell biology. 3<sup>rd</sup> Edition. Elsevier.
6. Marshak, D. R., Gardner, R. L. and Gottleb, D., 2001. Stem Cell Biology. Cold Spring Harbor New York.
7. Templeton, N. S. and Lasic, D.D., 2000. Gene Therapy: Therapeutics Mechanisms and Strategies. Marcel Dekker, Inc.
8. Templeton, N.S., 2015. Gene and Cell Therapy: Therapeutic Mechanisms and Strategies. 4<sup>th</sup> Edition. CRC Press.
9. Vile, R. G. and Lemoine, N. R. 2002. Understanding Gene Therapy, Springer-Verlag, N.Y.
10. Turksen, K. 2016. Embryonic stem cell protocols. Humana Press. New York
11. Cathomen, T., Hirsch, M., & Porteus, M. H. 2016. Genome editing: The next step in gene therapy. Springer.

## **ANIMAL MOLECULAR BIOLOGY**

**CREDIT HOUR (2+1)**

### **LEARNING OUTCOMES:**

The students will be able to understand basic concepts of molecular biology and its applications in animal and veterinary sciences.

### **COURSE CONTENTS:**

Structural and functional organization of chromosomes and genes in various livestock species, genetic and genomic variations and their selection for breed improvement, a battery of basic and advanced methods to characterize animal genes and genomes, functional and comparative genomics of farm animals. Role of molecular biology methods in assessment of food quality, illegal trade, epidemic origins, wildlife poaching hotspots and animal theft, animal cloning and its applications, genetic manipulations of embryos,

transgenic animals and expression of therapeutic proteins, animal models for human genetic disorders

**PRACTICALS:**

1. Different protocols for nucleic acids extraction from various tissues
2. Karyotyping of different farm animals
3. Species identification through PCR, RFLP, multiplex PCR and sequencing
4. DNA fingerprinting
5. Preparation and transformation of recombinant DNA molecules

**RECOMMENDED BOOKS:**

1. Khatib, H. 2015. Molecular and Quantitative Animal Genetics, Wiley-Blackwell.
2. Portner, R. 2007. Animal Cell Biotechnology, Humana Press.
3. Primrose, S.B. and Twyman, R.M. 2007. Principles of Genome Analysis and Genomics, Wiley-Blackwell.
4. Tropp, B.E. 2014. Principles of Molecular Biology, Jones & Bartlett Learning.
5. Verma, A. and Singh A. 2014. Animal Biotechnology: Models in Discovery and Translation, Elsevier Inc.
6. Liu, D. 2016. Molecular detection of animal viral pathogens. CRC Press.

# **MS & MPhil 2-YEARS PROGRAMME IN MOLECULAR BIOLOGY**

MS/MPhil (2-years programme, 18 years of education in Molecular Biology will spread over four semesters. The students have to complete course work of 24 credit hours in two semesters and there will be 06 credit hour research for thesis in 2<sup>nd</sup> year. According to the available expertise and statutes of the university elective courses

A list of the proposed courses (2+1 credit hours each) is given below; however, more subjects can be added as per requirements of the institute/university.

## **LIST OF CORE COURSES:**

1. Biologics
2. Professionalism Molecular Biology
3. Recent trends in Molecular Biology
4. Research Planning and Scientific writing

## **LIST OF ELECTIVE COURSES:**

1. Advances in Cell and Molecular Biology
2. Recent trends in Molecular Diagnostics
3. Advances in plant Molecular Biology
4. Advances in animal Molecular Biology
5. Advances in Pharmacogenomics
6. Advances in Molecular Genetics
7. Advances in Protein Chemistry
8. Advances in Bioinformatics
9. Advances in Fermentation Technology
10. Advances in Immunology
11. Advances in Fungal Biotechnology
12. Advances in Microbiology
13. Advances in Microbial Genetics
14. Recent trends in Biochemical Engineering
15. Advances in Nanobiotechnology
16. Advances in Biosensor Technologies
17. Advances in Forensic Sciences
18. Advances in Plant Tissue Culture
19. Advances in animal cell Culture
20. Biopharming in Plants, Principles and Techniques
21. Advances in Proteomics
22. Advances in Genomics
23. Advances in Biochemistry
24. Advances in neurobiology
25. Advances in Health Biotechnology

26. Advances in Vaccine Research
27. Bioresources and Gene Pool Conservation
28. Biofilms-natural communities
29. Behavioral Genetics
30. Aquatic genetics
31. DNA Barcoding
32. Current Trends in Molecular Medicine

## **DETAIL OF CORE COURSES**

### **BIOLOGICS**

**CREDIT HOURS 3 +0**

#### **LEARNING OUTCOMES**

**Students will be able to understand:**

1. About the biologic which is a type of highly complex medicine created by biotechnology processes.
2. How to get your Biologic Product to Market and keep it there.

#### **COURSE CONTENTS:**

Introduction to biologics and regulatory process. Biologics production process, prefield agroproducts, preclinical studies and good laboratory practice; clinical trials; containment and clean room requirements; special design and operational considerations; validations, good manufacturing practices and Inspection; format for quality module common technical documents; WHO system of acceptability in principle for the qualification of vaccine; changes to marketed drugs, introduction to the relevant regulatory authorities and laws.

#### **RECOMMENDED BOOKS:**

1. Calver, J.. 2012, Biologics: How to get your biological product to market and keep it there, Create Space Independent Publishing Platform.
2. Chow, S-H., 2013. Biosimilars: Design and Analysis of Follow-on Biologics. Chapman and Hall/CRC. Taylor and Francis Group, 6000 NW Broken Sound Parkway, Suite 300 Boca Raton, FL 33487

### **PROFESSIONALISM IN MOLECULAR BIOLOGY**

**CREDIT HOURS 3+0**

#### **LEARNING OUTCOMES:**

**Students will be able to learn:**

1. Ethical issues regarding molecular research
2. Professional responsibilities as molecular biologist

#### **COURSE OUTLINES:**

Ethical issues in molecular research and the professional responsibilities of molecular biologist based on readings and occasional lectures. The topics are intended to cover the requirements for ethical training of students in Good

laboratory practices, bioethics, biosafety and biosecurity and relevant international rules and regulation, recommendations of the regulatory authorities. Case studies on recent controversial issues.

## **RECENT TRENDS IN MOLECULAR BIOLOGY**

**CREDIT HOURS 3+0**

Course details will be based on critical readings, group discussions, analysis and presentation of recent research articles/ reviews/ websites/ data bases. Extension lectures regarding new inventions in molecular biology.

## **RESEARCH PLANNING AND SCIENTIFIC WRITING**

**CREDIT HOURS 3 +0**

Identification of biological research problems; Literature survey, hypothesis formulation, experimental designing, data analysis and interpretation. Scientific writing (report, synopsis, thesis, review and research article, research grants); conference presentation; ethics of scientific writings, designing consent and survey forms; Reference managers; plagiarism policies and software, responsibilities of research supervisor and students.

## RECOMMENDATIONS

At the end of session the committee recommended that:

1. There will be no midpoint entry into the BS programme unless they have already had prerequisite courses.
2. Field trips given in the practical session of different courses of BS programme should be funded by the HEC.
3. Refresher courses in biosafety and Molecular Biology programme should be conducted by the HEC Biosafety. Bioethics committees should be made in each institute.
4. Survey of undergraduate labs in different universities may be conducted by the regional committees of HEC and funds (partial or total) may be arranged by HEC to cater the basic infrastructure and other requirement for BS Molecular Biology Programme. Member of committee will submit for grants strengthening the Labs.
5. After implementation of BS Programme, feedback from students and teachers of Molecular Biology may be obtained by the HEC. And up gradation of the labs and courses should be aligned with the contemporary needs.
6. Separate Molecular Biology department should be established (with adequate funding) in universities of the different provinces of the country.
7. Teaching of Molecular biology should be started in colleges of all the provinces of Pakistan. The subject should be taught after appointing qualified (BS/MSc, MS/MPhil and PhD) Molecular Biologists.
8. Federal and Provincial Public Service Commission should be requested to include Molecular biology as one of the subjects in their list and consider it equivalent to biology/Biological sciences. Equivalence should be given to biology/biological sciences/equivalent biomedical sciences degree
9. The HEC and Ministry of Science and Technology whenever announcing a national awards scholarship/fellowship must clearly mention Molecular Biology as one of the discipline in their advertisement.
10. Application of Molecular Biology should be promoted by establishing interaction between industry, hospitals and universities in the last two years of BS Programme. Students should get the training (during summer vacations) in industry, hospitals, pharmaceutical industry.

11. All the appointed Teachers (in Molecular Biology) must be asked to undergo a training to develop the skills of Presentation and Communication.
12. HEC should encourage all the universities to organize programmes for continuing education in the form of workshops/seminars of a day or two, by providing a moderate grant for this purpose.
13. Maximum class enrollment should not be more than 40.
14. Workshop for patent filing should be arranged by HEC at each regional office/centre.
15. Credit hours for one year research in MS/MPhil should be equivalent to the credit hours prescribed for course work.