

CURRICULUM
OF
MICROBIOLOGY
BS/MS

(Revised 2013)



HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

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

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

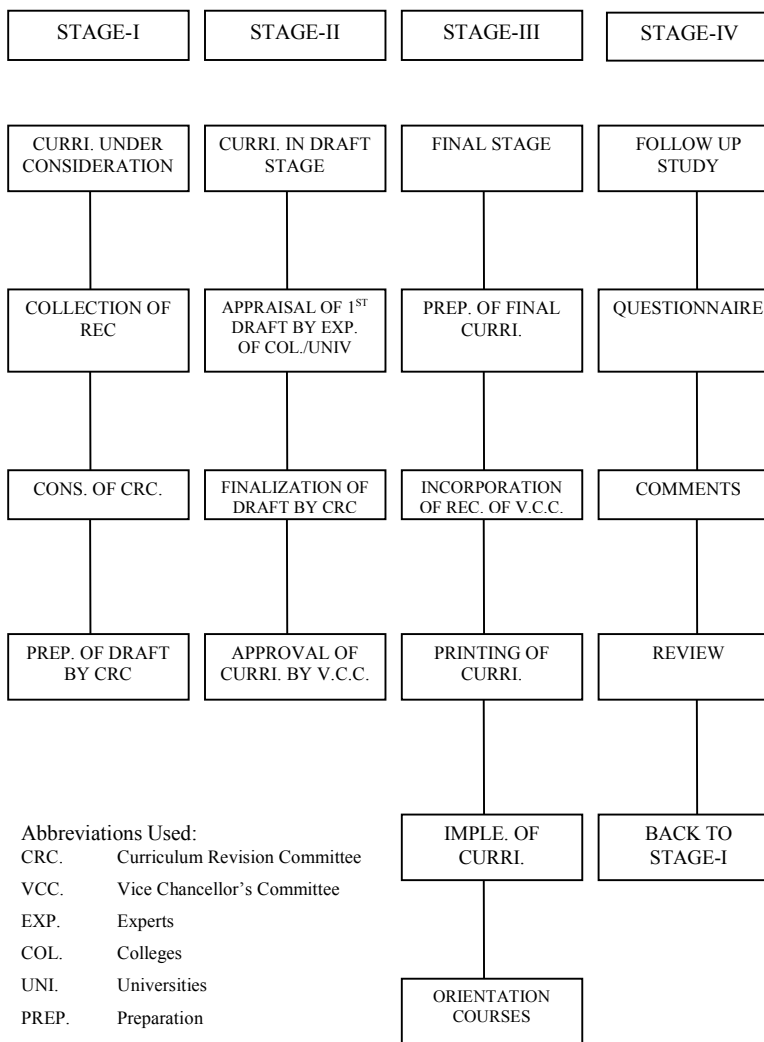
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector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

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

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

(Fida Hussain)
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



INTRODUCTION

MINUTES OF THE FINAL MEETING OF NCRC IN THE DISCIPLINE OF MICROBIOLOGY HELD ON MARCH 12-14, 2013 AT HEC REGIONAL CENTRE, LAHORE

The Final Meeting of National Curriculum Revision Committee in the discipline of Microbiology was held on March 12-14, 2013 at Higher Education Commission, Regional Centre, Lahore. The purpose of the meeting was to finalize the draft curriculum of Microbiology reviewed in the Preliminary Meeting held on October 10-12, 2012 at the same venue. Following Members attended the meeting:

1. **Prof. Dr Nusrat Jamil,** **Convener**
Professor,
Department of Microbiology,
University of Karachi, Karachi.
2. **Prof. Dr Muhammad Mukhtar,** **Member**
Vice Chancellor,
The Islamia University of Bahawalpur,
Bahawalpur.
3. **Prof. Dr. Shahana Urooj Kazmi,** **Member**
Dean Faculty of Science,
Department of Microbiology,
University of Karachi, Karachi.
4. **Dr. Fauzia Yusuf Hafeez,** **Member**
Professor,
Department of Bio Sciences,
CIIT, Islamabad
5. **Prof. Dr. Anjum Nasim Sabri** **Member**
Professor & Chairperson,
Microbiology and Molecular Genetics
Department, Quaid-e-Azam Campus
University of the Punjab, , Lahore
6. **Prof. Dr. Iftikhar Hussain,** **Member**
Professor & Director,
Institute of Microbiology, University of
Agriculture, Faisalabad.
7. **Prof. Dr. Jawad Ahmed,** **Member**
Professor & Director,
Department of Microbiology,
Institute of Basic Medical Sciences, Khyber
Medical University, Hayatabad, Peshawar.
8. **Dr. Abdul Haleem Shah,** **Member**
Professor,

- Department of Biological Sciences,
Gomal University, D.I. Khan.
9. **Dr. Ikram-ul-Haq, SI** **Member**
Director,
Institute of Industrial Biotechnology,
Government College University, Lahore.
 10. **Dr. Aqeel Ahmad,** **Member**
Chairman,
Department of Microbiology,
University of Karachi, Karachi.
 11. **Prof. Dr. Safia Ahmed,** **Member**
Professor & Chairperson,
Department of Microbiology,
Quaid-i-Azam University, Islamabad.
 12. **Dr. Bushra Uzair,** **Member**
Assistant Professor,
Department of Environmental Science,
IIU, Islamabad.
 13. **Dr. Ameer Afzal Memon,** **Member**
Assistant Professor,
Department of Microbiology,
Liaquat University of Medical & Health
Sciences, Hyderabad.
 14. **Dr. Muhammad Khurram,** **Member**
Assistant Professor,
Department of Microbiology &
Biotechnology, Sarhad University of
Science & Information Technology,
Peshawar.
 15. **Ms. Sahar Nigar,** **Member**
Lecturer
Center of Biotechnology & Microbiology,
University of Peshawar, Peshawar.
 16. **Dr. Muhammad Nazir Uddin,** **Member/Secretary**
Assistant Professor,
Department of Microbiology,
Abasyn University, Peshawar.

2. Following Members could not attend the meeting due to other engagements:

- 1 **Dr. Agha Muhammad Raza,**
. Chairman,
Department of Microbiology,
Balochistan University of Information Technology,
Engineering & Management Sciences, Quetta.
- 2 **Prof. Dr Tahir Yaqub,**
. Director,

University of Veterinary and Animal Sciences, Lahore.

3 **Dr. Azra Yasmin,**

. Associate Professor,
Department of Environmental Sciences,
Fatima Jinnah Women University, Rawalpindi.

4 **Dr. Shumaila Naz,**

. Assistant Professor,
Department of Biosciences,
University of Wah, The Mall, Wah Cantt.

5 **Dr. Shugufta Naz,**

. Professor / Head of Department,
Department of Biotechnology & Microbiology,
Lahore College for Women University, Lahore.

6 **Dr. Yasmeen Faiz Kazi,**

. Professor,
Department of Microbiology,
Shah Abdul Latif University, Khairpur.

7 **Dr. Umar Farooq,**

. Assistant Professor,
Institute of Food Science & Nutrition,
University of Sargodha, Sargodha.

3. The meeting started with the recitation of Holy Verses from the Holy Quran by Mr. Farrukh Raza, Assistant Director (Curriculum), HEC, followed by welcome address by Mr. Farman Ullah Anjum, DG (Acad.), HEC. He briefed the aims and OBJECTIVES of the meeting with particular focus on revision and finalizing the curriculum of Microbiology so as to bring it in line with the international standards keeping in view the national needs. After brief introduction of participants, the DG (Acad.) requested the Convener and Secretary of NCRC viz. **Prof. Dr. Nusrat Jamil**, Professor, Department of Microbiology, University of Karachi, and **Dr. Muhammad Nazir Uddin**, Assistant Professor, Department of Microbiology, Abasyn University, Peshawar, to conduct the further proceeding of the meeting for three days.

4. The Convener and Secretary of NCRC thanked the HEC for providing an opportunity to review/finalize the curriculum of Microbiology and recalled the proceeding of Preliminary Meeting held at Lahore. They further requested the participants to give their suggestions/inputs for improvement of curriculum and opened house for discussion. After long and thorough deliberation during three days, the Committee unanimously approved the curriculum of Microbiology for BS and MS/MPhil and made the recommendations, **as Annexed.**

5. The Convener and Secretary of the Committee thanked all the Members for sparing their valuable time and quality contribution towards finalization of the curriculum. The Committee highly admired the efforts made by the officials of HEC as well for making excellent hospitality and arrangements to facilitate the smooth work by the Committee at Lahore.

6. The meeting ended with the vote of thanks to the Chair as well as participants of the meeting.

Objective

The curriculum designed for the BS Microbiology will prepare the graduates to cope up with the issues for wide spectrum of areas including Medicine, Dairy, Poultry, Agriculture and Industry. These groomed man power will play a vital role in the economic growth would bring qualitative change in the above mentioned areas in the country. Internship in the curriculum will provide hands on experience in different fields mentioned above. It will also create awareness about public health and safety and facilitate the establishment of liaison between Microbiologist with society & industry.

FRAME WORK FOR BS MICROBIOLOGY (4 YEAR PROGRAMME)

Total numbers of Credit Hours	124-133
Duration	4 years
Semester duration	16-18 weeks
Semesters	8
Course Load per Semester	15-18 Cr hr
Number of courses per semester	4-6 (not more than 3 lab / Practical courses)

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments		Discipline Specific Foundation Courses	
07 courses		7-8 courses		9-10 courses	
Subject	Cr. Hr	Subject	Cr. Hr	Subject	Cr. hr
1. English I	3	1. Human Phy-I	2+1	1. Fundamentals of Microbiology-I	2+2
2. English II	3	2. Human Phy-II	2+1	2. Fundamentals of Microbiology II	2+2
3. Pakistan Studies	2	3. Biochemistry-I	2+1	3. Introduction to medical Microbiology	2+2
4. Islamic Studies / Ethics	2	4. Biochemistry-II	2+1	4. Gen.Imunology	2+1
5. Mathematics-I	3	5. Sociology	3+0	5. Microbial Taxonomy	2+1
6. Mathematics II OR Biostatistics	3	6. Environ-mental Current Issues	3+0	6. Gen.Virology	2+1
7. Computer Application	2+1	7.Genetics	2+1	7. Cell Biology-I	2+1
		8.Botany	2+1	8. Mycology	2+1
		9.Zoology	2+1	9. Research Methodology	2+1
		10. Chemistry	2+1	10. Biotechnology	2+1
		11. Biodiversity of animals	2+1	11. Biosafety & Risk Mnagement	3+0
		12. Biodiversity of plants	2+1		
		13. Plant physiology	2+1		
		14.Ecology and Ecosystem	2+1		
Note*		Note***			
Note**					
07 courses	19		24		33

* 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, Animal/Human/Plant Physiology, Chemistry/Biochemistry, Plant diversity and Genetics

Major courses including research project/internship		Elective Courses within the major	
11-13 courses		4 courses	
		12 Credit Hours	
Subject	Cr. hr	Subject	Cr. Hr
1. Cell Biology-II	2+1	Elective-I	2+1
2. Microbial Anatomy & Physiology	2+1	Elective-II	2+1
3. Fresh Water Microbiology	2+1	Elective-III	2+1
4. Bacterial Genetics	2+2	Elective-IV	2+1
5. Clinical Bacteriology	2+2		
6. Soil Microbiology	2+1		
7. Epidemiology, Public health and bioethics	2+1		
8. Environment Biotechnology	2+1		
9. Molecular Mechanism of Anti microbial Agent	2+2		
10. Genetic Engineering	2+2		
11. Medical Virology	2+2		
12. Immunobiology	2+1		
13. Research Project	0+6		
14. Internship	0+3		
15. Food Microbiology	2+1		
Note****			
	42		12

**** Student may take 11 courses out of the list of 15 courses in major other than Research Project and Internship

List of Elective Courses

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

- Cell & Tissue Culture Technology.
- Applied Microbial Technology.
- Plant Microbiology.
- Food and Dairy Microbiology.
- Marine Microbiology.
- Diagnostic Virology.
- Animal Virology.
- Clinical Bacteriology.
- Food Preservation Technology.
- Molecular Immunology.
- Clinical Parasitology.
- Plasmids, Episomes and Insertion Sequences.
- Microbial Enzyme Technology.
- Bioinformatics and Protein Structure/Function.
- Advances in Soil Microbiology.
- Environmental Microbiology and Public Health.
- Diagnostic Chemistry for Microbial Diseases.
- Veterinary Microbiology.
- Mycotic infections
- DNA Damage, Repair and Carcinogenesis.
- Management of Infectious Waste.
- Epidemiology: Analytical and Experimental Approaches.
- Advances in Microscopy and image analysis
- Nanobio technology.
- Structural and computational Biology.
- Industrial Microbiology
- Epigenetics

SCHEME OF STUDIES FOR (4 YEAR BS)

Semester/Year	Name of Subject	Credits
First	ENGLISH-I	3
	PAKISTAN STUDIES	2
	MATH- I	3
	GENERAL-I	2+1
	GENERAL-II	2+1
	FOUNDATION-I	2+2
		18
Second	ENGLISH-II	3
	ISLAMIC STUDIES / ETHICS	2
	MATH/STAT-II / UNIV. OPTIONAL	3
	GENERAL-III	2+1
	GENERAL-IV	2+1
	FOUNDATION-II	2+2
		18
Third	COMPUTER APPLICATION	3
	GENERAL-V	3
	GENERAL-VI	3
	FOUNDATION-III	2+2
	FOUNDATION-IV	2+1
		16
Fourth	GENERAL-VII	2+1
	GENERAL-VIII	2+1
	FOUNDATION-V	2+1
	FOUNDATION-VI	2+1
	FOUNDATION-VII	2+1
		15
Fifth	FOUNDATION-VIII	2+1
	FOUNDATION-IX	2+1
	MAJOR-I	2+2
	MAJOR-II	2+2
	MAJOR-III	2+1
	17	
Sixth	FOUNDATION-X	2+1
	MAJOR-IV	2+2
	MAJOR-V	2+2
	MAJOR-VI	2+1
	MAJOR-VII	2+1

		17
Seventh	MAJOR- VIII	2+2
	MAJOR-IX	2+1
	ELECTIVE-I	2+1
	ELECTIVE-II	2+1
	ELECTIVE PAPER / RESEARCH PROJ / INTERNSHIP	3
		16
Eight	ELECTIVE PAPER / RESEARCH PROJ / INTERNSHIP	3
	MAJOR-X	2+1
	MAJOR-XI	2+1
	ELECTIVE-III	2+1
	ELECTIVE-IV	2+1
	TOTAL – 124-136	15
	TOTAL CREDIT HOURS	132

COMPULSORY COURSES

1. English I
2. English II
3. English III (optional)
4. Pakistan Studies
5. Islamic Studies/Ethics
6. Mathematics-I
7. Computer Application.
8. Mathematics-II / Biostatistics

DETAIL OF COURSES

(ENGLISH –I) Functional English

Credit Hours: (3+0)

OBJECTIVES: To enhance language skills and develop critical thinking

Course Detail:

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

1. 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

1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking**(ENGLISH –II) Communication Skills**

Credit Hours: (3+0)

OBJECTIVES To enable the students to meet their real life communication needs

Course Detail**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 and minutes of the meeting, use of library and internet resources

Presentation skills

- Personality development (emphasis on content, style and pronunciation)

Note: Documentaries to be shown for discussion and review

Recommended Books

- 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 Y

ENGLISH-III (Optional)**Technical Writing and Presentation Skills**

Credit Hours: (3+0)

OBJECTIVES: To enhance language skills and develop critical thinking

Course Detail**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

- 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 (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
- b) Presentation Skills
- c) Reading
The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Pakistan Studies (Compulsory)

Credit Hours: (2+0)

(As Compulsory Subject for Degree Students)

OBJECTIVES

- To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Detail

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

ISLAMIC STUDIES (Compulsory)

Credit Hours: (2+0)

OBJECTIVES: To learn about Islam and its application in day to day life.

Course Detail

INTRODUCTION TO QURANIC STUDIES

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

STUDY OF SELECTED TEXT OF HOLLY QURAN

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

STUDY OF SELECTED TEXT OF HOLLY QURAN

- 1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6,21,40,56,57,58.)

- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

SEERAT OF HOLY PROPHET (S.A.W) I

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

SEERAT OF HOLY PROPHET (S.A.W) II

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

INTRODUCTION TO SUNNAH

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

SELECTED STUDY FROM TEXT OF HADITH

INTRODUCTION TO ISLAMIC LAW & JURISPRUDENCE

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

ISLAMIC CULTURE & CIVILIZATION

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

ISLAM & SCIENCE

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

MATHEMATICS - I

Credit Hours: (3+0)

OBJECTIVES

This is the first course of the basic sequence, Calculus I-III, serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts and skills needed for mathematical manipulation. Calculus I & II focus on the study of functions of a single variable.

Course Detail

- Limits and continuity.
- Derivative of a function and its applications.
- Optimization problems.

- Mean value theorem (Taylor's theorem and the infinite Taylor series with applications) and curve sketching; anti-derivative and integral.
- Definite integral and applications.
- The fundamental theorem of Calculus.
- Inverse functions (Chapters 1-6 of the text)

Recommended Books

1. Anton H, *Calculus: A New Horizon* (6th edition), 1999. John Wiley, New York.
2. Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)
3. Thomas G. B, Finney A. R., *Calculus* (10th edition), 2002. Addison-Wesley, Reading, Ma, U.S.A.
4. Anton, H., 1999. *Calculus: A New Horizon*, 6th Edition, John Wiley, New York.
5. Stewart J, 1995. *Calculus* ,3rd Edition, Brooks/Cole
6. Thomas, G. B. and Finney, A. R, 2002. *Calculus* 10th Edition, Addison-Wesley, Reading, Ma, U.S.A.

COMPUTER APPLICATIONS

Credit Hours: (2 +1)

Course Detail

- Introduction to Computer and Window 98/2000.
- 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.

BIO-STATISTICS

Credit Hours: (3+0)

OBJECTIVES

- It will help the students to analyze data pertaining to their research work
- To assess the significance of their experimental designs. Without statistical analysis research articles are not accepted for publication by the scientific journals.
- Students must have sound knowledge of the statistical programs.

Course Detail

- Introduction to Biostatistics and its scope in Microbiology.

- 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, ED₅₀ (LD₅₀ in detail), Quantile.
- 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.
- Laboratory Experiments pertaining to the course.

Recommended Books

1. Stanton, A.G., 2001. Primer of Biostatistics. McGraw-Hill.
2. Jekel, J., Elmore, J.G., Katz, D.L., 2001. Epidemiology, biostatistics and preventive medicine. W. B. Saunders.
3. Quinn, G., 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
4. Fernholz L.T, Morgenhaler, S., Stahel, W., 2000. Statistics in Genetics and in Environmental Sciences, Birkhauser Verlag.
5. Kuzma J. W. and Bohnenblust, S. E. 2001, Basis Statistics for the Health Sciences, McGraw-Hill International Education.

LIST OF GENERAL COURSES

1. Human Physiology-I
2. Human Physiology-II
3. Biochemistry-I
4. Biochemistry-II
5. Sociology
6. Environmental Current Issues
7. Genetics
8. Ecology
9. Ecosystem
10. Biodiversity of plants and Fungi
11. Plant/ Animal Physiology

DETAIL OF COURSES

HUMAN PHYSIOLOGY-I

Credit Hours (2 +1)

OBJECTIVES

- This course particularly imparts the concepts and mechanisms of integration in the different functional systems of humans.
- To understand coordination among various systems.

Course Detail

Introduction to Organization of human body including chemical and cellular levels.

- Tissue: Structure and function, Epithelial, Connective, Muscle and Nervous tissues, Bone and Cartilage, Adaptive cellular and tissue behavior, Hyperplasia, Hypertrophy, Atrophy and Genetic abnormalities.
- Blood: Physical characteristics and components of blood, Origin and development of blood cells, Structure and function of RBC, WBC, Platelets, Clotting Cascade, Blood groups and Homeostasis.
- Cardiovascular System: Cardiac Cycle, Heart Sounds, Cardiac Conduction System, Structure and Function of Blood Vessels.
- Lymphatic System: Overview of Lymph, Structure and function of lymphatic tissues and organs.
- Antibodies and Immune cells. Specific and nonspecific immune reactions.
- Respiratory System: Lung volumes and capacities, Non-respiratory air movements, Alveolar ventilation; mechanism of alveolar gas exchange.

- Digestive System: Structure and function of the digestive organs, Salivary glands and their secretions, Phenomenon of deglutition, Gastric and pancreatic juice and Digestion, absorption and movements of GIT.

Practical

1. Methods of obtaining blood samples, choice of anticoagulants and preservation.
2. To determine the Clotting Time.
3. To determine total leukocytes count (TLC).
4. To Determine Differential leukocytes count (DLC).
5. To determine the specific gravity and viscosity of blood and plasma.
6. To record the human blood pressure by using Palpatory and Auscultatory methods.
7. To observe and record normal heart activity in exposed frog heart by Kymography.
8. To observe respiratory movement and determination of respiratory rate by Kymography.
9. To determine the normal chemical composition of human saliva.

Recommended Books

1. Shier, D., Butler, J., Lewis, R., 2003. Hole's Essentials of Human Anatomy and Physiology, 8th ed; McGraw-Hill,
2. Tortora, G. J. J., and Grabowski, S. R., 2000. Principles of Anatomy and Physiology, 9th ed; John Wiley and Sons,
3. Guyton, A. C. and Hall, J. E. 2005. Textbook of Medical Physiology, 12th ed; W. B Saunders,
4. Waugh, A., Grant, 2002. A., Ross and Wilson Anatomy and Physiology in Health and Illness, 9th ed; Churchill Livingstone,
5. Marieb, E. N., 1997 .Human Anatomy and Physiology, 4th ed; Benjamin/Cummings Science Publishing,
6. Hall, J. E and Guyton, A. C., 2005. Guyton and Hall Physiology Review Elsevier Health Sciences.
7. Seifter, J., 2005. Concepts in Medical Physiology. Lippincott Williams and Wilkins.
8. Martini, F. H., and Ober, W. C., 2005. Fundamentals of Anatomy and Physiology, Pearson Education.
9. Marieb, E. N., 2005. Human Anatomy and Physiology Laboratory Manual: Fetal Pig Version, Update, Pearson.
10. Martini, F. H. 2005. Fundamentals of Anatomy and Physiology - Study Guide, Pearson.
11. Wood, M., 2005 Laboratory Manual for Anatomy and Physiology, Cat Version Pearson.
12. Wood, M, G., 2005. Anatomy and Physiology: Main Version Pearson Education.
13. Moore, K, L., Dalley, A. F. and Dalley, A. F., 2005. Clinically Oriented Anatomy .Lippincott Williams and Wilkins

HUMAN PHYSIOLOGY-II

Credit Hours (2 +1)

OBJECTIVES

- To study the details of physiological systems maintaining the homeostasis.
- Interrelations of the systems.
- Regulatory features of the each system's function.
- To study the details of nervous and hormonal coordination at molecular and cellular level in animal.
- Bio synthetics, secretary and regulatory aspects of coordination.

Course Detail

- Excretory system: System organization, Kidneys, Urine formation, Glomerular filtration, Processes of tubular reabsorptions and secretion.
- Endocrine System: Cellular secretions and their types, Structure and function of endocrine glands, Basic mechanism of hormone action, Control of hormone secretion by Hypothalamo-pituitary axis, Secretions of non-endocrine glands of body.
- Reproductive System: Female reproductive system, Oogenesis and its hormonal regulation, Menstrual cycle: Phases of menstruation, hormonal regulation, Overview of secondary sex characteristics, external genitalia and mammary glands, Male reproductive system, Testes and Spermatogenesis, Male sex hormones and their role in spermatogenesis, Accessory sex glands and composition of semen.
- Musculo-skeletal System: Structure and function of muscle, Neuromuscular junction.
- Nervous System: Structure and function of neuron, Membrane potential and nerve impulse, Synaptic transmission, Sensory and motor system.
- Spinal Cord: Nerve Pathways, Sensory and motor tracts and Spinal nerves, Reflexes and reflex arc.
- Brain: Functional areas of brain and cranial nerves, Formation and regulation of cerebrospinal fluid, Cerebral blood flow and blood brain barrier, Receptors and their classification.

Practical

1. To observe and determine the normal physical and chemical properties of urine sample.
2. Detection of abnormal constituents of urine in detail.
3. To determine (quantitative) blood urea nitrogen/Creatinine in the provided pathological sample for the detection of uremia.

4. Spectrophotometric determination of urinary calcium/Uric acid concentration.
5. Spectrophotometric determination of urinary phosphate concentration.
6. To study the muscular contraction kymography Isolation of nerve and muscle (Sciatic and Gastrocnemius) in frog and to observe irritability on mechanical and electrical stimulation.

Recommended Books

1. Shier, D., Butler, J., Lewis, R., 2003. Hole's Essentials of Human Anatomy and Physiology, 8th ed; McGraw-Hill.
2. Tortora, G. J. J., and Grabowski, S.R., 2000. Principles of Anatomy and Physiology, 9th ed; John Wiley and Sons,
3. Guyton, A. C. and Hall, J. E. 2005. Textbook of Medical Physiology, 12th ed; W. B Saunders.
4. Waugh, A., Grant, (2002). A., Ross and Wilson Anatomy and Physiology in Health and Illness, 9th ed; Churchill Livingstone,
5. Marieb, E.N., 1997. Human Anatomy and Physiology, 4th ed; Benjamin/Cummings Science Publishing,
6. Hall, J. E and Guyton, A. C., 2005. Guyton and Hall Physiology Review Elsevier Health Sciences
7. Seifter, J., 2005. Concepts in Medical Physiology Lippincott Williams & Wilkins.
8. Martini, F. H. and Ober, W. C., 2005. Fundamentals of Anatomy and Physiology, 2005. Pearson Education.
9. Marieb, E. N., 2005. Human Anatomy and Physiology Laboratory Manual: Fetal Pig Version, Update, Pearson.
10. Martini, F. H. 2005. Fundamentals of Anatomy and Physiology - Study Guide, Pearson.
11. Wood, M., 2005. Laboratory Manual for Anatomy and Physiology, Cat Version Pearson.
12. Wood, M. G., 2005. Anatomy and Physiology: Main Version. Pearson Education
13. Moore, K. L., Dalley, A. F. and Dalley, A. F., 2005. Clinically Oriented Anatomy. Lippincott Williams and Wilkins.

BIOCHEMISTRY-I

Credit Hours (2 +1)

OBJECTIVES

- The course will provide in depth knowledge about the polymerized organic compounds of life. The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work.

- In this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Detail

- Amino Acids; Peptides and Proteins; The Covalent and 3-D structure of proteins sequences and evolution.
- Carbohydrates: Monosaccharides, Oligosaccharides, Polysaccharides, Glycoconjugates, Glycosaminoglycans, Proteoglycans, Glycoproteins, Carbohydrates as informational molecules.
- Enzymes: Nature and Function of enzyme, Classification and Nomenclature.
- Mechanism of enzyme action and enzyme kinetics, Regulatory enzyme precursors and associates and Buffer and pH.
- 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, Steroles and Isoprenoids.

Practical

1. Normal Solutions.
2. Acid and Bases.
3. Electrolytes.
4. Non Electrolytes.
5. Buffers and pH.
6. Study of hydrolysis of starch by using mineral acids.
7. Various qualitative tests for Monosaccharide, oligosaccharides and polysaccharides
8. Preparation of calibration curve for glucose
9. Estimation of serum glucose by using calibration curve
10. Detection of reducing sugars in the presence of non-reducing sugars
11. Qualitative tests for different lipids.
12. Paper and thin-layer chromatography of sugars.
13. Paper chromatography of various amino acids.

14. Determination of pK values of amino acids (Glycine, Alanine) by preparation of titration curves.
15. Qualitative and quantitative analysis of proteins by colorimetric methods (Biuret and Lowry's)

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 5th Edition. W.H. Freeman and Company, New York.
3. Devlin, T. M., 2002. Textbook of Biochemistry with Clinical Correlations 5th Edition. John Wiley and Sons. Inc., New York,
4. Berg, J.M., Tymoczko, J.L., Stryer, L., 2006. Biochemistry: International 6th edition. W. H. Freeman and Co Ltd;
5. Cox, M. and Nelson, D. L., 2005. Lehninger Principles of Biochemistry 4th edition, Palgrave Macmillan.
6. Murray, R., Granner, D., Mayes, P., and Rodwell, V., 2006. Harper's Illustrated Biochemistry 27th Edition. McGraw-Hill Education.
7. Denniston, S., 2006. General, Organic and Biochemistry, 5th Edition. McGraw-Hill.

BIOCHEMISTRY-II

Credit Hours (2 +1)

OBJECTIVES

- The course will provide in depth knowledge about the polymerized organic compounds of life. The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work.
- In this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Detail

- Metabolism: Carbohydrate, Lipid and Protein, Gluconeogenesis, Biosynthesis and breakdown of glycogen in animals, Regulation of glycogen metabolism.
- Bioenergetics and Thermodynamics, Electron transport chain and oxidative phosphorylation in mitochondria, Role of mitochondria in Apoptosis and oxidative stress, Photosynthesis, Photophosphorylation and light absorption.

- Biosynthesis of Lipids: Mobilization and transport of fats, Biosynthesis of fatty acids and Eicosanoids.
- Biosynthesis of triacylglycerols.
- Membrane phospholipids
- Cholesterol and steroids.
- Biosynthesis of amino acids.
- Integration and hormonal regulation of mammalian metabolism.

Practical

1. Extraction and salting out of proteins.
2. Isolation and purification of proteins by various column chromatographic techniques (gel filtration and ion exchange).
3. Quantitative analysis of proteins by UV spectrophotometry
4. 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 5th Edition. W.H. Freeman and Company, New York.
3. Devlin, T. M., 2002. Textbook of Biochemistry with Clinical Correlations 5th Edition. John Wiley and Sons. Inc., New York.
4. Zubay, G., 1995. Biochemistry 4th Edition. W. C. Brown Publishers, Inc., Oxford England.
5. Plummer, D. T., 1990. An Introduction to Practical Biochemistry 4th Edition. McGraw-Hill Book Company, London,
6. Wilson, K. and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Edition. Cambridge Univ. Press, London
7. Berg, J. M., Tymoczko, J. L., Stryer, L., 2006. Biochemistry: International 6th edition. W.H. Freeman & Co Ltd.
8. Cox, M. and Nelson, D.L., 2005. Lehninger Principles of Biochemistry 4th edition, Palgrave Macmillan.
9. Murray, R., Granner, D., Mayes, P., and Rodwell, V., 2006. Harper's Illustrated Biochemistry 27th Edition. McGraw-Hill Education.
10. Denniston, S. 2006. General, Organic and Biochemistry, 5th Edition. McGraw-Hill.

SOCIOLOGY

Credit Hours (3+0)

OBJECTIVES

- The course is designed to introduce the basic concepts of sociology with particular reference to environment and social relationships.
- It provides understanding of the role of human being in creating and recreating the environment.
- It evaluates the development and environment relationships, environmental policies and environmental movements with reference to environmental issues.

Course Detail

- 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.
- Social 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.

CURRENT ISSUES IN ENVIRONMENT

Credit Hours (3+0)

OBJECTIVES

- This course aims to provide knowledge about various environmental issues in multidimensional perspectives. It uses critical approach to global, regional and local environmental issues.
- The course provides review of the different environmental issues including ecological, conservation, pollution, resources, population and socioeconomic issues.
- It deals with the management and planning issues using case studies. This will enable the students to identify and analyze various environmental issues critically.
- They will be able to draw and formulate different strategies to address the multidisciplinary issues in different countries in general and in Pakistan in particular.

Course Detail

- 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, Greenhouse effect, Greenhouse gases, Changes in CO₂- Carbon Cycle, Changes in temperature, Socioeconomic effect, Environmental effects.
- Ozone Depletion: Ozone-structure, Properties/Significances, Ozone destroying catalysts, Natural, Anthropogenic, Antarctic ozone 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.
2. Cooper, G.J., 2003. The Science of the Struggle for Existence (On The Foundation of Ecology, Cambridge University Press.
3. Baker, A.J., 2000. Molecular Methods in Ecology, Science.
4. Nico, M., Straalen, V., and Roelofs, D., 2006. An Introduction to Ecological Genomics. Oxford University Press.
5. Aston, A., Harris, S., Lowe, A., 2004. Ecological Genetics: Planning and Application. Blackwell Science (UK).
6. Costa, L. G., and Eaton, D. L., 2006. Gene-Environment Interactions: Fundamentals of Ecogenetics. John-Wiley and Son Limited.
7. Freeland, J. R., 2005. Molecular Ecology. John-Wiley and Son Limited.
8. Light, A and Rolston III. H. 2003. Environmental Ethics. Blackwell Publishers Ltd. U.S.A.
9. Wenz, P. S., 2001. Environmental Ethics Today, Oxford University Press.
10. Louis P. and Pojman, L. P., 2004. Environmental Ethics: Readings in Theory and Application, 4th edition. Wadsworth Publishing.
11. Light, A., and Rolston, III. H., 2005. Environmental Ethics. Blackwell Publishing Incorporated.
12. Raven, P. H., and Berg, L. R., 2005. Environment, 5th Edition. John-Wiley and Son Limited
13. Bradshaw, V., 2006. The Building Environment: Active and Passive Control Systems, 3rd Edition. John-Wiley and Son Limited

GENERAL GENETICS

Credit Hours (2+1)

OBJECTIVE

- To learn about the genetics of eucaryotes
- To learn about the structure and function of chromosome
- To understand the mechanism of heredity in animal.

Course Detail

- 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.

Practical

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. Costa, L. G. and Eaton, D. L. 2006. Gene-Environment Interactions; Fundamentals of Ecogenetics, John Wiley and Sons, N.Y.
2. Primrose, S. B. and Twyman, R. M. 2006. *Principles of Gene Manipulation and Genomics*, Blackwell Scientific Publications, U.S.A.
3. Philip, M., *Advanced Genetic Analysis: Genes, Genomes and Networks in Eucaryotes*. (2009). Oxford University Press.
4. Leland, H., Leroy, H. *Genetics: From Gene to Genome*. (2010) McGraw Hill Sciences.
5. Asche, 2013. *Recent Advances in Cloning Genetics and Stem Cell Technology*. RDM.

6. James D. W. 2013. Molecular Biology of Gene. Benjamin Cumming.

BIODIVERSITY OF PLANTS AND FUNGI

Credit Hours (2+1)

OBJECTIVE

- To learn about the phylogenetic relation between plants and fungi.
- To learn about the evolutionary history and of fungi and plant.

Course Detail

- Introduction: Diversity of life.
- Arranging the diversity of life into Kingdoms.
- Prokaryotes and origin of metabolic diversity
- The origin of eukaryotic diversity: Eukaryotic origin by symbiosis among prokaryotes.
- Eukaryotic algae as key producers in aquatic ecosystem.
- Major characteristics of phyla of kingdom Plant and colonization of land.
- Plant diversity and evolutionary history of plant kingdom, structural and reproductive adaptation for colonization of land.
- Plant structure and Growth
- Reproduction & Development: Life cycle of plant.
- Evolutionary adaptation in germination of seeds, methods of reproduction and their role in agriculture, overview of developmental mechanism in plants.
- Control systems of Plants to cope with environmental stresses
- Body plan and nutritional modes in Fungi
- Classification of Fungi

Practical

1. Study of morphology and reproductive structures of eucaryotes and prokaryotes 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. Schafer, 2006. Photomorphogenesis in plant and Bacteria.
2. Barbara J. E.s., Christine J. C. B. and Thomas N. S. 2010. Microbial Roots Endophytes. Springer.
3. Shelly, 2010. Stern's Introductory Plant Biology. McGraw-Hill Sciences.

4. Anna M. P. and A. Carolina F. 2011. Endophytes of forest Trees. Springer.
5. Alexopoulos, 2012. Introductory Mycology.
6. Teiji S., Hideki K. et al. 2013. Species Diversity and Community Structure. Springer.

ECOSYSTEM

Credit Hours (2+1)

OBJECTIVE

- To learn about different ecosystems
- To learn about food dependency of organisms in an ecosystems.

Course Detail

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

Practical

1. Study of pond freshwater ecosystem.
2. Study of vegetation profile grassland and forest.
3. Study of some biotic and abiotic factors of grassland and aquatic ecosystem, methods of sampling.
4. Measurements and description of plant communities by different methods.
5. Study of decomposition of leaf litter by organisms.

Recommended Books

1. Prakash, 2008. Molecular Biology of Ecology. DPH
2. Joanne W. and Linda S., Chris W. 2010 Prescott's Microbiology. McGraw-Hills Science.
3. Larry L. B. and Dian E. W. 2011. Microbial Ecology. Wiley Blackwell.
4. Thomas M. S. and Robert L. S. 2012. Elements of Ecology. Benjamin Cumming.
5. Manuel M. 2012. Ecology: Concepts and Application. McGraw-Hill Science.

LIST OF FOUNDATION COURSES

1. Fundamentals of Microbiology-I
2. Fundamentals of Microbiology-II
3. Introduction to Medical Microbiology-III
4. General Immunology
5. Microbial Taxonomy
6. General Virology
7. Cell Biology-I
8. Mycology
9. Research Methodology
10. Biotechnology
11. Biosafety & Risk Management

DETAIL OF FOUNDATION COURSES

FUNDAMENTAL MICROBIOLOGY-I

Credit Hours (2+2)

OBJECTIVES

- To enable the students to work with microorganisms.
- To understand the basic techniques of sterilization, culturing and isolation.
- Determining different characteristics of the microorganisms.

Course Detail

- Fundamentals of microbiology.
- Microorganisms and their respective place in the living world.
- Differentiation between pro- and eukaryotic cells.
- Historical development of Microbiology and its scope.
- Microscopy: An outline of the principles and applications of light and electron microscope.
- Morphology, arrangement and detailed anatomy of bacterial cell.
- Bacterial taxonomy and nomenclature, basis of classification of bacteria.
- Growth, nutrition (physical and nutritional requirement and nutritional types; sources of energy, C, N, H, O, S, P, H₂O, trace elements, growth factors) and reproduction.
- General methods of studying microorganisms: cultivation, isolation, purification and characterization.
- Control of microorganisms by physical and chemical methods.
- Chemotherapeutic agents and antibiotics. Modes of action of antibiotics on microorganisms.
- Basic properties of fungi, protozoa and algae.

- A brief introduction to structure and propagation of viruses and bacteriophages.

Practical

1. Laboratory safety: Containment and decontamination.
2. An introduction to microscopy.
3. Principles of Staining Procedures: Simple staining, Gram's staining, Acid-fast staining, cell-wall staining, flagellar staining, capsule staining, spore staining and spirochaete staining. Study of cell motility by hanging drop preparation.
4. Preparation and sterilization of bacteriological media and glassware.
5. Inoculation techniques. Study of colony characteristics of microorganisms.
6. Standard plate count technique (SPC).
7. Microbiological analysis of air.

Recommended Books

1. Baker , S., Khan , N., Nicklin, J. and Killington, R., 2006. Instant Notes in Microbiology, 3rd Ed edition, Taylor and Francis.
2. Black, J. G. 2005. Microbiology: Principles & Explorations, 6th edition, John Wiley and Sons, N.Y.
3. Talaro, K. P. 2008. Foundations in Microbiology: Basic Principles, McGraw-Hill Companies, N.Y.
4. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. Microbiology: An Introduction, Benjamin-Cummings Publishing Company, U.S.A.
5. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. Study Guide for Microbiology: An Introduction. 11th edition. Benjamin-Cummings Publishing Company, U.S.A.

FUNDAMENTAL MICROBIOLOGY-II

Credit Hours (2+2)

OBJECTIVES

- To know about the applications of the science of microbiology in the different fields of life.
- The course may initiate students' interest in agricultural, industrial and/or environmental microbiology.

Course Detail

- Structure and chemical composition of nucleic acid. Role of RNA, DNA in protein synthesis.

- Mode of reproduction: Cell division (prokaryote), mitosis and meiosis (eukaryote), bacterial mutation and variation. Introduction to the genetical intermixing of bacteria including transformation, transduction and conjugation.
- Introduction to metabolism and role of phosphorus in energy transfer. Glycolysis and T.C.A. cycle.
- Microbiology of water and wastewaters. Water as a source of infection and methods of water purification. Methods of sewage treatment and disposal.
- Introduction to food and dairy microbiology. Methods of food preservation.
- Differentiation between food intoxication and food-infection.
- Microbiology of soil with particular reference to nitrogen cycle.
- Microbiology of air.

Practical

1. Isolation of Chromosomal DNA from E.coli.
2. Electrophoresis of Microbial DNA.
3. Effect of UV light on phenotype and genotype of bacteria.
4. Enumeration of bacteria in drinking water, milk, soil and air.
5. Pure culture study of (on the basis of morphological, cultural and biochemical characteristics): *E. coli*, *Salmonella sp*, *Shigella sp*, *Staphylococcus aureus*, *S. epidermidis* and *S. fecalis*, *Corynebacterium*.
6. Microscopic study of *Leishmania*, *Entamoeba*, *Plasmodium* and *Giardia*.
7. MPN technique.

Recommended Books

1. Black, J. G. 2005. Microbiology: Principles & Explorations, 6th edition, John Wiley and Sons, N.Y.
2. Talaro, K. P. 2008. Foundations in Microbiology: Basic Principles, McGraw-Hill Companies, N.Y.
3. Tortora, G. J., Funke, B. R. and Case, C. L. 2008. Microbiology: an introduction 9th Edition, Pearson Education.
4. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. Study Guide for Microbiology: An Introduction. 11th edition. Benjamin-Cummings Publishing Company, U.S.A.
5. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. Microbiology: An Introduction, Benjamin-Cummings Publishing Company, U.S.A.

INTRODUCTION TO MEDICAL MICROBIOLOGY

Credit Hours (2+2)

OBJECTIVES

- To understand pathogenesis of microorganisms
- To learn basic mechanism of infection and molecular mechanism of Pathogenesis.

Course Detail

- Introduction: Host-parasite interactions.
- Determination of pathogenicity and molecular mechanisms of pathogenesis.
- Chemotherapy and drug resistance.
- Study of bacterial infections with emphasis on mechanisms of pathogenesis of the following groups: *Streptococcus*, *Staphylococcus*, *Niesseria*, *Pseudomonas*, *Corynebacterium*, *Bordetella*, *Vibrio*, Enterobacteraceae, *Clostridium*, *Bacillus*, *Campylobacter*, *Aeromonas* and *Helicobacter*, *Legionella*, *Mycobacterium*, *Actinomycetes/ Nocardia*, *Chlamydia* and *Mycoplasma*.
- Zoonotic infections.
- Study of viral and rickettsial diseases including epidemic and endemic typhus, AIDS, Hepatitis. Poxviruses and Herpes viruses.
- Protozoan infections with emphasis on Leishmaniasis and Toxoplasmosis.
- Pathogenesis of mycotic infections with particular emphasis on mycetoma.
- Classical and newly emerging pathogens.

Practical

1. Collection and transportation & microscopic examination of clinical samples.
2. Infections of ear, nose, throat, eye, GIT, urogenital tract (swabs).
3. Isolation and identification of selected micro-organisms.
4. Antibiotic assays by disc diffusion methods and dilution method.
5. Determination of MIC and MBC.
6. Antibacterial activity of serum.
7. Agglutination test (Widal test).
8. Precipitation tests.
9. Urine analysis (physical, chemical and microbiological)

- 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).

Practical

1. 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. Chen, E. R. and Kasturi, S. 2006. Deja Review: Microbiology and Immunology, McGraw-Hill Companies, N.Y.
2. Van Emon, V. M. 2006. Immunoassay and Other Bioanalytical Techniques, CRC Press, F.L...
3. Abbas, A. K., Lichtman, A. H. and Pillai, S. 2007. Cellular and Molecular Immunology, Elsevier Health Sciences, N.Y.
4. Johnson, A. G. G., Ziegler, R. J., Lukasewycz, O. A. and Lukasewycz, O. A. 2007. Microbiology and Immunology: Board Review Series, Lippincot Williams and Wilkins, M.D.
5. Lichtman, A. H. 2007. Basic Immunology. Elsevier Health Sciences, N.Y.
6. Murphy, K., 2011. Janeway's Immunobiology (Immunobiology: The Immune System, 8th Edition. Garland Science Publishers.

MICROBIAL TAXONOMY

Credit Hours (2+1)

OBJECTIVES

- Identify the OBJECTIVES of classification.
- Identify traits used to classify microorganisms.
- Locate microorganisms in the realm of living world.

Course Detail

- Basic concepts and aims of classification.
- Classical and molecular basis of classification of prokaryotes and eukaryotes.
- Bacterial nomenclature.
- Classification of Enterobacteriaceae, spore formers, Actinomycetes (*Mycobacterium & Nocardia*), Spirochetes (*Treponema & Leptospira*).
- Detailed classification of viruses, fungi, protozoa and Algae.
- A brief introduction of Rickettsia, Chlamydia and Mycoplasma.
- An introduction to Prions and Viroids.

Practical

1. Characterization of bacteria (enteric & nosocomial) and fungi on the basis of different biochemical and cultural characteristics.
2. Study of phylogenetic relationship using appropriate computer software.

Recommended Books

1. Garrity, G. M., Krieg, N. R., Brenner, D. J., 2006. Bergey's Manual of Systematic Bacteriology: The Proteobacteria, Vol. 2. Williams and Wilkins Co, Baltimore.
2. Scott F. and Jon c. H., 2007. Evolutionary Analysis. Benjamin Cumming.
3. Roberto K. and Stanley M. 2012. Microbes and Evolution: The World That Darwin Never Saw. ASM. Press.
4. David L. K. 2012. Process in Microbial Ecology. Oxford University Press.
5. Ralf G. Dietzgen, R.F., and Ivan V. Kuzmin, I.V., 2012. Rhabdoviruses: Molecular Taxonomy, Evolution, Genomics, Ecology, Host-Vector Interactions, Cytopathology and Control Caister Academic Press. USA.

GENERAL VIROLOGY

Credit Hours (2+1)

OBJECTIVES

- To identify major components of viruses.
- System of traits used for classification of viruses.
- Describe how viruses interact with cells.
- Examine the ways that viruses persist in host cells.

Course Detail

- 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 viriod.
- Origin of life and Evolution.

Practical

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. Mahy, B.W.J., & Van Regenmortel, M.H.V., 2008. Encyclopedia of Virology 3rd. Edition. Elsevier

2. Cann, A. J., 2011. Principles of Molecular Virology.5th Edition. Academic Press.
3. Robert, W. Molecular Biology. 2011. McGraw-Hill Sciences
4. Ralf G. Dietzgen, R.F., and Ivan V. Kuzmin, I.V.,2012. Rhabdoviruses: Molecular Taxonomy, Evolution, Genomics,
5. Caister. 2012. Ecology, Host-Vector Interactions, Cytopathology and Control Academic Press. USA.

CELL BIOLOGY- I

Credit Hours (2+1)

OBJECTIVES

- To learn about the cell and its organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.
- To learn the various ultra-structural, molecular and functional aspects of the cells.

Course Detail

- Introduction to cell biology.
- Difference between prokaryotes and eukaryotes.
- Physico-chemical properties of protoplasm.
- Ultra-structure, chemical composition and functions of cell wall, cell membrane, cellular organelles (mitochondria, endoplasmic reticulum, Golgi apparatus, Lysosome, Glyoxysome, Nucleus, Ribosomes, etc.) Cytoskeleton.
- Chemical composition and molecular structure of chromosomes.
- Cell cycle and apoptosis.
- Cell reproduction.
- Signal transduction.
- Plant Cell culture.

Practical

1. Study of different types of prokaryotic and eukaryotic cell.
2. Study of different cell organelle by staining: Karyotyping.
3. Study of meiosis (pollen) and mitosis (onion root).

Recommended Books

1. Alberts. B., 2007. Molecular Biology of the Cell Taylor and Francis, Inc.
2. Karp, G., 2007. Cell and Molecular Biology, Study Guide: Concepts and Experiments.5th Edition. Wiley, John and Sons Inc.
3. Lodish, H., 2011. Solutions Manual for Molecular Cell Biology.7th Edition. W.H. Freeman & Company
4. Lodish, H., Berk, A., Kaiser, C. A., M Krieger; Bretscher, A., Ploegh,H; Amon,A., Scott, M., 2012. Molecular Cell Biology.7th Edition. W. H. Freeman Company.
5. James, D. W. 2013. Molecular Biology of Gene Benjamin Cumming.

MYCOLOGY

Credit Hours (2+1)

OBJECTIVES

- To learn characteristics of fungi for classification.
- Examine fungal metabolism.
- To learn about pathogenic fungi and their infections in plant and animal.

Course Detail

- Introduction to mycology.
- Fundamentals of fungal classification.
- Structure and physiology of fungi.
- Physical and nutritional factors affecting the growth of fungi.
- Structural development and reproduction in fungi including cell cycle.
- Fungal metabolism (with reference to food and beverages).
- Economic impact of fungal plant, animal and human diseases and their control.
- Mycotoxins.
- Use of fungi in biotechnology.
- Edible fungi.

Practical

1. Isolation and identification of fungi from:
 - Environment
 - Rhizosphere
 - Clinical samples.
2. Effect of temperature on growth of fungi.

3. Determination of antifungal activity of (nystatin, actidion, amphotericin B etc.)
4. Propagation of edible mushroom.

Recommended Books

1. Hocking, A.D., Pitt, J.I., Samson, R.A., Thrane, U., 2006. Advances in Food Mycology, Springer.
2. Webster, J. and Weber, R. 2008. Introduction to Mycology, Cambridge University Press.
3. Ainsworth, G.C., 2009. Overview: Introduction to the History of Mycology. Cambridge University Press.
4. Inderjeet K. S. and Surinder K. W., 2010. Text Book of Fungi and Their Allies.
5. Katherine B., Daniel J. E., 2010. Cellular and Molecular Biology of Filamentous Fungi. ASM Press
6. Caister Gioconda, S-B. and Richard, C. A., 2012. Pathogenic Fungi: Insights in Molecular Biology. Academic Press.

RESEARCH METHODOLOGY

Credit Hours (3+0)

OBJECTIVES

- To introduce the methods involved in research
- To learn about the misconduct, copyright and patents law.

Course Detail

- Introduction: Research and professions.
- Understanding the research process.
- History and Principles of research ethics.
- Originality of Research.
- Conflicts of interest.
- Copyright and Patent Law.
- Aims of research, the research topic.
- Title and research problem.
- Literature review: Search, retrieve and manage information.
- Research design.
- Parametric, non-parametric and semi-parametric methods.

- Qualitative Methodologies and interpretation of results.
- Conclusions and its validity.
- Report writing and the research proposal.
- Community Research.
- Principles of presentation.
- Communication-oral, posters.
- Abstract and manuscript preparation.
- Communicating your own credentials.
- Communicating own work-CV.

Recommended Books

1. Ann Bowling, A. and Ebrahim S., 2005. Handbook of Health Research Methods. Open University Press, Two Penn Plaza, New York, NY.
2. Baumgartner, T. and Hensley, L. 2006. Conducting and Reading Research in Health and Human Performance 4th ed. McGraw-Hill, New York.
3. Kumar, R., 2010. Research Methodology: A Step-by-Step Guide for Beginners. 3rd edition. SAGE Publications, London
4. Flick, U., 2011. Introducing Research Methodology: A Beginner's Guide to Doing a Research Project SAGE Publications London
5. Chilisa, B., 2011. Indigenous Research Methodologies SAGE Publications, London.

BASIC BIOTECHNOLOGY

Credit Hours (2+1)

OBJECTIVES

To understand the potentials of microorganisms and utilizations of beneficial microorganisms

Course Detail

- Introduction to history of biotechnology.
- Recombinant products expression and transgenic.
- Design of sterilization systems.
- Fermentation.
- Product recovery, waste treatment and safety.

- Biosensors: applications of biosensors, transducer technology, principles of biosensors.
- Recombinant Protein Production, General aspects of heterologous protein expression.
- Bacterial expression systems - *Escherichia coli* and *Bacillus subtilis*.
- *Saccharomyces cerevisiae* as a system for expression of heterologous proteins.
- Expression in non-*Saccharomyces* yeast species and filamentous fungi and microbial productions of: pharmaceuticals, diagnostic proteins, vaccines, microbial toxins and insecticides.

Practical

1. Isolation and screening microorganism
2. Screening for microbial extracellular metabolites, enzymes and antimicrobial agents
3. Citric acid fermentation.
4. Field trip to an industry with a large scale fermentor.

Recommended Books

1. Tourte, Y., and Tourte, C., 2005. Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications. Science Publishers.
2. Alex. 2010. Principles of Biotechnology. ADP.
3. Baskar, C., Baskar, S., Dillon, R. S., 2012. Biomass Conversion: The Interface of Biotechnology, Chemistry and Materials Science .Publisher: Springer-Verlag, New York, LLC.
4. Thiemann, W.J., Palladino, M.A., 2012. Introduction to Biotechnology. 3rd Edition. Benjamin Cummings Publishers.
5. Aunger. 2013. Recent Advances in Bacterial Biotechnology, RDM.

BIO-SAFETY AND RISK MANAGEMENT

Credit Hours (3+0)

OBJECTIVES

- To learn safe practices for handling of microbes.
- To learn about risky and hazardous environment.
- To learn about the development of safe and healthy environment.

Course Detail

- Detailed concept of Risk and Hazardous Environment, Chemicals, Biological factors and Radiations.
- Risk assessment & Management: Preventions, Surveillance and Monitoring.
- Judicial rights / Penalties.
- Concepts of Biosafety Environment: Terrestrial, Marine, Atmosphere.
- Designing of labs based on Biosafety and Biological Containment parameters.
- Details of Biological Containment: Plants, Animals, Microbes.
- Bioethical issues related to Biosafety.
- Biosafety levels.

Recommended Books

1. Fleming, D.O., and D.L. Hunt, D.L.2006. Biological Safety. Principles and Practices, 4th edition, ASM Press, Washington, D.C.
2. US Health Department. 2010. Biosafety in Microbiological and Biomedical Laboratories Edition 5. Books Express Publishing.US
3. Horst, K.N., 2011. Biosafety Cabinet .Dig Press.
4. Russell, J. Cohn, R., 2012. Biosafety. Bookvika Publisher.

LIST OF MAJOR COURSES

1. Cell Biology-II
2. Microbial Physiology
3. Fresh Water Microbiology
4. Bacterial Genetics
5. Clinical Bacteriology
6. Soil Microbiology
7. Epidemiology
8. Environment Biotechnology
9. Molecular Mechanism of Anti-microbial Agent
10. Genetic Engineering
11. Medical Virology
12. Immunobiology
13. Research Project
14. Internship
15. Food Microbiology

DETAIL OF MAJOR COURSES

CELL BIOLOGY-II

Credit Hours (2+1)

OBJECTIVES

- To understand the cell and its organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.
- To learn the various ultra-structural, molecular and functional aspects of the cells.

Course Detail

- *E. coli* and yeast as representative prokaryotic and eukaryotic models for molecular differentiation.
- Molecular mechanism of Replication.
- Transcription and Translation.
- Transcriptional and translational regulation of gene expression.
- Regulation of gene expression in prokaryotes and eukaryotes.
- Types of recombination.
- Mutations and chromosomal aberrations.

- DNA damage and repair.
- Gene sequencing.
- Principles of Recombinant DNA technology.
- Role of Recombinant DNA Technology in economic development.
- Human Genome Project.
- Stem Cell Research.

Practical

1. Karyotyping.
2. Study of DNA damage by physical and chemical methods.
3. Case study of chromosomal abnormalities in human and agricultural specimen.
4. Ames test for identification of mutagenic agents.

Recommended Books

1. Alberts. B., 2007. Molecular Biology of the Cell. Taylor and Francis, Inc.
2. Pollard, T. D., Lippincott-Schwartz, J., Earnshaw, W. C., 2007. Cell Biology: Saunders W. B. Co.
3. Alberts, E.A., 2006. Essential Cell Biology Academic Internet Publisher
4. Lodish, H., 2011. Solutions Manual for Molecular Cell Biology.7thEdition. W.H. Freeman & Company.
5. Lodish, H., Berk, A., Kaiser, C.A., M Krieger; Bretscher, A., Ploegh, H; Amon, A., Scott, M., 2012. Molecular Cell Biology.7th Edition. W. H. Freeman Company.
6. James D. W. 2013. Molecular Biology of Gene. Benjamin Cumming.

MICROBIAL PHYSIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To identify the basic components of cells.
- To distinguish the features of procaryotic cells and eucaryoatic cells.
- To learn the use and characteristics of microscope.

Course Detail

- Detailed organization of microbial cells.
- Structure & Function relationship.

- Chemical composition and biosynthesis of macromolecules in microbial cells.
- Genomic organization of prokaryotes.
- Regulation of gene expression under stress condition..
- Uptake and secretion of molecules.
- Aerobic and anaerobic respiration and fermentation.
- Cell metabolism: protein, nucleic acid and fat.
- Microbial enzymes and metabolites. Classifications, chemistry, mechanism of action and inhibition.
- Stress responses.
- Microbial physiology and its implications in genomic era; genomic, proteomic and traditional tools.

Practical

1. Isolation of polysaccharides from bacteria.
2. Isolation of lipids from bacteria.
3. Estimation of total protein from bacterial cell.
4. Isolation and purification of a bacterial enzyme.
5. Growth curve under variable conditions.

Recommended Books

1. Seckbach, J., 2007. Journey to Diverse Microbial Worlds Adaptation to Exotic Environments .Publisher: Springer-Verlag New York.
2. David L. N. and Michael M. C. L., 2008. Principles of Biochemistry. W. H. Freeman.
3. Rathi. 2009. Microbial Physiology genetics and Ecology. MPDI.
4. Moat , A. G., Foster, J.W., Spector, M.P., 2009. Microbial Physiology 4th Edition. Wiley, John & Sons
5. Poole, R.K., 2012. Advances in microbial Physiology .Book series. Elsevier Ltd.
6. Allison. 2013. Recent Advances in Applied Microbiology. . RDM.

FRESH-WATER MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To develop the understanding of fresh water reservoirs and their ecosystem.

- To understand the portability of fresh water and implication of fresh water microbes on geochemical environment.

Course Detail

- Introduction to fresh-water environment and its microbiology.
- Stratifications in lakes and ponds.
- Laws of ecology with particular reference to fresh-water ecosystem: environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms.
- Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures.
- Fresh-water microorganisms: some important groups of fresh-water microorganisms.
- Detailed study of biogeochemical cycling of C, N, S & P.
- Advantages and disadvantages of fresh-water microorganisms including their importance in fresh-water biotechnology.
- An introduction to aquaculture and some common microbiological problems.
- Some common diseases of fresh-water fauna.

Practical

1. Study of microbial population from fresh water.
2. Study of Microbial counts.
3. Biological oxygen demand of fresh water sample.
4. Effect of physical factors on microbial fresh water flora.

Recommended Books

1. Gjedrem, T., 2005. Selection and Breeding Programs in Aquaculture. Springer-Verlag, New York, LLC.
2. Laybourn, P. and Johanna., 2006. Freshwater Biology, Volume 51, Number 10. Blackwell Publishing.
3. Robson, G. D, van West P. and Gadd, G. M., 2007. Exploitation of Fungi. Cambridge University Press.
4. Berthelin, J., 2008. Effect of Mineral-Organic-Microorganism Interactions on Soil and Freshwater Environments: 1st Edition .Springer-Verlag New York, LLC
5. David Sigee, D., 2012. Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment 1st Edition. Publisher: Wiley, John & Sons

BACTERIAL GENETICS

Credit Hours (2+2)

OBJECTIVES

- To understand about the continuity of the life from one generation to other generation on the basic mechanisms involving nucleus, chromosomes and genes etc.
- To understand the process of continuity and transfers of traits of the parents, that imparts variations render the generations sustainable in changing environment.

Course Detail

- Nucleic acids structure and functions.
- DNA replication: replicon origins, events that occur at the replication fork, the structure and functions of DNA polymerases, and replication strategies.
- Control of DNA replication: dichotomous replication in prokaryotes.
- Control of gene expression in prokaryote: polycistrons, transcriptional initiation and termination, the operon, catabolite repression and attenuation control.
- Protein synthesis - mRNA translation: Genetic code - non universality, codon usage. Events on ribosomes (c.f. prokaryotes), ribosome structure-function relationships, organelle and archaebacterial systems.
- Plasmids, episomes and transposons.
- DNA mutagenesis and mutagenic agents, repair and mutation suppression.
- Genetic recombination: generalized recombination, site specific recombination and illegitimate recombination.
- Gene transfer mechanisms and their role in evolution.
- Transformation, transduction, conjugation and cross-phylogenetic transfer.
- Gene mapping by conjugation and transduction.
- Circular chromosomal maps of bacteria.
- Introduction to genetic rearrangements.

Practical

1. Plasmid extraction.
2. Nucleic acid extraction (DNA & RNA).
3. Transformation, transduction, conjugation.
4. Catabolite repression through growth curve.
5. Beta galactosidase assay.
6. Development of mutant by physical and chemical agents.

Recommended Books

1. Costa, L.G., and Eaton, D. L., 2006. Gene-Environment Interactions Fundamentals of Ecogenetics, John Wiley and Sons Limited.
2. Brooker, R.J., 2011. Genetics: Analysis and Principles 4th Edition. McGraw-Hill Science. Harlt,
3. D., L., and Ruvolo, M.,2011. Genetics. 8th Edition. Snustad, D.P and Simmons . M.J., 2011. Principles of Genetics, 6th edition. John Wiley and Sons.
4. Snustad, D.P. and Simmons . M.J., 2012. Genetics, 6th Edition. John Wiley and Sons.
5. Strickberger,M.V.,. 2012 Genetics .Macmillan Publishing Company. New York.

CLINICAL BACTERIOLOGY

Credit Hours (2+2)

OBJECTIVES

- To explore the general nature of relationship between human and microorganisms
- To identify the major factors determining virulence and their genetic basis

Course Detail

- An introduction to clinical bacteriology.
- Hazards in clinical microbiology laboratory.
- Role and importance of normal flora in different parts of body.
- Respiratory tract infections.
- Infections of eye ear and skin.
- Fluids from infected joints, CSF, pleural and peritoneal fluids.

- Differential diagnosis of selective systemic bacterial infections of GIT, genito-urinary, cardiovascular and central nervous system.
- Nosocomial infections: community acquired infection, prevention and control.
- Principles of conventional, rapid and molecular diagnostic procedures.

Practical

1. Good laboratory practices.
2. Collection and processing of different clinical specimen for isolation and identification of pathogens.
3. Antibiotic sensitivity test by various techniques.
4. Conventional, rapid and molecular diagnostic methods.

Recommended Books

1. Murray, P. R., Rosenthal, K. S., Pfaller, M. A., Rosenthal, K. S., 2005, Medical Microbiology: Elsevier Health Science.
2. Hawkey, P.M., Gillespie, S.H., Hawkey, P., 2006. Principles & Practice of Clinical Bacteriology. 2nd Edition. Wiley, John & Sons.
3. Woodford, N. Johnson, A.P., 2010. Genomics, Proteomics, and Clinical Bacteriology: Methods and Reviews. 1st Edition. Springer-Verlag New York, LLC.
4. Versalovic, J., 2011. Manual of Clinical Microbiology, 10th Edition. ASM Press
5. Vinay, K., 2011. Robbin's and Ctran Pathologic Basis of Disease Saunder.

SOIL MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the ecological interaction of microorganisms.
- To examine the major kinds of interactions of microorganisms.
- To examine the habitats where microorganisms can be found

Course Detail

- Elements of soil formation and conservation.
- Soil microbial population and methods of study with their advantages and disadvantages.

- Role of microorganisms in mineral transformations with special and detailed emphasis on Carbon and Nitrogen transformations. Brief introduction to Sulphur and Phosphorus.
- Introduction to soil ecology and rhizosphere. Plant-microbe interactions and microbe-microbe interactions and their impact on soil fertility and formation of compost and humus.
- Biotechnological potentials of soil microorganisms.
- Importance of the subject in the agricultural development of Pakistan.
- Problems of salinity and water logging and the methods of land reclamations.
- Microbial remediation: salt, heavy metals and pesticides.
- **Biofertilizers**
- **Mycorrhiza.**

Practical

1. Role of microbes in soil formation.
2. Reduction of metallic salts by microbial activity.
3. Buried slide technique.
4. Symbiotic and antagonistic relationship of soil microflora.
5. Cellulolytic activity of soil microorganisms.
6. Isolation of antibiotic producing and pesticide degrading microbes.
7. Effects of biofertilizer on plant growth and health.

Recommended Books

1. Diane Tice, D., 2005. Principles and Applications of Soil Microbiology. 2nd Edition. Oxford University Press.
2. Paul, E.A., 2007. Soil Microbiology, Ecology and Biochemistry .Elsevier Science. Varma, A., 2010. Advanced Techniques in Soil Microbiology: 1st Edition .Springer-Verlag New York, LLC.
3. Geoffrey R. Dixon, G.F., 2010. Soil Microbiology and Sustainable Crop Production: 1st Edition. Springer-Verlag New York, LLC
4. Paul, E.A., Study guide for Soil Microbiology, Ecology. Content Technologies, Inc. Publisher
5. Vallabhaneni, S., 2012. Soil Microbiology- A Laboratory Manual. LAP Lambert Academic Publishing AG & Co. KG.
6. Carrey. 2013. Recent Advances in Soil Microbiology and Soil Biotechnology. RDM.

EPIDEMIOLOGY, PUBLIC HEALTH AND BIOETHICS

Credit Hours (2+1)

OBJECTIVES

- To develop the understanding of epidemiology.
- To use different mathematical tools of epidemiology.
- To learn and examine the descriptive and analytical epidemiology.

Course Detail

- Introduction to epidemiology: Types of epidemiology, clinical, occupational, experimental, interrelation of factors.
- Epidemiological methods, incidence, prevalence, rate, susceptibility etc.
- Types of studies, cross sectional, cohort, case control.
- Epidemiologic consideration in disease process.
- Cyclicity of diseases: Chicken Pox, Measles.
- Health information and biostatistics.
- Sampling methodology: procedure, sample size, cluster sampling, sampling error, bias, risk, data collection of infectious disease cases, antibiotic resistance profile of infectious agents.
- Screening tests, accuracy of screening tests, predictive value, reliability.
- Epidemiological polarization.
- Disease pattern in community & Social diversity
- Flu, common cold and prevailing pandemics and epidemics.
- Surveillance, prevention, control and eradication of disease.
- Status of health services in Pakistan: comparison with other countries.
- Predisposing factors of epidemics in developed countries and a comparison with the existing factors in Pakistan.
- Bioethics.

Practical

- Questioner based survey to determine the current infections and prevailing infections.
- Application of statistical tools for data analysis.

Recommended Books

1. Ziegler, A., and Koenig, I. R., 2006. A Statistical Approach to Genetic Epidemiology: Concepts and Applications. John-Wiley and Son Limited. Khardori, N., 2006. Bioterrorism Preparedness: Medicine - Public Health Policy. John Wiley and Sons limited.
2. Fos, P.J., 2010. Epidemiology Foundations: The Science of Public Health: 1st Edition. Wiley, John & Sons, Incorporate
3. Friis, R.H., 2010. Epidemiology for Public Health Practice: 4th Edition .Publisher: Jones & Bartlett Learning.
4. Baily, S., 2012. Introduction to Epidemiologic Research Methods In Public Health Practice. Jones & Bartlett Learning.
5. Rothman, K.J., 2012. Epidemiology: An Introduction: 2nd Edition .Oxford University Press.

ENVIRONMENTAL BIOTECHNOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the role of microbial activities on biochemical and geologic processes.
- To determine the role of microorganisms in pollution.
- To determine the role of microbes in bioremediation.

Course Detail

- Introduction to environmental biotechnology.
- Microbial techniques for pollution control.
- Role of microorganisms for the production of food and fodder products from agricultural and forestry wastes.
- Biological and chemical pesticides: their advantages and disadvantages.
- Microbial degradation of toxic and poorly degradable (recalcitrant) compounds.
- Bioremediation of environment contaminated with wood preservatives, petroleum products, hydrocarbons, fuels and industrial wastes etc.
- Bioaccumulation of heavy metals and phytoremediation.
- Applications of recombinant microorganisms in reducing environmental pollution.

- Microbes as a tool for the assessments of risks associated with the environment.
- Recent advances in agricultural and environmental biotechnology.

Practical

1. Isolation of Oil degrading bacteria from environment.
2. Isolation of microorganisms from industrial effluent.
3. Remediation of metal ions through microbes.
4. Effects of industrial effluents on germination and growth of seedlings.
5. Isolation of microbes resistant to heavy metals

Recommended Books

1. Borlak, J., 2005. Handbook of Toxicogenomics: Strategies and Applications John-Wiley and Son Limited.
2. Wang, L.K., (Editor), Hung, Y-T., Ivanov, V., Tay, J-H., 2010 Environmental Biotechnology. 1st edition.. Springer-Verlag New York, LLC.
3. Chakrabarty, A.M., 2010. Environmental Biotechnology: Principles and Applications. 1st Edition. Moo-Young, M., W.A. Anderson, W.A... Springer-Verlag New York, LLC.
4. Evans, G. G., Furlong , J., 2012. Environmental Biotechnology: Theory and Application. 2nd Edition. Wiley, John & Sons, Incorporated.
5. Jain, P.K., Gupta, V.K., Vivek Bajpai, V. 2011. Recent Advances In Environmental. Biotechnology LAP Lambert Academic Publishing
6. Joshi,N., Sharma, K.C., Sharma,M.,2012.Environmental Biotechnology-Recent Perspectives .LAP Lambert Academic Publishing AG & Co. KG.

MOLECULAR MECHANISMS OF ANTIMICROBIAL THERAPUTIC AGENT

Credit Hours (2+2)

OBJECTIVES

- To understand the mechanisms of chemotherapy.
- To develop general understanding of microbial control.
- To examine various factors that influence microbial control.

Course Detail

- 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.

Practical

1. Isolation of antibiotic resistant bacteria from environment.
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. Greenwood, D., Finch, R., Davey, P., Wilcox, M., 2007. Antimicrobial Chemotherapy. Oxford University Press; 5th Rev Ed edition.
3. Franklin, T.J., Snow, G.A., 2010. Biochemistry and Molecular Biology of Antimicrobial Drug Action. 6th Edition. Springer-Verlag New York, LL.
4. Amyes, S., 2010 Antibacterial Chemotherapy: Theory Problems, and Practice. Publisher: Oxford University Press, USA.
5. Finch, R., Davey, P., Wilcox, M. H., Irving, W., 2012. Antimicrobial Chemotherapy. Oxford University Press.

GENETIC ENGINEERING

Credit Hours (2+2)

OBJECTIVES

- To learn basic techniques used in recombinant DNA technology.
- To understand the potential problems related to genetic engineering.

Course Detail

- 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. Practical uses of endonucleases. Role in genetic engineering.
- Construction of cloning vector by λ -phage.
- *In vitro* genetic engineering; cloning vehicles: plasmids, cosmids and phagemids, YAC and BAC etc.
- Principles of nucleic acid isolation (DNA & RNA).
- Cloning strategies: construction of chimeric plasmids.
- Methods of introducing exogenous DNA.
- Methods for screening the clones.
- DNA sequencing.
- PCR: its application and primer designing.
- Prokaryotes and Eukaryotes Expression systems.
- Labeling methods of probes.
- Construction of genomic libraries.

Practical

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

Recommended Books

1. Meyers, R.A., 2006. Genomics and Genetics . John-Wiley and Son Limited.
2. Primrose, S.B., and Twyman, R.M. 2006. Gene Manipulation and Genomics 6th edition. Blackwell Publishing.
3. Snustad, D.P., and Simmons . M.J., 2012. Genetics, 6th Edition. John Wiley and Sons.
4. Snustad, D.P., and Simmons . M.J., 2011. Principles of Genetics, 6th edition. John Wiley and Sons.
5. James, D. W. 2013 Molecular Biology of Gene. Benjamin Cumming.

MEDICAL VIROLOGY

Credit Hours (2+2)

OBJECTIVES

- To understand different systems used for classification of viruses.
- To learn viral multiplication, pathogenesis and viral oncogenesis.

Course Detail

- Classification and structure of medically important viruses.
- Host cells for viral multiplication, productive infections.
- Introduction to the replication of viral genome.
- Maturation and release of viruses.
- Special features of molecular biology, biochemistry and genetics of the following viruses: Picornaviruses, Poxviruses, Myxoviruses, Paramyxoviruses, Rubella viruses, Rhabdoviruses, Reoviruses, Herpes viruses, Hepatitis viruses, Retroviruses and Tumor viruses (DNA & RNA), Adenoviruses, Coronaviruses.
- Viruses of Zoonotic significance.
- Virus-host interactions.
- Genetics of viruses shift and drift.
- Diagnostic procedure for viral infections including isolation identification and serology.
- Antiviral agents, viral prophylaxis.
- Interferon and chemotherapeutic agents.

- Emerging viral infection.

Practical

1. Chick embryo inoculation.
2. Enzyme Linked Immunosorbent Assay (ELISA).
3. Haemagglutination Inhibition (HI).
4. Haemagglutination (HA).
5. Precipitation.
6. Cytopathic effects.
7. Animal inoculation.
8. Fluorescent Antibody Test (FAT).
9. Polymerase Chain Reaction (PCR).

Recommended Books

1. Strauss, J. H., Ellen G. Strauss, E.G., 2007. Viruses and Human Disease. Elsevier Science.
2. Mettenleiter, T.C., and Francisco Sobrino, F., 2008. Animal Viruses: Molecular Biology. Caister Academic Press
3. Shi, P.Y., 2012. Molecular Virology and Control of Flaviviruses. Caister Academic Press
4. Stent, G.S., and Dohm, J.L., 2012. Molecular Biology Of Bacterial Viruses. Literary Licensing, LLC.
5. Maramorosch, K., and Frederick A. Murphy, F.A., 2013. Advances in Virus Research. Elsevier Science.

IMMUNOBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand body defense mechanism against infections.
- To learn cells and tissues involved in antibody production.
- To learn surface markers for identification of cells of immune system.

Course Detail

- The immune system: organs constituting the immune system, their location in the human body and basic architecture.
- The immunocompetent cells: their origin, surface markers, population and sub-populations. Immunological characterization and functions.

- Antibody induction and production: antigen and antibody metabolism. Cells involved in cellular sequence of events. Kinetics of antibody synthesis.
- The role of T-cells and immunoglobulins in the immune response.
- Immunologic memory: positive and negative. Phenomenon of natural tolerance.
- Manifestations of antigen-antibody reactions including precipitation, agglutination, complement fixation and neutralization.
- Cellular immune response and its characterization.
- Basics and applications of ELISA, RIA, immunofluorescence and immunoblotting. Lab work pertaining to above course.
- Immuno suppression a need, agents.
- Animal handling practices.

Practical

1. Culture of immune cells.
2. Phagocytosis specific and non-specific.
3. Detection of B-cells.
4. Hemolytic plaque assays.
5. Immunization of animal with soluble and particulate antigens.
6. Latex agglutination
7. Immunochromatography
8. C reactive proteins

Recommended Books

1. Paul, W., 2006. Fundamental Immunology. Fifth Edition. Lippincott Williams and Wilkins.
2. Lichtman., A. H., 2007. Basic Immunology. Elsevier Health Sciences.
3. Abbas, A. K., Lichtman, A. H., and Pillai., S., 2007. Cellular and Molecular Immunology: Elsevier Health Sciences.
4. Murphy, K., 2011. Janeway's Immunobiology (Immunobiology: The Immune System .8th Edition. Garland Science Publishers.
5. Kenneth Murphy,K., Travers,P., Walport , M., 2011.Janeway's Immunobiology. 8th Edition, Taylor & Francis.

FOOD MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To learn about the relevance of microbes with food industries
- To learn about food related microorganism.
- To learn about microbial food spoilage and its control.

Course Detail

- Introduction and scope of food microbiology
- Food related microorganisms their classification, genetics and biochemistry.
- Sources of microorganism in food.
- Microbial interaction, attachment and growth.
- Factors influencing microbial growth in food environment.
- Lactic acid producing bacteria (LAB) in food and their important metabolites: bacteriocins, antibiotics, probiotics and enzymes.
- Applications of LAB in food technology.
- Traditional fermented food; microbiology of fermented foods
- Microbial food spoilages; Factors and microbial metabolites.
- Food borne pathogens, infection, toxification and indicators of food borne pathogens.
- Control of microbes in food by physical, chemical and biological methods.
- Introduction to hurdle technology.
- HASSAP.

Practical

1. Detection of food borne pathogens.
2. Total viable count.
3. Detection of mycotoxins and toxins.
4. Application of hurdle technology.
5. Visits to food industries: Brewery, Fisheries and food factories.

Recommended Books

1. Ray, B. 2007, Fundamental Food Microbiology, 4th edition, CRS Press New York.
2. Montville, T. J. & K. R. Matthews. 2008. Food Microbiology: An Introduction, 2nd Edition ASM Press, USA.
3. Weidmann M. and W. Zhang. 2011 Genomic of food borne bacterial pathogens (Food Microbiology and food Safety) 1st Edition. Springer, ISBN-13: 978-14419765857.
4. El Mansi, E. M. T. et al. 2011. Fermentation, Microbiology and Biotechnology. CRC Press.

5. Michael, P. D. and Robert, L. B. 2012, Food Microbiology: Fundamentals and Frontiers. ASM Press.
6. Thomas, J. M., Matthew, K. R. and Kniel, K. E. 2012, Food Microbiology: An Introduction. ASM Press.

RESEARCH PROJECT/ INTERNSHIP

List of Elective Courses

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

1. Animal Virology
2. Applied Microbial Technology
3. Advances in Soil Microbiology
4. Advances in Microscopy and image analysis
5. Bioinformatics and Protein Structure/Function
6. Cell & Tissue Culture Technology
7. Clinical Bacteriology
8. Clinical Parasitology
9. Diagnostic Virology
10. DNA Damage, Repair and Carcinogenesis
11. Diagnostic Chemistry for Microbial Diseases
12. Epigenetics
13. Environmental Microbiology and Public Health
14. Epidemiology: Analytical and Experimental Approaches
15. Food and Dairy Microbiology
16. Industrial Microbiology
17. Marine Microbiology
18. Molecular Immunology
19. Microbial Enzyme Technology
20. Mycotic infections
21. Management of Infectious Waste
22. Microbes and Nervous systems
23. Nanobio technology
24. Plant Microbiology
25. Plant Virology
26. Plasmids, Episomes and Insertion Sequences
27. Structural/ computational Biology
28. Veterinary Microbiology

DETAIL OF COURSES

CELL & TISSUE CULTURE TECHNOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the process of tissue culture technology.
- To study the nutritional and physical requirements of primary cell culture and established cell lines.
- To use as viable media for the cultivation of viruses; and in diagnosis
- To understand the cellular differentiation.

Course Detail

- History and application of cell culture.
- The eukaryotic cell: general structure and function, cell cycle, chromosomes, polyploidy, polytene and karyotypes.
- Nutritional requirements, growth and metabolism of cells, and growth control, topoinhibition, source substitutes, pH regulation.
- Outlines of methodology of plant, insect and animal cell and tissue culture.
- Cell culture, cell types and morphology of cells in culture.
- Primary and secondary culture, cell strains and established cell lines.
- Establishment of cell lines.
- Establishment of clones of plant and animal cells.
- Lymphoid cells culture.
- Transformed cells: growth control of mouse fibroblasts and malignancy, the normality of 3T3 fibroblasts cell lines from tumors.
- Genetics of cells in culture. Origin of mutant cell lines. Negative selection: heterokaryons, malignancy of hybrids.
- Differentiated, serum dependent normal cells. Role of cyclic nucleotides.
- Selective cell line and their specialized uses (HeLA, Vero, 3T3 fibroblast, WEHI, etc.)
- Tissue culture and virology (CPE, Plaque Assay).
- Applications of plant tissue culture.
- Stem cell technology.

Practical

1. Starting a primary culture (tissue digestion, cell count and cell culture).
2. Maintenance of a cell line.
3. Cryopreservation of cell line.
4. Plant cell culture.
5. Vital staining.
6. Organ culture

Recommended Books

1. Halford, N., 2006. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops .John Wiley and Sons Limited.
2. Vunjak-Novakovic, G., Freshney, R.I., 2006.Culture of Cells for Tissue Engineering.1st Edition Wiley, John & Sons
3. 2013. Principles of Tissue Engineering. Elsevier Science
4. Freshney, R.I., 2006. Culture of Animal Cells: A Manual of Basic Technique. 5th Edition. Wiley, John & Sons.
5. Neumann, K-H., Kumar,A., Imani, J., 2009. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application .1st Edition. Springer-Verlag New York, LLC.
6. Abbot. 2013. Recent Advances in Plant Tissue Culture and Biotechnology. RDM.

APPLIED MICROBIAL TECHNOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the beneficial role of microbial activities.
- To study the role of microorganism in bioremediation.
- Industrial application of microbes.

Course Detail

- Properties of microorganisms useful to the industry. .
- Scope of fermentation biotechnology.
- Scientific disciplines used in microbial biotechnology (Agriculture, Health, Environment and Food.
- Immobilized enzymes and microbial cells and their application
- Large-scale microbial fermentation, the principles and problems.
- An introduction to downstream processing.

- Strain Development spectrum of for microbial, Isolation and identification of industrially important microorganisms. Different approaches improvement of industrial microbes. Empirical and Semi-empirical strain development, mutagenesis, screening and selection.
- Use of auxotroph and analogue resistant mutants in strain development.
- Growth and Development of Microorganisms in Bioreactors.
- Quorm (r) myco-protein, a product produced by continuous flow fermentation.
- Continuous culture technologies for strain improvement.
- Metabolic Control Analysis: principles and means of rational strain development.

Practical

1. Citric Acid production.
2. Ethanol production.
3. Lactic Acid production.
4. Enzyme immobilization,
5. Effect of microorganism on plants.
6. Estimation of Microbial cell mass.
7. Mutagenesis (Physical and Chemical).
8. Field trips to the relevant industries.

Recommended Books

1. Ricardo Melendez-Ortiz , R., and Sánchez , V., 2005. Trading in Genes: Development Perspectives on Biotechnology, Trade and Sustainability. Earthscan/James and James.
2. Groves, M. J., 2005. Pharmaceutical Biotechnology. CRC Press.
3. Doelle, H. W., and C.G. Heden, C.G., 2007. Applied Microbiology. 1st Edition .Springer-Verlag New York, LLC
4. Kaplan, N.O., Mosbach, K., Kaplan, N.P., 2010. Immobilized Enzymes and Cell. Springer-Verlag New York, LLC
5. Cirino, Z., 2011. Metabolic Control Analysis. Civ Publishers.
6. Capasso,V., and Bakstein, D., 2012. An Introduction to Continuous-Time Stochastic Processes: Theory, Models, and Applications to Finance, Biology, and Medicine. Birkhauser Verlag

MICROBIAL PLANT DISEASES

Credit Hours (2+1)

OBJECTIVES

- To study selected microbial plant diseases and their importance for economy.
- To identify fungal and bacterial diseases of plant.
- To develop the strategies for the control of plant diseases.

Course Detail

- Study of major microbial plant diseases.
- Importance of plant diseases in Pakistan.
- Nature and classification of plant diseases.
- Etiology and symptoms of plant diseases of field crops, fruits and vegetables.
- Fungal diseases: Rusts, Smuts, Wilts and Root rots.
- Bacterial diseases: Blights, Cankers, Leaf spots and Rots.
- Viral diseases: Mosaics, Dwarfs, Stunts, Yellows, Leaf curl, Witches Broom, Ring spots and Wilts'
- Quarantine, eradication and International Plant Protection.
- Cultural practices in disease control, chemical control.
- Resistant varieties.
- Future problems and prospects of Plant Microbiology.

Practical

1. Sample collection, isolation and identification of plant pathogen (farms, orchards, nurseries etc.).
2. Field trips.

Recommended Books

1. Nautiyal , C.S., Dion, P., (Editor), V. L. Chopra , V.L., 2008. Molecular Mechanisms of Plant and Microbe Coexistence.1st Edition. Springer-Verlag New York, LLC.
2. Aneja K. R. 2009. Experiment in Microbiology: Plant Pathology & Biotechnology. New Age Int. Pvt. Ltd.

3. Narayanasamy, P., 2010. Molecular Biology in Plant Pathogenesis and Disease Management: Microbial Plant Pathogens. 1st Edition. Springer-Verlag New York, LLC
4. Chen, J., 2011. Experimental Plant Virology. 1st Edition. Springer-Verlag New York, LLC
5. Van Regenmortel M. H. V. and Fraenkel-Conrat H. 2013 The Plant Viruses. Springer.

FOOD & DAIRY MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To study the mechanisms of food preservation and spoilage of food.
- To review the role of microorganisms in production of some selected industrial products.

Course Detail

- Scope of food and dairy microbiology.
- World food problems.
- Microorganisms important in food industry & dairy industries.
- Factor affecting the growth of food microorganisms.
- Probiotics.
- Spoilage of food products.
- Food hygiene, sanitation and legislation.
- Quality assurance in food industries.
- Recent advances in food industry.
- Problem/Control of biofilm forming in food industry.
- Technology of food processing.
- Preservatives and agents for improving the quality, shelf-life and optic properties of foods.
- Neutralizers, stabilizers, firming agents, coating and wrapping agents.
- Principles and methods of food preservation.
- Bacteriology of preserved foods.
- Preserved food Packaging and related microbial problems.
- Food borne diseases.

Practical

1. Isolation of starter culture from: Cheese and Yogurt.
2. Isolation of phages from lactobacilli.
3. Enumeration of bacteria from: Poultry, Beef, Milk, Eggs and Fish.
4. Detection of food pathogens.
5. Field trips to: Brewery industry and Milk plant.

Recommended Books

1. James, G., 2006. Brennan Food Processing Handbook. Wiley, John and Sons, Incorporated.
2. Jay, J. M., Loessner, M. J. and Golden, D. A., 2006. Modern Food Microbiology. 7th Edition, Springer Science, Inc., U.S.A.
3. Karl, R. and Matthews, M. P., 2006. Doyle Microbiology. ASM Press.
4. Doyle, M. P., Erickson, M.C., 2008. Imported Foods: Microbiological Issues and Challenges. ASM Press
5. Doyle, M.P., Buchanan, R.L., 2012. Food Microbiology: Fundamentals and Frontiers, Fourth Edition. ASM Press.
6. Montville, T.J., Matthews, K.R., and Kniel, K.E., 2012. Food Microbiology: an Introduction, Third Edition. ASM Press.

MARINE MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To identify distribution of various types of microorganisms in marine environment.
- To identify sources of food contamination and water pollution.
- To study the effect of pollution on marine fauna and flora.

Course Detail

- Introduction to marine microbiology.
- Zonation and microbial stratification in marine environment.
- Effect of movement of water in marine environment.
- Laws of ecology with particular reference to marine ecosystem: environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms.
- Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures.

- Marine microorganisms: some important groups of marine microorganisms.
- Detailed study of biogeochemical cycling of C, N, S & P.
- Advantages and disadvantages of marine microorganisms including their importance in marine biotechnology.
- Some common diseases of marine fauna.

Practical

1. Isolation of luminescence organisms.
2. Isolation of Cyanobacteria, Photosynthetic bacteria.
3. Isolation and screening of antimicrobial activity of marine microbes.
4. Isolation of polymer producing bacteria.
5. Isolation of halophyte organisms.

Recommended Books

1. Horst, D. S. and Matthias Z., 2006. Marine Geochemistry. Springer.
2. Paul F. and Andrew H. K., 2007. Evolution of Primary Producers in the Sea. Academic Press.
3. Chauhan. 2009. Cyanobacteria Antimicrobial Activity. NIPA.
4. Scheper, T., Marine Biotechnology December 2011. Springer-Verlag New York, LLC
5. Munn, C., 2011. Marine Microbiology: Ecology & Applications. Taylor & Francis press

DIAGNOSTIC VIROLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the diagnostic tools for viral infections.
- Collection, transportation and processing of clinical samples from infected patients.

Course Detail

- History and Introduction.
- Development of diagnostic virology and laboratory diagnosis of the viral diseases.
- Laboratory management and biosafety.
- Collection, transportation and processing of specimen.

- Methods for the diagnosis of herpesviruses, adenoviruses, rotaviruses, coronaviruses, viruses associated with rash diseases, hepatitis viruses, enteroviruses, retroviruses, poxviruses, orthomyxoviruses, paramyxoviruses and arboviruses.
- Conventional rapid molecular detection of viruses..
- Interpretation of Lab, investigation.

Practical

1. Collection and safe handling of samples.
2. Practicing biological containment
3. Identification of infectious agent through ELISA & PCR.

Recommended Books

1. Leonard C. N., 2009. Virology: Molecular Biology and Pathogenesis. ASM Press.
2. Kudesia, G., 2009. Clinical and Diagnostic Virology. Cambridge University Press.
3. John R. S. and Warnes A. Diagnostic Virology Protocol: Method in Molecular Biology. Humana Press.
4. Stephenson, J.R., and Warnes, A., 2011. Diagnostic Virology Protocols Springer-Verlag New York, LLC
5. Bachmann, P.A.,2012. New Developments in Diagnostic Virology. Springer-Verlag New York, LLC
6. Stephen N. J. K., & Gert Van Zyl. Et al. 2012. Virology. Churchill Livingstone.

MOLECULAR IMMUNOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the various types of antibodies: their structure and function.
- Immune cells surface receptors involve in immune response and histocompatibility.
- Immune response other than antibody production i.e. complements system.
- To study the molecular mechanisms of various molecules involved in induction of immune response.

Course Detail

- Introduction to molecular basis of immunogenicity and antigenic specificity: distinction and parameters.

- Molecular basis of antigen antibody interactions: Chemical bonds involved, study and kinetics employing mono and polyvalent ligands. Quantitative measurements of antibody precipitated in an immune complex.
- Basis of immunodominance.
- Immunochemical aspects of polysaccharide antigens of selective group of Microorganisms and their significance.
- Structure and functions of human immunoglobulins: Sequence studies, genetic variants, three dimensional configurations and location of paratope in the molecule of IgG, IgM, and IgA, Antibody diversity, maturation of B lymphocytes and expression of Immunoglobulin genes.
- Structure function of the T-cell Receptor: Molecular basis of T-cell antigen recognition and activation, Immunoglobulin superfamily. T-cell gene rearrangement and generation of diversity.
- Toll like receptors, chemokines and cytokines.
- Human Leukocyte Antigens: classes, distribution, chemistry and basis of polymorphism.
- Complement System: Chemistry, components, activation via classical and alternate pathway, complement genes, their expression and regulation.

Practical

- Immunization of animal with particulate and soluble antigens.
- Characterization of immune cells.
- T & B cell identification.
- Hemolytic plaque assay.
- Complement fixation.

Recommended Books

1. Bert Popping, B., 2009. Molecular Biological and Immunological Techniques and Applications for Food Chemists: 1st Edition. Wiley, John & Sons, Incorporated
2. Abbas, A.K., Lichtman, A. H., Pillai, S., 2011. Cellular and Molecular Immunology. 7th Edition. Elsevier Health Sciences.
3. Kenneth M. 2011. Janeway's Immunobiology. Garland Science.
4. Chames, P., 2012. Antibody Engineering: Methods and Protocols, Second Edition. Springer-Verlag New York, LLC
5. Clark, D.P., 2012. Molecular Biology. 2nd Edition Elsevier Science.

CLINICAL PARASITOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand the existence of pathogenic parasites in different environment.
- To study some selected parasites human diseases, their diagnosis, treatment and control.

Course Detail

- Etiology, life cycle, epidemiology, symptomatology, pathogenesis, lab. diagnosis, treatment, prevention and control of:
Protozoa, Entamoeba histolytica, Giardia lamblia, Plasmodium spp, Balantidium coli, Trypanosoma spp, Leishmania spp, Toxoplasma gondii, Trichomonas vaginalis.
- Brief introduction of Helminthes, *Ascaris lumbricoides, Enterobius vermicularis, Trichuris trichiura, Ancylostoma duodenum and Necator americanus, Wucherria bancrofti, Taenia solium & Taenia saginata, Echinococcus granulosus, Hymenolepsis nana, Schistosoma haematobium, Fasciola hepatica.*
- Mediators/vectors of parasitic infection
- Recent advances in the diagnosis and control of parasitic infections.
- Newly emerging parasitic infections.

Practical

1. Collection and processing of clinical samples.
2. Immuno and molecular techniques.
3. Detection of plasmodium in blood.
4. Detection of Protozoa, Helminthes and Amoeba in clinical samples and water.
5. Staining methods.

Recommended Books

1. Anne, Z. and Gary C., 2006. Veterinary Clinical Parasitology. Blackwell publishing.
2. Pearson, R.D., Gillespie, S.H., 2009. Principles and Practice of Clinical Parasitology. 1st Edition .Wiley, John & Sons
3. Sun, T., 2012. Progress in Clinical Parasitology. Springer-Verlag New York, LLC
4. Zeibig, E., 2012. Clinical Parasitology: A Practical Approach. 2nd edition. Elsevier Health Sciences

PLASMIDS, EPISOMES AND INSERTION SEQUENCES

Credit Hours (2+1)

OBJECTIVES

- To understand the existence of various types of extra-chromosomal elements and their implications in genome of an organism.

Course Detail

- Introduction and scope.
- Repeated DNA sequences in plasmids, phages and bacterial chromosome.
- Definitions of transposable elements in prokaryotes.
- Mutations caused by insertion sequences.
- The mutations of *E.coli* caused by insertion sequence elements, transposons and plasmids.
- Types of plasmids and their significance
- Plasmid entry & exclusion: super-infection immunity & curing
- Formation of conjugative drug resistance R-plasmids. Antibiotic resistant transposons, their integration and excision.
- X mutations in Mu. G segment of Mu and P1. Integrative recombination of bacteriophage lambda.
- Controlling elements in Maize, insertion mutations in Drosophila and transposition of mating type genes in fission yeast.
- Retro transposons.

Practical

1. Isolation of plasmid from bacteria.
2. Characterization of plasmid by conjugation.
3. Transformation.
4. Phage isolation from different sources

Recommended Books

1. Howe, C., 2007. *Gene Cloning and Manipulation* Cambridge University Press.
2. Snyder, L. and Champness W., 2007. *Molecular Genetics of Bacteria, 3rd Ed*, American Society for Microbiology.
3. Lankenau, D-H., Jean-Nicolas Volff, J.N., 2010. *Transposons and the Dynamic Genome*. 1st Edition. Springer-Verlag New York, LLC

4. Fedoroff, N.V., 2013. Plant Transposons and Genome Dynamics in Evolution .Wiley, John & Sons, Incorporated.
5. James, D. W., 2013. Molecular Biology of Gene. Benjamin Cumming.

MICROBIAL ENZYME TECHNOLOGY

Credit Hours: (2+1)

OBJECTIVES

- To develop skills for industrial and commercial production of enzymes.
- To learn about molecular, analytical and biochemical activity of biocatalyst.
- To identify clinical and therapeutic applications of enzymes.

Course Detail

- *Introduction to enzymes*: Nature, structure & function, Biological role of enzymes, their sources and biosynthesis, Enzyme turnover.
- *Multi-enzyme complexes, Kinetics of enzyme reaction*, Mechanisms of enzyme reaction, Reversible and irreversible changes, *Regulatory enzymes* and the control of *metabolic pathways*- feedback inhibition.
- Allosteric enzymes.
- *Industrial enzymes*: Types, their sources, uses and applications, Fermentative production of industrial enzymes, enzyme purification.
- Enzyme immobilization: methods of immobilization and kinetics; properties of immobilized enzymes, Uses of free and immobilized enzymes in industries.
- *Analytical application of enzymes*: enzymes as biosensors, Clinical and therapeutic application of enzymes.

Practical

1. Assays for microbial enzyme detection i.e. cellulose, lipase, amylase, proteases and nucleases.
2. Isolation of proteolytic, lipolytic and amylolytic organism from different sources.
3. Production of industrially important enzymes from microbes.
4. Enzyme immobilization.
5. Isolation of microbial enzymes.

Recommended Books

1. Thomas R. N., Hans C. F. Jost W. 2011. Microbial Extracellular Polymeric Substances. Springer.

2. Chrost, R.J., 2012. Microbial Enzymes in Aquatic Environments Springer-Verlag New York, LLC.
3. Karl E. L. E., Robert A. B. and Paul A. 2012. Microbial & Enzymatic Degradation of Wood and Wood Components Springer.
4. McNeil, B., Archer, D., Giavasis, L., Harvey, L., 2013. Microbial production of food ingredients, enzymes and nutraceuticals Woodhead Publishing, Limited.
5. Vijai K., Gupta M. G. T and Gauri D. S. 2013. Application of Microbial Genes in Enzyme Technology. Nova Science Pub. Inc
6. Brian M., David A., Ioannis G. and Linda H. 2013. Microbial Production of Food Ingridients, Enzyme and Nutraceuticals. Woodhead Publishing.

BIOINFORMATICS AND PROTEIN STRUCTURE/FUNCTION

Credit Hours (2+1)

OBJECTIVES

- To learn the details of proteins structure and their bioactive configuration.
- To learn about computational analysis of proteins structure and functions
- To learn about computational tools for protein and nucleic acid analysis.

Course Detail

- Amino acids and their properties.
- Protein structure classification and super folds.
- Mechanisms of protein folding and folding pathways.
- Role of chaperones in protein folding.
- Experimental techniques for characterizing membrane protein structure and function.
- A case study: proteases - function and mechanisms.
- Simple sequence analysis - use of hydropathy plots.
- Introduction to sequence databases.
- Comparing sequences against sequence databases.
- Predicting protein coding regions.
- Prediction of protein structure from sequence data.
- Genome sequencing projects.
- Bioinformatics and genome analysis.

- Protein, protein docking.
- Experimental methods for determining protein structure.
- Protein domains.

Practical

1. Demonstration of the use of Web based tools for Bioinformatics analysis.
2. BLAST, SWISSPROT etc.

Recommended Books

1. Bujnicki, J.B., 2009. Prediction of Protein Structures, Functions, and Interactions. Wiley, John & Sons, Incorporated
2. Peirce, M.J., and Wait, R., 2010. Membrane Proteomics: Methods and Protocols. 1st Edition.. Springer-Verlag New York, LLC
3. Rigden, D.J., 2010. From Protein Structure to Function with Bioinformatics. 1st Edition. Springer-Verlag New York, LLC
4. Jeremy W. D., Malcolm V. S. and Nicholas P. 2011. From Gene to Genome. Wiley.
5. Kanwal, S., Nishat, S., Khan, I.M., 2012. Bioinformatic Approaches to Structure and Function of Protein LAP Lambert Academic Publishing AG & Co. KG.

ADVANCES IN SOIL MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To learn about details of composition, structure and ecology of soil.
- To study microbial existence and activity on soil texture and fertility.
- To learn about agriculture field technology.

Course Detail

- Introduction: agricultural microbiology and field management technology.
- Soil ecology: kinetics of ecosystems and ecosphere.
- Interactions: Dynamics and interaction of microbial population in rhizosphere, rhizoplane and phylloplane.
- Soil hydrology: different forms of water present in the soil, their physico-chemical and biological properties.

- Soil colloidal system: its significance in soil, Organic matter and its role in soil processes.
- Detailed study of cation exchange capacity of the soil: its role in the availability and uptake of the nutrients.
- Composting and its role in enhancing soil fertility, bio-fertilizers.
- Microbe mediated nutrient uptake and losses, recent advances in N uptake and losses from soil.
- Phosphorus and role of mycorrhiza in “P” solubilization, Effective microorganisms (EM).
- Metabolomic & Metagenomic.

Practical

1. Determination of soil structure, pH and texture.
2. Isolation of bacteria associated with “C” cycle.
3. Isolation of “N” fixing bacteria.
4. Isolation of microbe from rhizosphere.
5. Isolation of microbial plant growth hormones.

Recommended Books

1. Diane Tice, D., 2005. Principles and Applications of Soil Microbiology. 2nd Edition. Oxford University Press.
2. Paul, E.A., 2007. Soil Microbiology, Ecology and Biochemistry .Elsevier Science.
3. Varma, A., 2010. Advanced Techniques in Soil Microbiology: 1st Edition .Springer-Verlag New York, LLC.
4. Geoffrey R. Dixon, G.F., 2010. Soil Microbiology and Sustainable Crop Production: 1st Edition. Springer-Verlag New York, LLC
5. Vallabhaneni, S., 2012. Soil Microbiology- A Laboratory Manual. LAP Lambert Academic Publishing AG & Co. KG.

ENVIRONMENTAL MICROBIOLOGY & PUBLIC HEALTH

Credit Hours (2+1)

OBJECTIVES

- To learn about diversified environmental implications on public health.
- To get brief idea about epidemiology and community acquired ailments.
- To learn about waste water health hazards and its management.

Course Detail

- An introduction to environmental pollutants and their impact.

- Aeromicrobiology.
- Microbiology of water including water pollution. Detection and elimination of polluting bacteria from waters.
- Water purification by various means.
- Microbiology of wastewater including disposal and treatment.
- Microbiology of food and milk pertaining to public health.
- Prevention and control of epidemic diseases.
- Prophylactic measures and vaccines
- An introduction to bioremediation.
- Environmental pollution: an introduction to environmental diseases.
- Nosocomial and community acquired infection biomonitoring.
- National and international standards for monitoring the environment.
- Biosensors and bioindicators.
- Surveillance of epidemics through GIS.
- Environmental Laws and Regulations.

Practical

1. Detection of water, air and soil pollutants.
2. Isolation of microbes from air samples.
3. Designing of schemes as flow diagram for waste water treatment/management.
4. BOD and COD detection.
5. MPN technique.
6. Case study for different epidemics.

Recommended Books

1. Khardori, N., 2006. Bioterrorism Preparedness: Medicine - Public Health Policy. John Wiley and Sons limited.
2. Ziegler, A., and Koenig, I. R., 2006. A Statistical Approach to Genetic Epidemiology: Concepts and Applications. John-Wiley and Son Limited.
- 3.. Fos, P.J., 2010. Epidemiology Foundations: The Science of Public Health: 1st Edition. Wiley, John & Sons, Incorporate
4. Friis, R.H., 2010. Epidemiology for Public Health Practice: 4th Edition Publisher: Jones & Bartlett Learning.
5. Baily, S., 2012. Introduction to Epidemiologic Research Methods In Public Health Practice. Jones & Bartlett Learning.

6. Rothman, K.J., 2012. Epidemiology: An Introduction: 2nd Edition Oxford University Press.

DIAGNOSTIC CHEMISTRY FOR MICROBIAL DISEASES

Credit Hours (2+2)

OBJECTIVES

- To develop the skills for microbial diagnosis based on visual and biochemical tests.
- To learn about different human body organ and their functional evaluation in diseased condition.
- To learn sample collection from different parts of the body.

Course Detail

- The concept of visually detectable and undetectable changes, direct and indirect evidences for the diagnosis of microbial diseases.
- Gastrointestinal function test : Test based on:
Salivary digestion: a brief description of salivary digestion, the role of saliva in prevention of dental diseases and digestion and test based on salivary enzyme and its interpretation.
- Gastric digestion: a brief description of gastric digestion, test: Collection, analysis, and interpretation of Fasting content, Fractional Test Meal (FTM) secretion, Basal acid secretion, Alcohol test meal secretion, Augmented histamine test secretion, Insulin hypoglycaemic test secretion.
- Intestinal digestion: a brief description of intestinal secretions, pancreatic enzymes, pancreatic hormones and liver secretions involved in digestion, tests and their interpretation: amylase activity in serum and urine, faeces Examination: Physical, chemical and microscopic examination, test for endocrine function of pancreas: Glucose estimation in blood and urine, Glucose Tolerance Test (GTT), Renal Threshold, Ketone bodies in urine and Intestinal absorption: a brief description of intestinal absorption, test and its interpretation: Xylose excretion test.
- Role of gastrointestinal tract disturbances in development of anaemia
- Kidney Function Tests: a brief description of kidney functions, tests and their interpretations.

- Urinalysis: Collection of urine, Physical, chemical and microscopic examination, Estimation of waste products: blood urea and serum creatinine, tests for specific functions of kidney: Test for Glomeruli Filtration Rate: Urea clearance test, Creatinine clearance test. Phenolsulphonephthalein Excretion test and test for maximal tubular capacity: Concentration test, Dilution test.
- Liver Function Tests: a brief description of liver Functions (Circulatory, Excretory, Metabolic, Protective and Haematologic functions), Tests based on Abnormality of pigment metabolism, Qualitative Test: Van den Bergh Test, Quantitative Test, Estimation of Serum Bilirubin, Detection of Bile Pigments and Urobilinogen in urine, Plasma Proteins: Plasma Total Proteins, Albumin, Globulins, A/G Ratio, Flocculation Test, Lipid metabolism: A brief description of lipid profile, Blood Cholesterol estimation, Liver's part in carbohydrate metabolism: galactose tolerance test, excretion of Injectable, Bromosulphthalein Retention Test, Detoxification Function: Hippuric acid synthesis, a brief description of tests based on Blood Ammonia, Prothrombin Time, Serum enzyme activity (Transaminases, Alkaline phosphatases, lactic dehydrogenase).
- A brief description of cerebrospinal fluid (CSF).

Practical

1. Sample collection from different organs.
2. Transportation of clinical samples and biochemical tests.
3. Internship in hospitals/pathological labs.

Recommended Books

1. Ellen, J. B., James, J., Ellen, J. B., Marie, L. L., Michael, A. P., 2007. Manual of Clinical Microbiology. ASM Press.
2. Paul, G. E., Janet, D. E., 2007. Laboratory Diagnosis of Infectious Diseases: Essentials of Diagnostic. Lippincot Williams and Wilkins.
3. Connie R. M., Donald C. L. and George M. 2010. Text Book of Diagnostic Microbiology.
4. K.B., and Abaynesh , T., 2012. Quality of Liver & Kidney Functional Tests among Medical Laboratories. LAP Lambert Academic Publishing AG & Co. KG.
5. Mousmi D. and Prasad G. B. 2012. Microbes: Concept and Application. Wiley Blackwell

VETERINARY MICROBIOLOGY

Credit Hours (2+1)

OBJECTIVES

- To learn about viral and bacterial infections of animals and birds.
- To learn about common pathogens of human and animals.
- To get know how of symptoms, diagnosis, epidemiology and control of veterinary infections.

Course Detail

- Study of major animal diseases in Pakistan. Etiology, Symptomatology, Immunology, Epidemiology, diagnosis, and prevention.
- Tuberculosis, Anthrax, Brucellosis, Johne's Disease, Bovine Mastitis, tick fever, Salmonellosis (including Pullorum).
- Rabies, Foot and Mouth Disease. New castle Disease, Infectious laryngotracheitis, Fowl pox, Sore Mouth of sheep and goats, avian influenza, infectious bursal disease (Gumboro), hydropericardium syndrome (Angara).
- Importance of Zoonoses in Pakistan.
- Quarantine and international control of animal livestock farming.

Practical

1. Isolation of etiological agents of infections in animals.
2. Isolation of etiological agents of infections in poultry.
3. Mode of immunization of birds and animals.
4. Field trips.

Recommended Books

1. Martin E., Jones,H., William T. and Hubbert,V. H., 2005. Zoonoses: Recognition, Control and Prevention, Blackwell Publishing.
2. Mettenleiter, T. C and F. Sobrino, F., 2008. Animal Viruses: Molecular Biology Caister Academic Press.
3. Songer, J, G., and Post, K., 2009.Veterinary Microbiology: Bacterial and Fungal Agents of Animal Disease. 1st Edition. Wiley, John & Sons, Incorporated.
4. Quinn, P.J., Markey, B.K., Leonard, F.C.,Hartigan, P., Fanning, S.,2012.Veterinary Microbiology and Microbial Disease. Wiley, John & Sons, Incorporated.

MYCOTIC INFECTION

Credit Hours: (2+1)

OBJECTIVES

- To learn about some selected human fungal infections
- To learn about etiology of some cutaneous and systematic mycosis.
- To learn about sample collection, diagnosis and control of fungal infections.

Course Detail

- Introduction to human mycotic infections.
- Host parasite interactions and molecular mechanisms.
- Study of the following human diseases with particular reference to etiology, epidemiology, symptomatology, lab. diagnosis and therapeutic considerations of: Actinomycosis, nocardiosis, candidiasis, histoplasmosis, blastomycosis, coccidiomycosis, geotrichosis, aspergillosis, chromoblastomycosis, mycetoma, sporotrichosis, cryptococcosis, and zygomycosis.
- Dermatophytes and dermatomycosis, Tinea versicolor, white and black Piedra, Tinea nigra.
- Prophylaxis and chemotherapy.
- Immunity in fungal infections.
- Zoonotic fungal infections.
- Newly emerging fungal infections.

Practical

1. Detection of etiological agents in sputum, nails, hairs, and skin samples.
2. Microscopic observation of fungi in clinical samples.
3. Cultivation of fungi.
4. Rapid molecular diagnostic methods
5. Antifungal sensitivity test.

Recommended Books

1. Webster, J. and Weber, R., 2008 Introduction to Mycology. Cambridge University Press.
2. Lechevalier, H., A practical guide to Generic Identification of Actinomycetes volume 4 of Bergey's Manual of Systematic Bacteriology.

3. Borkovich K. and Daniel J. E. 2010. Cellular and Molecular Biology of filamentous Fungi. ASM Press.
4. Errol R., Shadomy J. and Lyon G. H. 2011. Fundamental Medical Mycology. Wiley Blackwell.
5. Gioconda, S.B. and Richard, C. A., 2012. Pathogenic Fungi: Insights in Molecular Biology. Caister Academic Press.
- 6.. Goadby K. W. ,2012. The Mycology of the Mouth. Rare Books Club.

DNA DAMAGE, REPAIR AND CARCINOGENESIS

Credit Hours (2+1)

OBJECTIVES

- To learn about physical and chemical DNA damaging agents.
- To learn about exo and endogenous mutagenic agents.
- To learn about the mechanism of carcinogenesis and mutations.

Course Detail

- 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.
- Chemical as damage inflicting agents. Exogenously and endogenously induced base modifications and their biological consequences.
- Restoration of DNA damages: photo-enzymatic restoration and dealkylation. Environmental and physiological factors influencing recovery phenomenon viz. Liquid holding recovery, thermal and UV reactivation.
- Repair of DNA damages: 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.
- Relevance of inducible repair to carcinogenesis.
- Somatic theory of cancer. Chemistry of carcinogenesis, cellular transformation.
- Anticarcinogenesis: role of repair processes in tumor progression. Molecular genetics of human cancer: diagnostic and therapeutic indices.

- Repair and spontaneous mutagenesis, plasmid gene mediated repair, genetic control of repair phenomenon.
- Enzymology of DNA repair.
- Cancer and gene therapy.

Practical

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

Recommended Books

1. Friedberg, E.C., 2006. DNA Repair and Mutagenesis: 2nd Edition
Publisher: ASM Press.
2. Howe, H., 2007. Gene Cloning and Manipulation Cambridge University Press
3. Snyder, L. and W. Champness, W., 2007. Molecular Genetics of Bacteria, 3rd edn American Society for Microbiology.
4. Caldecott, K.W., 2011. Eukaryotic DNA Damage Surveillance and Repair: 1st Edition. Springer-Verlag New York, LLC.
5. Stone, M., 2011. Structural Biology of DNA Damage and Repair. American Chemical Society.
6. James D. W. 2013. Molecular Biology of Gene. McGraw-Hill Science.

MANAGEMENT OF INFECTIOUS WASTE

Credit Hours (2+1)

OBJECTIVES

- To learn the categorization of waste.
- To identify risk of infections associated with different type of waste.
- To learn proper handling and management of different types of waste.

Courses Detail

- An introduction to the management of infectious waste materials.
- Various types of infectious materials: handling and methods of their disposal.
- Segregation of waste materials.
- Infectious diseases and methods of spread of agents involved.

- Laboratory and Hospital acquired infections: possible sources and causes.
- Hazardous groups of microorganisms including genetically modified organisms.
- Basic containment rules and laboratory containment levels.
- Control measures and maintenance of control. Guidelines for workers in pathological Labs. and post mortem rooms.
- Rules for safe conduct of field work expeditions in outdoor activities.
- Risk assessment: recognition of hazards, competence, elimination of hazards, collection of data etc.
- Risk group personnel: their education, training and monitoring.
- Radiation hazards and disposal of radioactive wastes.

Practical

1. Visit to hospitals for the evaluation of efficiency of the waste management plan.
2. Identification of pathogens in infectious waste.
3. Identification of hazardous chemical waste in water reservoirs.

Recommended Books

1. Frosch, M., Martin C. and Maiden, J., 2006. Handbook of Meningococcal Disease: Infection Biology, Vaccination, Clinical Management. John Wiley & Sons, Inc U.S.A.
2. Gillespie, S., and Hawkey, P. 2006. Principles and Practice of Clinical Bacteriology, 2nd Edition . John Wiley& Sons, Inc U.S.A.
3. Miller, C.H., 2009. Infection Control and Management of Hazardous Materials for the Dental Team: 4th Edition. Elsevier Health Sciences
4. Callahan, R.J., 2012. Emerging Biological Threats: A Reference Guide. Greenwood Publishing Group, Incorporated
5. Miller, C.H., and Palenik, J.C.,2013. Infection Control and Management of Hazardous Materials for the Dental Team Elsevier Health Sciences.

EPIDEMIOLOGY

ANALYTICAL AND EXPERIMENTAL APPROACHES

Credit Hours (3+0)

OBJECTIVES

- To learn the experimental, analytical and statistical tools for epidemiology.
- To learn about communicable diseases their mode of transmission, reservoir host, control and prevention.

Course Detail

- An introduction to epidemiology: Diseases: including cancer, malnutrition, road accidents & mental illness, population, ecological approaches.
- Analytical and experimental epidemiology.
- Epidemiology of communicable diseases: Agents, Reservoir, Host, Route of transmission.
- Epidemiology of non-communicable diseases.
- Tropical environment: Physical, Biological, Social.
- Health statistics.
- Natural immunity (innate) and factors affecting host immunity.
- Control of communicable diseases: general principles of prevention.
- Nosocomial infections.
- Infection Gastrointestinal tract.
- Infection through skin and mucous membrane.
- Air and arthropod borne infections.
- Life threatening diseases and their control (AIDS, hepatitis B & C etc).
- Epidemiology and control of nutritional diseases.
- Environmental health and health education: Fundamental principles of environmental sanitation and hygiene.
- Public health: quality of life and life style.
- Introduction to molecular epidemiology.

Recommended Books

1. Haines, J. L., Pericak-Vance, M. A., 2006. Genetic Analysis of Complex disease. Wiley, John and Sons Incorporated.
2. Khardori, N., 2006. Bioterrorism Preparedness: Medicine - Public Health Policy. John Wiley and Sons limited.
3. Fos, P.J., 2010. Epidemiology Foundations: The Science of Public Health: 1st Edition. Wiley, John & Sons, Incorporate
4. Friis, R.H., 2010. Epidemiology For Public Health Practice: 4th Edition .Publisher: Jones & Bartlett Learning

5. Rothman, K.J., 2012. Epidemiology: An Introduction: 2nd Edition .Oxford University Press.
6. Baily, S., 2012. Introduction to Epidemiologic Research Methods In Public Health Practice. Jones & Bartlett Learning.

ADVANCES IN MICROSCOPY AND IMAGE ANALYSIS

Credit Hours (2 +1)

OBJECTIVES

- To develop the concept in students about different types of microscopy
- To examine detailed structures of cells in different perspectives.

Course Detail

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

Practical

Visit to different institute for hands on experience on different instruments

Recommended Books

1. 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.
2. Eaton, P. and West, P. 2010. *Atomic Force Microscopy*, Oxford University Press, U.S.A.
3. Gabriel Popescu. 2010. Nanobiophotonics. McGraw Hill.
4. Gabriel Popescu 2011. Quantitative Phase Imaging of Cells and Tissue. McGraw-Hill.
5. John S., Curry A. and Eyden B. 2013. Diagnostic Electron Microscopy. Wiley.
6. David C. B. and Erdman N. 2013. Low Voltage Electron Microscopy: Principles and Application. Wiley.

NANO-BIOTECHNOLOGY

Credit Hours (2+1)

OBJECTIVES

- To understand about nanoparticles produce by microorganisms.
- To learn about the application of nanoparticles in various fields.
- To learn about the use of nanoparticles in medical sciences.

Course Detail

- Biomaterials : 1st generation, 2nd generation , 3rd generation biomaterials: their historical overview and current directions
- Nanobiotechnology and nanoscience ; top down and bottom up approaches to analyze nanoscopic properties;
- Nanoparticles and nanoscale materials.
- Cellular nano- and microstructures.
- Nanocarbon tubes and abalone shells.
- Nanomanipulation via different types of micromanipulators.
- Nanoprobes and probe array.
- DNA nanotechnology and DNA-modified surfaces
- Applications of nanobiotechnology in living systems.

Practical

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

Recommended Books

1. Prasad. 2008. Advanced Nanotechnology. DPH.
2. Thomas M. M. 2009. Nanobiotechnology: Synthetic Biology and RNAi Marquette University Law School.
3. Vedpriya A. and Kumar R. 2011. Nanobiotechnology: Biological Synthesis of Silver nanoparticles in Brassica Juncea. LAP LAMBERT Academic Publishing.
4. Sandra J. R. and David W. W. 2013. Nano-biotechnology protocol. Humana.

INDUSTRIAL MICROBIOLOGY

Credit Hours (3+1)

OBJECTIVES

- To learn about microorganisms of industrial importance.

- To learn about the commercial utilization of microbes for the production of organic acids, organic solvents and fermentable products.
- To learn the industrial microbial processing techniques.

Course Detail

- Fundamentals of modern fermentation technology and industrial microbiology.
- Culture techniques.
- The food processing, food manufacture, preservation.
- Environmental quality and sanitation.
- Screening of biotechnologically important microorganisms.
- Outlines of isolation, cultivation and maintenance of biotechnologically important microorganisms.
- Microbial fermentations: Organic acids -Citric, lactic and acetic acid.
- Organic solvents - Acetone, butanol and ethanol.
- Microbial enzymes: amylases.
- Amino acids: Lysine and glutamic acid.
- Scope of fermentation biotechnology In Pakistan.

Practical

1. Current techniques of industrial and applied microbiology with emphases on continuous cultures.
2. Immobilized cell techniques.
3. Study of different types of fermentations by different microorganisms.
4. Use of biotechnological techniques in fermentation of organic compounds.

Recommended Books

1. Prescott S. C., 2007. Industrial Microbiology, Agrobios India
2. Naduka Okafor. 2007 Modern Industrial Microbiology and Biotechnology. Science Publisher.
3. Richard H. B. Julian E. D. et al., 2010. Manual of Industrial Microbiology and Biotechnology. ASM Press.
4. El-Mansi E. M. T. et al., 2011. Fermentation Microbiology and Biotechnology. CRC Press.
5. Pauline M. D., 2012. Bioprocessing Engineering Principles. Academic Press.

EPIGENETICS

Credit Hours (2+1)

OBJECTIVES

- This will give insight into the genetic regulation.

- To learn heritable changes in gene expression and cellular phenotypes.
- To learn about changes in phenotypes other than changes in underlying DNA sequences.

Course Detail

- Genome organization of eukaryotes.
- Structure of chromosomes.
- Structure of gene
- Types of DNA.
- Types of RNA.
- Regulatory sites on DNA.
- Heterochromatin and euchromatin.
- Genetic modulation by CpG Island, DNA methylation and its implication on gene expression.
- Types of methylases, DNA/RNA methylation, and its implication on gene expression.
- Types of acetylases, acetylation of histones.
- Book marking, Imprinting, Maternal effects, Paramutation, X chromosome inactivation, Position effect, Gene silencing, Transvection and Reprogramming.
- Implication of epigenetic on gene expression, cellular differentiation and signal transduction.

Practical

1. Karyotyping of eukaryotes.
2. Detection of CpG motifs by restriction enzymes.
3. Detection of CpG motif by PCR.
4. Detection of methylated sites on DNA.

Recommended Books

1. Trygve Tollefbo. 2010. Handbook of Epigenetics. Academic Press.
2. Jhon Hancock. 2010. Cell signaling. Oxford University Press.
3. Benedikt H. and Brian K. H., 2011. Epigenetics: Linking Genotype and Phenotype in Development and Evolution University of California Press.
4. Richard C. F., 2012. Epigenetics. W. W. Norton & Company.
5. Nessa Carey. 2012. The Epigenetic Revolution. Columbia University Press.

PLANT VIROLOGY

Credit Hours (2+1)

OBJECTIVES

- To learn about the phytopathogen viruses of economically important plants.
- Understanding of plant viruses classification and their mode of replication.
- To learn about the dynamics of host pathogen interaction that result in diseases.

Course Detail

- History of plant viruses.
- Physicochemical properties of plant viruses and virioids.
- Virus structure, composition and genome organization.
- Classification of plant viruses.
- Host range and virus vector interaction.
- Mode of replication and transmission of plant viruses.
- Symptoms of viral diseases.
- Important viral diseases of plant and resistance mechanisms.
- Economic aspects of viral diseases of plants.
- Management strategies of plant viral diseases.

Practical

1. Isolation and purification of plant viruses.
2. Immunodetection of plant viruses i.e ELISA, TPIA.
3. Symptomatology and Biotest.
4. Molecular detection of plant viruses.
5. Viral/ virioid RNA/DNA extraction and purification.
6. PCR and RT-PCR.
7. Detection of viral inclusions by light microscopy.

Recommended Books

1. Khan, J. and Dijkstra, J. 2006. The Hand Book of Plant Viruses. CRC Press.
2. Roger, H. 2009. Comparative Plant Virology 2nd Edition Academic Press.
3. Carole, C., Miguel, A., A., Mark, T. and Juan, J. L. M. 2011, Recent Advances in Plant Virology. Caister Academic Press.
4. Roger, H., 2013. Plant Virology 5th Edition Academic Press.
5. Sastry, K. S. 2013 Seed-Borne Plant Virus Diseases. Springer.

MICROBES AND NERVOUS SYSTEM

Credit Hour (3+0)

OBJECTIVE

- To learn the basic principles of microbial interaction with the nervous system.
- Understanding of microbial intervention in neurotransmission.
- Mechanism of microbial entry into the brain.

Course Detail

- Introduction to infectious diseases of the brain e.g. Meningitis, Encephalitis, Myelitis and Abscess.
- Bacteria causing meningitis (Meningococci, pneumococci and Staphylococci).
- Bacterial species causative agent for meningo encephalitis (Mycobacterium, Listeria and Treponema).
- Parasitic infection of brain, Plasmodium, Trypanosomes and Toxoplasma.
- Fungal infections of brain.
- Viral infections of brain
- Miscellaneous pathways of microbial entry into the brain.
- Hematogenous routes and role of circumventricular organs, Cerebrospinal fluid and blood brain barriers.
- Peripheral nerve routes, olfactory pathway, trigeminal and spinal nerves.
- Emerging infections of brain.

Recommended Books

1. Richards, D., Clarke, C. E. and Clarke T., 2007. The Human Brain and its Disorders, Oxford University Press.
2. Nester, E., Anderson, D., Roberts, J. C. E. and Nester, M. 2008, Microbiology: A Human Perspective. McGraw-Hill Science.
3. Karen, I. R, and Tunkle, A. R. 2010, Bacterial Infections of Central Nervous System, Elsevier.
4. Jackson, A. C. 2013,. Viral Infections of the Central Nervous System. Springer.
5. Rose, H. and Rose, S. 2013. Genes, Cells and Brain: The Promethean Promises of the New Biology. Verso.

RECOMMENDATIONS

At the end of session the committee recommended that:

1. The committee strongly recommended that there will be no mid-point entry into the B.S program 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 program should be conducted by the HEC.
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. Program.
5. After implementation of BS. Program, feedback from students and teachers of microbiology may be obtained by the HEC. And upgradation of the Labs and Courses should be aligned with the contemporary needs.
6. National Reference Culture Collection Center should be established by the HEC.
7. Separate Microbiology department should be established (with adequate funding) in universities of the provinces of the country.
8. Teaching of Microbiology 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) Microbiologist.
9. The department of Microbiology in all the medical colleges should be administered by a qualified microbiologist with the PhD degree in the subject of Microbiology. All the staff members should also be the trained Microbiologists with at least BS/MSc, MS/MPhil in Microbiology.
10. Research and higher education in basic Medical Sciences at medical colleges/universities should be under the jurisdiction of HEC.
11. To streamline the higher education and focused research in different subjects of science, integration between different councils of Pakistan i.e. Medical, Agriculture, Pharmacy and Veterinary is inevitably required.
12. The committee strongly felt that Microbiology has been ignored by the Public Service Commissions, National Awards and scholarship/fellowship awarding agencies. It is therefore recommended that the HEC and Ministry of Science and Technology whenever announcing a national awards scholarship/fellowship must clearly mention Microbiology as one of the discipline in their

advertisement. Furthermore Federal and Provincial Public Service Commission should be requested to include Microbiology as one of the subjects in their list.

13. Application of Microbiology should be promoted by establishing interaction between industry and universities in the last two years of BS. Program. Student should get the training (during summer vacation) in industry, hospitals, pharmaceutical industry.
14. **Teachers Training Programme:**
It is recommended that all the appointed Teachers (in microbiology) must be asked to undergo a training to develop the skills of Presentation and Communication. Furthermore, the Department of Microbiology, University of Karachi and other elite institutions of the country may be identified as a focal point to train teachers from various colleges/universities having newly established or are establishing departments of Microbiology.
15. **Continuing Education Programme:**
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.