

CURRICULUM

OF

BIOTECHNOLOGY
BS (4 – YEAR)

(2009)



HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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Composed by Mr. Zulfiqar Ali, HEC Islamabad

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PREFACE

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

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

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor's Committee, the curriculum of a subject must be reviewed after every 3 years.

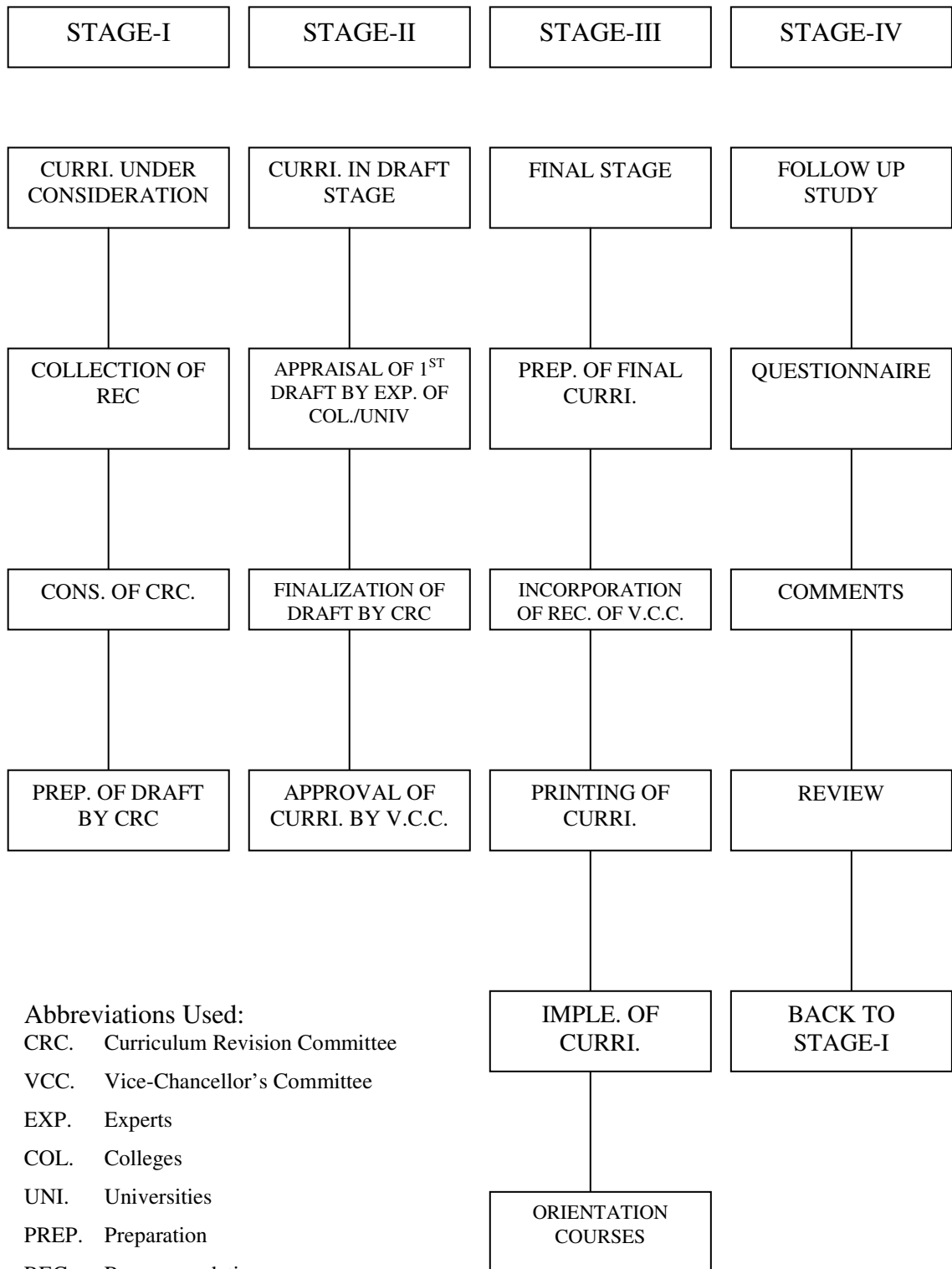
A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new Bachelor (BS) degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments.

For the purpose of curriculum revision various committees are constituted at the national level, comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations, respective accreditation councils and stake holders. The final draft curriculum prepared by the National Curriculum Revision Committee meeting on April 23-25, 2009 at HEC Regional Centre, Lahore in continuation of first preliminary meeting held on October 27-29, 2008 at HEC Regional Center, Lahore revised the curriculum in light of the unified template. The revised draft curriculum is being circulated for implementation in the concerned institutions.

PROF. DR. ALTAF ALI G. SHAIKH
Member Academics

August 2009

CURRICULUM DEVELOPMENT



INTRODUCTION

The members National Curriculum Revision Committee on Biotechnology developed frame work and revised the curriculum in two different meetings. The first meeting was held on October 27-29, 2008 at Higher Education Commission, Regional Centre, Lahore. The Second meeting was held on April 23-25, 2009 at HEC Regional Centre, Lahore. The following experts attended these meeting:

- 1. Prof. Dr. M. Amin Athar** **Convener**
Professor & Director,
Institute of Biochemistry & Biotechnology
New Campus, University of the Punjab,
Lahore.
- 2. Dr. M.A.K. Malghani** **Member**
Pro-Vice Chancellor
Balochistan University of Information Technology
Engineering and Management Sciences,
Quetta.
- 3. Dr.Zahoor Ahmed Swati,** **Member**
Director,
Institute of Biotechnology and Genetic Engineering,
NWFP Agricultural University,
Peshawar.
- 4. Dr. Shahida Hasnain,** **Member**
Professor/Chairperson,
Department of Microbiology and Molecular Genetics,
University of the Punjab,
Lahore.
- 5. Prof. Dr. Muhammad Ali,** **Member**
Director, Institute of Biotechnology,
Bahauddin Zakariya University,
Multan.
- 6. Dr. Shah Jehan Baig** **Member**
Chief Scientific Officer
PCSIR Laboratories Complex,
Lahore.
- 7. Dr. Hussnain Ali N. Sayyed** **Member**
Foreign Faculty Professor
Institute of Biotechnology,
Bahauddin Zakariya. University,
Multan.

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| <p>8. Dr. Shaheen N Khan
 Professor
 National Centre of Excellence in Molecular Biology
 University of the Punjab,
 Lahore.</p> | <p>Member</p> |
| <p>9. Dr. Safia Ahmed,
 Associate Professor,
 Department of Microbiology,
 Quaid-i-Azam University,
 Islamabad</p> | <p>Member</p> |
| <p>10. Dr. Quratul Ain Syed
 Principal Scientific Officer
 Biotechnology and Food Research Centre
 PCSIR Laboratories Complex,
 Lahore.</p> | <p>Member</p> |
| <p>11. Dr. Samina Shakeel,
 Assistant Professor
 Department of Biochemistry
 Quaid-i-Azam University,
 Islamabad.</p> | <p>Member</p> |
| <p>12. Dr. Ijaz Ali,
 Assistant Professor,
 Institute of Biotechnology & Genetic Engineering,
 NWFP Agricultural University,
 Peshawar.</p> | <p>Member</p> |
| <p>13. Mr. Sajid ul Ghafoor,
 Assistant Professor,
 Department of Genetics,
 Hazara University, Garden Campus,
 Mansehra, NWFP.</p> | <p>Member / Secretary</p> |

Proceeding of the Preliminary NCRC meeting:

The meeting started with recitation of verses from the Holly Quran by Mr. Shafiullah Deputy Director, HEC Islamabad. Mr Bashir Ahmed, Incharge Director HEC Regional Centre, Lahore welcomed the participants and assured them that the Regional Centre would extend all sort of facilities to make their stay comfortable at Lahore. Mr. Shafiullah, meeting coordinator from HEC Islamabad, briefed them about the overall structure of template / framework of BS (4 year) program, being developed by the conveners of the National Curriculum Revision Committee in Basic, Social and Applied Sciences in their meeting, held on April 30, 2008 at HEC Islamabad. He requested the participants to include at least two subjects of social sciences in the list of general subjects and to recommend latest books of reading in the subject. He further suggested to the committee members to

restrict the credit hours of the scheme in the range of 130 – 133 so that the universities should have an option to add more 3 Credit hours to fulfill the maximum limit of 136 Credit hours. The committee before taking up the regular agenda unanimously agreed to select Prof. Dr. M. Amin Athar as Convener and Dr. Zahoor Ahmed Swati as Secretary of the meeting. After a long discussion, the following layout and scheme of study was developed:

STANDARDIZED FORMAT FOR BS (4 YEAR) IN BIOTECHNOLOGY

STRUCTURE

Sr.	Categories	No. of courses	Credit Hours
1.	Compulsory Requirement (No Choice)	9	25
2.	General Courses to be chosen from other departments	7	24
3.	Discipline Specific Foundation Courses	11	33
4.	Major Courses including research project / Internship	15	39
5.	Electives within the major	4	12
	Total	46	133

- Total numbers of Credit hours 133
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course Load per Semester 14-18 Cr hr
- Number of courses per semester 4-7

LAYOUT FOR BS (4-YEAR) IN BIOTECHNOLOGY

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments	
9 courses		7-8 courses	
25 Credit hours		21-24 Cr. Hours	
Subject	Cr. hr	Subject	Cr. hr
1. ENGLISH I	3+0	1. Physical Chemistry.	2+1
2. ENGLISH II	3+0	2. Inorganic Chemistry.	2+1
3. ENGLISH III	3+0	3. Organic Chemistry	2+1
4. ENGLISH IV/ International language*	3+0 2+0	4. Plant Diversity.	2+1
5. PAKISTAN STUDIES	2+0	5. Animal Diversity	2+1
6. ISLAMIC STUDIES / ETHICS	3+0	6. Ecosystem & Environment	2+1
7. MATHEMATICS I	3+0	7. Two courses out of Social Sciences	
8. MATHEMATICS II / UNIV. OPTIONAL **	3+0	a) Sociology	(3+0)
9. INTRODUCTION TO COMPUTER		b) Mass Communication	(3+0)
		c) Economics	(3+0)
		d) Marketing	(3+0)
		e) Environmental Policy	(3+0)
		f) Psychology	(3+0)
		g) Fine Arts	(3+0)
		h) Political Science	(3+0)
		i) International Affairs	(3+0)
		j) Public Administration	(3+0)
	25		24

Discipline Specific Foundation Courses		Major courses including research project/internship		Elective Courses within the major	
10-11 courses		13-15 courses		4 courses	
30-33 Credit hours		36-42 Credit hours		12 Credit Hours	
Subject	Cr. hr	Subject	Cr. hr	Subject	Cr. Hr
1. Microbiology	2+1	1. Elements of Biotechnology	2+0	Elective I	2+1
2. Biochemistry I	2+1	2. Principals of Biochemical Engineering	2+1	Elective II	2+1
3. Biochemistry II	2+1	3. Agriculture Biotechnology	2+1	Elective III	2+1
4. Cell Biology	2+1	4. Health Biotechnology	3+0	Elective IV	2+1
5. Genetics	2+1	5. Environment Biotechnology	2+1	Note: These courses will be selected from the list of elective courses.	
6. Statistics	3+0	6. Food Biotechnology	2+1		
7. Analytical Chemistry & Instrumentation	2+1	7. Microbial Biotechnology	2+1		
8. Mol. Biology I	2+1	8. Recombinant DNA Technology	2+1		
9. Mol. Biology II	2+1	9. Cell and Tissue Culture	0+2		
10. Immunology	2+1	10. Bioinformatics	2+0		
11. Genetic resources & Conservations	2+1	11. Metabolomics, Proteomics and Genomics	1+0		
		12. Down Stream Technology	1+0		
		13. Bio-safety & Bioethics	0+1		
		14. Skill Enhancement			
		15. Research thesis/ Research Project/ Internship/ Special Paper	6+0		
	33		39		12

* **University has the option to recommend any other course in lieu of English IV /One language in addition to the English will be from (German, French, Spanish, Chinese, Japanese, Persian, Arabic etc.)**

** **University may recommend any other course in lieu of Mathematics II**

SCHEME OF STUDIES FOR BS (4 YEAR) BIOTECHNOLOGY

YEAR ONE / SEMESTER FIRST

S. No	Name of Subject	Credits
1	English-I	3+0
2	Pakistan Studies	2+0
3	Mathematics-I	3+0
4	Physical Chemistry (G)	2+1
5	Plant Diversity. (G)	2+1
6	Cell Biology (F)	2+1
	Total	17

YEAR ONE / SEMESTER SECOND

S. No	Name of Subject	Credits
1	English-II	3+0
2	Islamic Studies/Ethics	2+0
3	Mathematics-II	3+0
4	Inorganic Chemistry (G)	2+1
5	Animal Diversity (G)	2+1
6	Genetics. (F)	2+1
	Total	17

YEAR TWO/SEMESTER THIRD

S. No	Name of Subject	Credits
1	English-III	3+0
2	Introduction to Computer	3+0
3	Organic Chemistry (G)	2+1
4	Any subject from social sciences (G)	3+0
5	Biochemistry I (F)	2+1
6	Microbiology (F)	2+1
	Total	18

YEAR TWO /SEMESTER FOURTH

S. No	Name of Subject	Credits
1	English-IV/International Language*	3+0
2	Ecosystem & Environment (G)	2+1
3	Any subject from social sciences (G)	3+0
5	Analytical Chemistry & Instrumentation. (F)	2+1
6	Biochemistry II (F)	2+1
7	Mol. Biology I (F)	2+1
	Total	18

YEAR THREE /SEMESTER FIFTH

S. No	Name of Subject	Credits
1	Statistics. (F)	3+0
2	Immunology. (F)	2+1
3	Mol. Biology II (F)	2+1
4	Principles of Biochemical Engineering. (M)	2+1
5	Cell and Tissue Culture. (M)	2+1
6	Elements of Biotechnology (M)	2+0
	Total	17

YEAR THREE/SEMESTER SIXTH

S. No	Name of Subject	Credits
1	Genetic resources & Conservation (F)	2+1
2	Microbial Biotechnology	2+1
3	Agriculture Biotechnology. (M)	2+1
4	Food Biotechnology. (M)	2+1
5	Bioinformatics. (M)	0+2
	Total	14

YEAR FOUR /SEMESTER SEVENTH

S. No	Name of Subject	Credits
1	Health Biotechnology. (M)	3+0
2	Recombinant DNA Technology (M)	2+1
3	Skill Enhancement. (M)	0+1
4	Metabolomics, Proteomics and Genomics (M)	2+0
5	Elective-I	2+1
6	Elective-II	2+1
7	Research Dissertation, Research Project, Internship, Special Paper	3+0
	Total	18

YEAR FOUR /SEMESTER EIGHTH

S. No	Name of Subject	Credits
1	Elective-III	2+1
2	Environment Biotechnology. (M)	2+1
3	Down Stream Technology (M)	1+0
4	Bio-safety & Bioethics (M)	1+0
5	Elective-IV	2+1
6	Research Dissertation, Research Project, Internship, Special Paper	3+0
	Total	14

TOTAL CREDIT HOURS: 133

The 2nd day of the meeting started with recitation of the Holy Quran. The committee decided to develop details of all the Foundation, Major courses and Elective courses as per HEC format. The following members were then given the task by the committee to develop the course outlines of all Foundation and Major courses and Elective courses and send them to Convener and Secretary of the meeting and also to Mr. Shafiullah, Assistant Director (Curriculum) HEC Islamabad within 2-3 weeks.

Sr.No.	Name of Member	Courses
1.	Prof. Dr. M. Amin Athar Professor & Director, Department of Biochemistry & Biotechnology University of the Punjab Lahore	1. Bio-Chemistry I & II 2. Analytical Chemistry & Instrumentation 3. Immunology
2.	Dr.M.A.K. Malghani Pro-Vice Chancellor	1. Food Biotechnology 2. Pharmaceutical Biotechnology

	Balochistan University of Information Technology Engineering and Management Sciences, Quetta.	3. Diagnostics
3.	Dr. Shaheen N Khan Professor National Centre of Excellence in Molecular Biology University of the Punjab, Lahore	
4.	Dr. Shahida Hasnain Professor/Chairperson, Department of Microbiology and Molecular Genetics, University of the Punjab Lahore	1. Microbiology 2. Ecosystem & Environment 3. Statistics 4. Microbial Biotechnology 5. Recombinant DNA Technology 6. Animal Biotechnology 7. Radiobiology 8. Biomaterial 9. Marine biotechnology
5.	Dr. Hussnain Ali N. Syyed Foreign Faculty Professor Department of Biotechnology, Bahauddin Zakariya. University Multan	1. Plant Diversity 2. Agriculture Biotechnology 3. Bioinformatics 4. Fungal Biotechnology
6.	Dr. Shah Jehan Baig Chief Scientific Officer PCSIR Laboratories Complex, Lahore	1. Principle of Biochemical Engineering 2. Industrial Biotechnology 3. Bioelectronics and Biosensor 4. Biofuel and Biorefinery
7.	Dr. Quratul Ain Syed Principal Scientific Officer Biotechnology and Food Research Centre PCSIR Laboratories Complex, Lahore.	1. Down Stream Technology 2. Food Biotechnology
8.	Dr. Safia Ahmed, Associate Professor, Department of Microbiology, Quaid-i-Azam University, Islamabad	1. Waste Management 2. Water and waste water treatment
9.	Dr. Samina Shakeel Assistant Professor Department of Biochemistry Quaid-i-Azam University, Islamabad	1. Cell Biology 2. Health Biotechnology 3. Metabolomics, Proteomics & Genomics 4. Nanotechnology
10.	Sajid ul Ghafoor, Assistant Professor, Department of Genetics, Hazara University, Garden Campus, Mansehra, NWFP	1. Animal Diversity 2. Genetic Resources & Conservation 3. Environment Biotechnology 4. Bio-safety & Bio-ethics

11.	Dr.Zahoor Ahmed Swati Director, Institute of Biotechnology and Genetic Engineering, NWFP Agricultural University, Peshawar	1. Genetics 2. Molecular Biology I 3. Molecular Biology II 4. Elements of Biotechnology 5. Cell and Tissue 6. Plant Biotechnology
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Further more, the committee decided that each course will be designed as per HEC format as follow;

- | | |
|-------------------|---------------------------|
| 1. Name of Course | 2. Number of Credit Hours |
| 3. Prerequisite | 4. Objectives |
| 5. Contents | 6. Recommended Books |

On the 3rd day of the meeting, the members were taken to the Department of Biochemistry & Biotechnology, University of the Punjab, Lahore for exploring and studying of advance materials, reference books and research work in developing contents for Biotechnology Curriculum.

LIST OF ELECTIVE COURSES

- | | |
|------------------------------------|-----|
| 1. Industrial Biotechnology | 2+1 |
| 2. Pharmaceutical Biotechnology | 2+1 |
| 3. Plant Biotechnology | 2+1 |
| 4. Animal Biotechnology | 2+1 |
| 5. Fungal Biotechnology | 2+1 |
| 6. Waste Management | 2+1 |
| 7. Water and Waste water treatment | 2+1 |
| 8. Bioremediation | 2+1 |
| 9. Bio-fuel and Biorefinery | 3+0 |
| 10. Diagnostics | 1+2 |
| 11. Bioelectronics & Biosensor | 3+0 |
| 12. Radiobiology | 2+1 |
| 13. Biomaterial | 2+1 |
| 14. Marine Biotechnology | 2+1 |
| 15. Nanobiotechnology | 3+0 |

Proceeding of the final NCRC meeting:

The second & final meeting started with recitation from the Holy Quran by Mr. Shafiullah, Assistant Director (Curriculum), HEC Islamabad. Mr. Bashir Ahmed , In charge Director, HEC, Regional Centre, Lahore welcome the NCRC members in Biotechnology and assured that all available facilities would be extended to them to make their stay comfortable at Lahore. Before the start of further proceedings of the meeting, Mr. Shafiullah, Coordinator of the program requested the members to select new Secretary as Dr. Zahoor Ahmed Swati was not available and he has very kindly sent Dr. Ijaz Ali as his substitute. The committee unanimously selected Mr. Sajid ul Ghafoor, as new Secretary of the committee. After long discussion, the course outlines of all Foundation, Major and Elective courses, prepared by members assigned to them in the preliminary meeting, were taken up for thorough & detailed discussion . After discussion necessary changes were made in the courses. The details of finally developed courses are as follows:

DETAIL OF COURSES

COURSE TITLE:

CELL BIOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint students with cell structure, function and visualization of cell and its components.

COURSE CONTENTS:

Introduction to cell theory, structure, chemical constituents of cell and cell organelles and their functions, separation of cell organelles, Cell membrane, its molecular organization and functional role, The concept of the unit membrane, the fluid mosaic model, membrane receptors and transport mechanisms. Endoplasmic Reticulum. Lysosome, Micro-bodies, Mitochondrial ultra structure and function, Chloroplast ultra structure and the mechanism of photosynthesis, Cell movements, structure and function of cytoskeleton, centriole, cilia and flagella, the mitotic apparatus, The nucleus, structure and function of chromosomes, the cell cycle, mitosis, meiosis.

Practical:

Microscopy and staining techniques, Study of prokaryotic and eukaryotic cells, Study of plant and animals cell, Cell structure in the staminal hair of *Tradescantia*, Study of different types of plastids, Cellular reproduction, Mitosis: smear/squash preparation of onion roots.

RECOMMENDED TEXT BOOKS:

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, 4th Edition, 2006. Garland Sciences. Published by Academic Internet Publishers.
2. Molecular Cell Biology, Lodish, Berk, Zipursky, 4th Edition. 2000. W.H. Freeman.
3. Cell and Molecular Biology, Karp, 3rd Edition. 2002. John Wiley and Sons.

MICROBIOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint student with the knowledge of Microbiology and its applications.

COURSE CONTENTS:

Introduction and scope of Microbiology, Historical foundations of Microbiology, General characteristics of Microbes, methods of Microbiology, bacterial forms and ultrastructure, microbial nutrition, cultivation, reproduction and growth, Metabolic characteristics, symbiotic

relationships, taxonomy, classification, nomenclature of microorganism/bacteria. Physical and chemical control of microbes. Role of microbes in industry, agriculture, health, basic research and environment.

Practicals:

Sterilization techniques, culturing, staining (Gram, simple, negative, capsule and spore), colony and cell morphology, bacterial cell count and growth curve, biochemical tests (Oxidation Fermentation (OF), urease, oxidase and catalase) of bacteria.

RECOMMENDED TEXT BOOKS:

1. Talaro, K. P., 2006. Foundations in Microbiology: Basic Principles. Mcgraw Hill. Publisher.
2. Black, J. G., 2005. Microbiology: principles and explorations, *by* 6th Edition, J. Wiley & Sons, USA.
3. Cappuccino, J. G. and Sherman, N. 2004, Microbiology: a laboratory manual. Pearson Education, USA.
4. Pollack, R. A. Findlay, L., Mondschein, W. Modesto R. R., 2004. Laboratory Exercises in Microbiology *by* 2nd Edition, J. Wiley and Sons, USA.
5. Tortora, G. J., Funke , B. R. and Case, C. L. 2008. Microbiology: an introduction 9th Edition, Pearson Education, USA.
6. Kathleen P. T., and Arthur, T. 2001. Foundations in Microbiology: Basic Principles McGraw-Hill Companies/
7. Tortora, G. J., Funke, B. R., Case, C. L. 2000. Microbiology: An Introduction, Study Guide. Benjamin-Cummings Publishing Company.
8. Tortora, G. J., Funke, B. R. and Case, C. L. 2004. Microbiology: an introduction 8th Edition, Pearson Education, USA.
9. Tortora,G. J., Christine, L. Case, C. L., Funke, B. R., Funke, B., Case, C., 2006. Microbiology: An Introduction, Publisher: Pearson Education.
10. Alcamo, I. E., 2001. Fundamentals of Microbiology *published by* Jones and Bartlett Publishers, USA.
11. Baker, S., Khan, N., Nicklin, J. and Killington, R., 2006. Instant Notes in Microbiology, 3rd Ed edition, Taylor and Francis.
12. Madigan, M. T. and Martinko, J., 2005. Brock Biology of Microorganisms 11 International Ed edition Prentice Hall.
13. Talaro, K. P., 2006. Foundations in Microbiology: Basic Principles. Mcgraw Hill. Publisher.

COURSE OBJECTIVES:

To acquaint the student with the chemistry and biology of biomolecules.

COURSE CONTENTS:

Introduction to biochemistry, amino acids and proteins, general functions, classification, primary, secondary, tertiary and quaternary structure, Fibrous and globular proteins, Protein stability, Protein folding. Enzyme nomenclature and classification, co-factors and co-enzymes, general characteristics of enzymatic reactions. Enzyme kinetics. Classification of carbohydrates, structure and functions of mono, oligo and polysaccharides, sugar derivatives, Structural polysaccharides, storage polysaccharides, Structure and function of bacterial cell-walls. Classification, structure, properties and functions of different types of lipids, fatty acids, triglycerides, glycerophospholipids, sphingolipids, cholesterol, Micelles, bilayers and liposomes. Properties and functions of lipoproteins, Fat and water soluble vitamins, Structural and functional aspects of nucleic acids, Chemical structures of nucleotides, nucleosides and bases.

Practicals:

Qualitative tests for amino acids, Amino acid titration, Hydrolysis of proteins and chromatographic separation of amino acids, Isolation and solubilization of proteins from plant and animal tissues, Estimation of proteins using different methods, Estimation of glucose in a mixture of monosaccharides, estimation of sucrose by polarimeter, chromatographic separation of sugars. Estimation of acid, saponification and iodine values of fat, Enzymes assay, effect of pH, temperature and substrate concentration on the properties of enzymes, Kinetic analysis of enzymes. Isolation of nucleic acids.

RECOMMENDED TEXT BOOKS:

1. Principles of Biochemistry, A. L. Lehninger, D.L. Nelson, 3rd edition (2000), Worth Publishers.
2. Biochemistry, L. Stryer, 6th Edition (2006), W.H. Freeman and Co.
3. Biochemistry, D. Voet, T. G. Voet, 3rd edition (2004), John Wiley and Sons, New York.
4. Harper's Illustrated Biochemistry, 27th edition (2006), McGraw-Hill Medical.
5. Lippincott's Biochemistry, P.C. Champe, R.A. Harvey, D.R. Ferrier, 4th edition (2008), J.B. Lippincott Company.
6. An Introduction to Practical Biochemistry, D. T. Plummer, 3rd edition (1987), McGraw-Hill.
7. Handbook of Molecular and Cellular Methods in Biology and Medicines, P.B. Kaufmann, W.Wu, L.J. Creke (1995), CRC Press.
8. Modern Experimental Biochemistry, R.F. Boyer, 2nd edition (1993), Benjamin/Cummings Publishing.
9. The Basic Protein & Peptide Protocols, J.M. Walker (1994), Humana Press.

BIOCHEMISTRY-II

(2 + 1)

COURSE OBJECTIVES:

To acquaint the student with the key concepts of intermediary metabolism of proteins, nucleic acids, carbohydrates and lipids.

COURSE CONTENTS:

Amino acid deamination mechanisms, urea cycle and its regulation, biosynthesis and degradation of essential and non-essential amino acids, RNAs and their role in protein synthesis, transcription and translational processes, Chemical nature, synthesis and degradation of purine and pyrimidine nucleotides, Glycolytic pathway and its significance, fermentation, Glycogen breakdown and synthesis pathways. Citric acid cycle, mechanism of electron transport chain, oxidative phosphorylation and regulation of ATP production, gluconeogenesis, pentose phosphate pathway, Properties and functions of lipoproteins, fatty acid oxidation, fatty acid and triglyceride synthesis, Ketone bodies, utilization of cholesterol, Prostaglandins, prostacyclins, thromboxanes and leukotrienes.

Practicals:

Iodine test for polysaccharides, Formation of sugar derivatives, Fermentation of sugars by Baker's yeast. Isolation of amylose and amylopectin from starch, extraction of glycogen from liver, acid and enzymatic hydrolysis of glycogen. Extraction and estimation of Lipids from wheat grain, Lipid separation from brain tissue and fractionation by TLC. Effect of UV light on vitamin A. Preparation of mitochondrial fraction from heart muscles and measurement of enzyme activities like malate dehydrogenase and monoamine oxidase.

RECOMMENDED TEXT BOOKS:

1. Biochemistry, D. Voet, J.G. Voet, 3rd (2004), John Wiley and Sons Inc.
2. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, 3rd edition (2000), Worth Publishers.
3. Lippincott's Biochemistry, P.C. Champe, R.A. Harvey, D.R. Ferrier, 4th edition (2008), J.B. Lippincott Company.
4. An Introduction to Practical Biochemistry, D. T. Plummer, 3rd edition (1987), McGraw-Hill.
5. Modern Experimental Biochemistry, R.F. Boyer, 3rd edition (2000), Pearson Education Inc.

ANALYTIC CHEMISTRY & INSTRUMENTATION (2 + 1)

COURSE OBJECTIVES:

To acquaint the student with key analytical concepts of identification and analysis at molecular levels.

COURSE CONTENTS:

General methods of fractionation and characterization of proteins and nucleic acids, dialysis, ultrafiltration, lyophilisation, principles and application of visible, UV, IR, mass spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR), flame photometry, atomic absorption, fluorescence spectroscopy, Chromatographic techniques (thin layer, adsorption, partition, ion-exchange, hydrophobic and affinity), Chromatofocusing, native and SDS-PAGE, isoelectric focusing, agarose gel electrophoresis, immunoelectrophoresis. Radioisotopes and their applications in molecular and biomedical sciences, Amino acid analyzer, thermal cycler (PCR), DNA sequencer, Protein/DNA microarray.

Practicals:

Experiments in chromatography (TLC, column and paper), Dialysis, ultrafiltration, fractionation of proteins using gel filtration, ion-exchange chromatography, chromatofocussing and other chromatographic techniques. Fractionation of proteins using native and SDS gel electrophoresis, Molecular weight determination of proteins using UVP gel based computer software program, Isoelectric focusing, Preservation of biological samples by lyophilization.

RECOMMENDED TEXT BOOKS:

1. Methods for protein analysis, R.A. Copeland, (1994), Chapman and Hall.
2. Basic Biochemical Methods, R.R. Alexander, J. M. Griffiths, 2nd edition (1993), Wiley Liss.
3. A Biological Guide to Principles and Techniques of Practical Biochemistry, K.Wilson, K.H. Goulding, 3rd edition (1991), ELBS.
4. Protein Methods, D.M. Bollag, M.D. Rozycki, S.J. Edelstein, 2nd Edition (1996), Wiley- Liss.
5. A Biological Guide to Principles and Techniques of Practical Biochemistry, K.Wilson, K.H. Goulding, 3rd edition (1991), ELBS.
6. Methods for Protein Analysis, R.A. Copeland, (1994), Chapman and Hall.
7. Protein Methods, D.M. Bollag, M. D. Rozycki, S.J. Edelstein, 2nd Edition (1996), Wiley- Liss.
8. Analytical Chemistry, A. Skoog, M. Donald (2000), Saunder Publishers

IMMUNOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint the student with the basic principles of defense mechanism and immune system.

COURSE CONTENTS:

Body defense mechanisms, the immune system, elements of innate and acquired immunity, antibody structure and function, antigen-antibody interactions, cells of the immune system, monoclonal antibodies, Genetics of antibody structure and diversity, Activation and function of T and B cells and their receptors, Major histocompatibility complex, Complement system, Hypersensitivity, cytokines, Autoimmunity, resistance and immunity to infectious diseases, Immunochemical techniques.

Practicals:

Radioimmunoassay of hormones (thyroid, growth, adrenal and others), Enzyme-linked immunosorbent assay (ELISA), Blood group determination (ABO and Rh), Western blot. Ouchterlony analysis.

RECOMMENDED TEXT BOOKS:

1. Immunology, J. Kuby, 6th edition (2007), W.H. Freeman and Co.
2. Immunobiology - The immune system in health and disease, C.A. Janeway, P.Travers, 3rd edition (1997), Garland Publication Inc. New York.
3. Roitt's Essential Immunology, Ivan Roitt, 11th edn (2007), Blackwell Scientific Publication.
4. Harlow ED, David L., Antibodies - A laboratory Manual, (1988), Cold Spring Harbor laboratory Press.
5. Methods for protein analysis, R.A. Copeland, (1994), Chapman and Hall.
6. The Basic Protein and Peptide Protocols, J.M. Walker (1994), Humana Press.
7. The Protein Protocols Handbook, J.M. Walker (1996), Humana Press.
8. Basic Biochemical Methods, R.R. Alexander, J. M. Griffiths, 2nd edition (1993), Wiley Liss.

STATISTICS

(3 + 0)

COURSE OBJECTIVES:

To acquaint the student with experimental design, data collection and analysis.

COURSE CONTENTS:

Definition of statistics, characteristics, importance and limitations, population and samples, Frequency distribution and probabilities, formation of frequency table from raw data, histograms, Applications of probabilities to

simple events, Measures of central tendencies and dispersion, Arithmetic mean, median, mode, range, variance and standard deviation, standard error of the mean, mean deviation, semi interquartiles range. Standard distribution (Binomial, poisson and normal distributions, properties and application, Normality), Test of significance (t-test, X^2 -test, F-test, L.S.D. test, multiple range test), Design of experiment: Brief account of correlation and regression, Computer based statistical software applications.

RECOMMENDED TEXT BOOKS:

1. Sullivan, L.S., 2008. Essentials of biostatistics. Jones and Bartlett press.
2. Daniel, W.W., 2008. Biostatistics:A Foundation for Analysis in the Health Sciences John Wiley & Sons
3. Gertmsn, B. B, 2007. Basic biostatistics: statistics for public health practice. Jones and Bartlett press.
4. Essex-Sorlie, D. 1995. Medical Biostatics & Epidemiology, International Edition, Appleton & Lange 2nd.Edition,
5. Marzillier, L.F., 1990. Elementary statistics , Wm.C.Brown Publisher
6. Stanton, A.G., 2001. Primer of Biostatistics. McGraw Hill
7. Beth, D.D., Robert, G.T 2000. Basic and clinical biostatistics. Appleton & Lange
8. Streiner, N., Norman, G.R., 2000. Biostatistics: The bare essentials B.C. Decker, Inc.
9. Rosner, B., 2000. Fundamentals of biostatistics. Cole Pub. Co.
10. Quinn, G., 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
11. Bailey, N.T.J., 1994. Statistical Methods in Biology, Cambridge, University Press.
12. Barnett, V., 2003. Environmental Statistics: Methods and Applications. John-Wiley and Son Limited.

ECOSYSTEM AND ENVIRONMENT (2 + 1)

COURSE OBJECTIVES:

To acquaint the students with the knowledge of ecosystems and the environment.

COURSE CONTENTS:

Concept, overall structure and components of Ecosystem, Energy flow and Biogeochemical cycling, Energy transfer (Food chain, Food webs, Food cycle, Trophic levels), Ecological pyramids, Productivity of ecosystems, Factors influencing environments and habitats, Impact of man on ecosystem, Fundamental of population ecology and community ecology, Human impacts on ecosystems, The Atmosphere (Composition, Minor and major gases, Water in atmosphere, Aerosols, Global circulation pattern), Pollution (Air, Water, Land, Thermal, Radiation and Noise), Climate Change (Green House Effect and Global Warming), Ozone Depletion (Ozone-structure, Properties/Significances, Ozone destroying

catalysts, Natural, Anthropogenic, Antarctic zone hole, Changing ozone Level, Impact on biosphere), Waste Type, Disposal and Management, Environmental Ethics.

Practicals:

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

RECOMMENDED TEXT BOOKS:

1. Davet, P. 2004. Microbial ecology of soil and plant growth. Science Publishers.
2. Nico, M., Straalen, V., and Roelofs, D., 2006. An Introduction to Ecological Genomics. Oxford University Press.
3. Aston, A., Harris, S., Lowe, A., 2004. Ecological Genetics: Planning and Application. Blackwell Science (UK).
4. Costa, L. G., and Eaton, D. L., 2006. Gene-Environment Interactions: Fundamentals of Ecogenetics. John-Wiley and Son Limited.
5. Freeland, J. R., 2005. Molecular Ecology. John-Wiley and Son Limited.
6. Light. A and Rolston III.H. 2003. Environmental Ethics. Blackwell Publishers Ltd. U.S.A.
7. Wenz, P. S., 2001. Environmental Ethics Today, Oxford University Press.
8. Louis P. and Pojman, L. P., 2004. Environmental Ethics: Readings in Theory and Application, 4th edition. Wadsworth Publishing.
9. Light, A., and Rolston, III. H., 2005. Environmental Ethics. Blacwell Publishing Incorporated.
10. Raven, P. H., and Berg, L. R., 2005. Environment, 5 Editionth . John-Wiley and Son Limited

RECOMBINANT DNA TECHNIQUES (2 + 1)

COURSE OBJECTIVES:

To acquaint the students with Basic techniques and tools used in gene manipulation and its practical uses.

COURSE CONTENTS:

Introduction and History of Recombinant DNA technology, Basic techniques, gel electrophoresis, Blotting techniques, restriction endonucleases, restriction mapping, vectors and their types, cloning vectors, transformations, Polymerase Chain reaction, Cloning strategies, Site-directed mutagenesis. Sequencing strategies, Application of recombinant DNA Technology (agriculture, health, industry, environment and basic research).

Practicals:

DNA and plasmid isolation and agarose gel electrophoresis, conjugation, transformation, role of mutagenic agents in mutation, Blotting techniques.

RECOMMENDED TEXT BOOKS:

1. Robert F.W., 2005. Molecular Biology. McGraw-Hill.
2. Dale, J.W. and von Schantz, M. 2002. From Genes to Genomes: Concepts and Applications of DNA Technology. John-Wiley and Son Limited.
3. Meyers, R.A., 2006. Genomics and Genetics. John-Wiley and Son Limited.
4. Primrose, S.B., and Twyman, R.M. 2006. Gene Manipulation and Genomics 6th edition. Blackwell Publishing.
5. Watson, J.M., Caudy, A.A., Meyers, R.A., and Witkowski, J.A., 2007. Recombinant DNA. Gene and genomes. 3rd Edition. W.h. Freeman and Company, New York.

ANIMAL BIOTECHNOLOGY (2 + 1)

COURSE OBJECTIVES:

To acquaint the students with techniques to produce transgenic animal and embryonic micromanipulations.

COURSE CONTENTS:

Introduction and history of transgenic animals, Role of synthetic peptides/protein in animal health, Use of monoclonal antibodies as a diagnostic/therapeutic agents, Cytokines and their potential therapeutic value, Application to diagnosis of microbial infection and to genotype analysis, The micromanipulations of farm animal embryos, The incorporation of biotechnological techniques in animal breeding strategies, Gene transfer through embryo microinjection, Ethical and social issues in animal biotechnology.

Practicals:

Aquaculture techniques, various DNA recombinant techniques useful for animal biotechnologies.

RECOMMENDED TEXT BOOKS:

1. Freshney, II., .2000. Culture of animal cells: A manual of basic techniques Wiley, John and Sons
2. Masters, J. R., 2000. Animal cell culture. Oxford University Press.
3. Lanza, R.P., Lanza, B., Atala, A., 2001. Methods of tissue engineering Academic Press Inc.
4. Doyle, A., Griffiths, J. B., 1998. Cells and tissue culture: Laboratory. procedures in biotechnology. Wiley, John and Sons.

5. Barnum, S., 2004. Biotechnology: An Introduction (with Infotrac) Brooks /Cole.
6. Tourte, Y., and Catherine, T. C., 2005. Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications. Science Publishers.
7. Houdebine, L-M., 2003. Animal Transgenesis and Cloning. John Wiley and Sons Limited.

MICROBIAL BIOTECHNOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint the students with biotechnological potentials of microbes in food, pharmaceuticals, industries, mining, disease control and as a biofertilizer.

COURSE CONTENTS:

Issues and scope of microbial biotechnology, genetically modified microorganisms, microbes as tools for microbiological research, Biotechnological potential of microbes, significance of microorganisms in food production and fermentation, pharmaceutical and other industrial products, Vaccine development and production, biofertilizers, composting, microbiological mining, biofuels, use of microbes in petroleum industry, Microbial role in regulatory mechanism of plant, Significance of microbial biotechnology in economic development of Pakistan.

Practicals:

Isolation and screening of potential microbes from different environmental sources, Lab scale production of bacterial enzymes, lab scale production of alcohol by yeast, use of microbes in bioleaching, use of microbes in microbial enhanced oil recovery.

RECOMMENDED TEXT BOOKS:

1. Olguin, E., Sanchez, G., and Elizabeth Hernandez, E., 1999. Environmental Biotechnology and Cleaner Bioprocesses. CRC Press.
2. Agathos, S.N.N. and Reineke, W., 2002. Biotechnology for the Environment: Soil Remediation. Springer-Verlag New York, LLC.
3. Stevens, C., Verhe, R., Verhé, R., 2004. Renewable Bioresources: Scope and Modification for Non-Food Applications. Wiley, John and Sons, Incorporation
4. Groves, M. J., 2005. Pharmaceutical Biotechnology. CRC Press.
5. Glick, B. R., and Pasternak, J., 2002. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
6. Klefenz, H., 2002. Industrial Pharmaceutical Biotechnology, Wiley-VCH Verlag GmbH.
7. Mukhopadhyay, S. N, 2004. Process Biotechnology Fundamentals, 2nd Edition Viva Books Pvt. Limited, New Delhi.

8. Goodsell, D. S., 2004. Bionanotechnology: Lessons from Nature . John Wiley and Sons Limited.
9. Purohit, S. S., 2002, Biotechnology: Fundamentals and Applications, Agrobios publishers.
10. Prave, P., Faust, U., Sittig, W., and Sukatsch, D. A., 2002. Fundamentals of Biotechnology, John Wiley and Sons.
11. Thauer, R., and Wagner, F., 1991. Biotechnology Focus: Fundamentals - Applications – Information, Helen Cooper-Schluter Carl Hanser, Verlag GmbH and Co.
12. Ray, R. C., 2005. Microbial Biotechnology in Agriculture and Aquaculture. NBN International.
13. Kreuzer, H. and Massey, A., 2005. Biology and Biotechnology Science, Applications, and Issues American Society for Microbiology.
14. Harding, S. E., 2004. Biotechnology and Genetic Engineering Reviews: Volume 21 Intercept Ltd.
15. Parekh, R., 2004. The GMO Handbook: Genetically Modified Animals, Microbes and Plants in Biotechnology Humana Press

MARINE BIOTECHNOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint the students with biological roles of marine organisms and cultivation of marine organisms

COURSE CONTENTS:

Introduction to marine microorganisms and marine biotechnology, aquaculture techniques, Screening for new metabolites from marine organisms, role of biomarkers, marine enzymes, biologically active compounds and economic aspects of marine organisms, study of extreme environments as a resource for microorganisms and novel biocatalysts, aquaculture of non food marine organisms for natural substance cultivation and production, Bioprocess engineering on cultivation of marine prokaryotes and fungi. Downstream process in marine biotechnology, marine pharmacology, sea food allergies and their solutions through biotechnology.

Practical:

Aquaculture techniques in marine biotechnologies.

RECOMMENDED TEXT BOOKS:

1. LE Gal, Y., and Ulber, 2005. Marine Biotechnology I, Springer.
2. LE Gal, Y., and Ulber, 2005. Marine Biotechnology II, Springer.
3. LE Gal, Y., and Halvorson, H.O, 1998 New developments in Marine Biotechnology, Springer
4. Patil, C.S., 2008. Biotechnology. APH publishing Corporation
5. Paul, V.J., 2002. Ecological roles of marine natural products Comstock Publishing

RADIOBIOLOGY

(2 + 1)

COURSE OBJECTIVES:

To acquaint the students with use of radiation, radioactive materials in agriculture, health and basic research.

COURSE CONTENTS:

Introduction to radiobiology, radioisotopes and types of radiations and sources, effects of radiations on living cells, exposure and dose-effect, molecular basis of cellular effects and cell radiation sensitivity, radiation therapy, radiation protection, safety measures, treatment of radiation injuries, fundamental aspects and relationship of imaging physics and radiobiology, current regulation and recommendations in radiation biology, radiological technologies, labeling techniques. Use of radioisotopes as diagnostics and therapeutics tools.

Practical:

Visits of different medical centres/hospitals for study of use of different types of radiation, Visit of different stations/offices where any type of radio waves, electromagnetic waves etc. are in continuous use and collecting data about any harmful effects, DNA labeling, protein labeling, use of radioactivity counters

RECOMMENDED TEXT BOOKS:

1. Wambersie,A., 2007. Introduction to radiobiology, Tylor and Francis
2. Nias,A.H.W., 2007. Introduction to radiobiology. Academic Press.
3. Forshier, C.M, 2008. Essentials of radiation, biology and protection, 2nd Edition. Cengage learning press.
4. Washington, C.M., 2009. Principles and practice of radiation therapy. Elesvier Health Sciences.

HEALTH BIOTECHNOLOGY

(3 + 0)

COURSE OBJECTIVES:

To acquaint the student with diagnostic tools, immunization and therapeutics.

COURSE OUTLINES:

Introduction to Health biotechnology, Social acceptance of medical biotechnology, The molecular basis of disease, Molecular and genetic markers, Detection of mutations, Detection of infectious agents, Active and passive immunization, vaccines (live, killed, recombinant DNA vaccines, subunit vaccines, DNA vaccines, edible vaccines), Organ transplantation, transplant rejection, Applications of transgenic animals (animal models of diseases, pharming, farm animals improvement), Drug delivery systems, Blood transfusion, Grafting techniques, Pharmacogenetics, Strategies of

gene therapy, gene delivery vehicles, genetic disorders and gene therapy, Biopharmaceuticals from plants, Uses of stem cell technology.

RECOMMENDED TEXT BOOKS:

1. "Medical Biotechnology" by Judit Pongracz, Mary Keen "(2009). Published by Elsevier Health Sciences.
2. "Biotechnology and Your Health: Pharmaceutical Applications" by Bernice Zeldin Schacter, Bernice Schacter (2005). Published by Chelsea House Publishers,
3. "Health and Pharmaceutical Biotechnology" by D.M. Chetan, K.P. Dinesh, D.M. Chetan (2006). Published by Firewall Media.

ENVIRONMENTAL BIOTECHNOLOGY (2 + 1)

COURSE OBJECTIVES:

To acquaint the students with conservation and reclamation of environment through biotechnology.

COURSE CONTENTS:

Introduction to Environmental biotechnology, Fundamentals of Biological Intervention, Genetic manipulation strategies in environmental biotechnology, Pollution indicators, Pollution control strategies, Biology of Waste water and its treatment, Sludge treatment, Contaminated land and bioremediation, Aerobes and Effluents, Phytotechnology (Terrestrial Phyto-systems, Metal Phytoremediation, Rhizofiltration etc) Hyper accumulation, Solid Waste treatments, Concept of integrated Environmental biotechnology, Detoxification of hazardous chemicals: biodegradation, Biotransformation, Products of environmental biotechnology.

Practical:

Biodegradation of environmental pollutants by microorganisms, Bacteriology of Drinking water, Microscopic studies of water specimens collected from various locations, Field survey of polluted areas, Field study for pollution indicators (Plants, Microorganisms).

RECOMMENDED TEXT BOOKS:

1. Christon Hurst, Ronald Crawford, Jay Garland, David Lipson, Aaron Mills and Linda Stetzenbach (2007) Manual of Environmental Microbiology. 3rd Ed. Blackwell Publishers
2. Christopher F. Faster and D. A John Wase, John Wase (2004) Environmental Biotechnology. John Willey & Sons.
3. Derek R. Lovley (2000) Environmental Microb-Metal Interactions. ASM Press.
4. Environmental Biotechnology by Bhattacharyya and Rintu Banerjee (Paperback - Mar 1, 2007) OUP India.
5. Environmental Biotechnology by Bruce E. Rittmann and Perry L. McCarty (Paperback - Jan 1, 2001). McGraw-Hill Publishing Co.

6. Environmental Biotechnology Theory and application, 2003. Gareth M Evans and Judith C. Furlong. Wiley Publishers.
7. Environmental Biotechnology, 2008. T, Srinivas New Age international Publishers.
8. Environmental Microbiology: Methods and Protocols (Methods in Biotechnology) by John F. T. Spencer and Alicia L. Ragout de Spencer (Hardcover - Jul 15, 2004) Humana Press; 1 edition.
9. Laqrence P. Wackett (2001) Biocatalysis and Biodegradations: Microbial Transformation of Organic Compounds. ASM Press

WASTE MANAGEMENT

(2 + 1)

COURSE OBJECTIVES:

To acquaint the students with the Principles and applications of solid waste management.

COURSE CONTENTS:

An introduction to the management of infectious material/waste, Various types of infectious material, handling and methods of their disposal, 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 contamination 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:

Techniques for waste minimization, Sorting of waste, Anaerobic compositing, Aerobic compositing, Industrial and hospital waste treatment processes.

RECOMMENDED TEXT BOOKS:

1. LaGrega M D., Buckingham P. L. Evans J. C (2001). Hazardous Waste Management,. 2nd Edition. McGraw- Hills Companies Inc.1221. New York USA.
2. Forbes R McDougall, Peter R White, Marina Franke and Peter Hindle (2001). Integrated Solid Waste Management: A life cycle inventory, 2nd Ed. Blackwell Publishers
3. World Health Organization (2001) WHO Biosafety Manual. WHO, Geneva.
4. Garvin, ML, (1995) Infectious Waste Management: A Practical Guide Lewis Publishers, Inc.

5. Wayne, LT. (1995) Biohazardous Waste: Risk Assessment, Policy, and Management. Lewis Publishers, Inc.
6. H. Lanier Hickman Jr. Principles of Integrated Solid Waste Management. MSW Management

WATER AND WASTEWATER TREATMENT (2 + 1)

COURSE OBJECTIVES:

To acquaint the students with the principles and applications of treatment systems for water, waste water and hazardous wastes.

COURSE CONTENTS:

Theory and application of commonly used processes, Sedimentation, coagulation, filtration, disinfection, gas transfer, activated sludge, trickling filters, oxidation ponds, sorption, and sludge stabilization and disposal, Process combinations to produce treatment systems, The role of the micro organisms in waste treatment, Utilization and management of wastes, Water and wastewater characteristics, Microbial characterization, drinking water treatment process, industrial effluent treatment process. Novel treatment process and recycling technology.

Practical:

Design individual aerobic and anaerobic unit processes, Select the optimal process among several alternatives to meet given performance specifications, Devise control strategies maintain process performance in biological systems. Design a complete process system by integrating several unit processes.

RECOMMENDED TEXT BOOKS:

1. Wastewater Engineering: Treatment, Disposal, and Reuse. By: Metcalf and Eddy, Inc. Fourth edition, McGraw-Hill, Inc., 2003
2. Clark, N., Crull, A (1997) Bioremediation of hazardous wastes, waste water and Municipal waste. Business communication Methcalf and Eddy Wastewater Engineering – Treatment and Reuse, 4th Edition, McGraw-Hill, 2003
3. Maier, RM., Pepper, IA., Gerba, CP (1999) Environmental Microbiology. Academic Press Inc.
4. Bitton, G (1999) Wastewater Microbiology. Wiley, John & Sons. Inc.
5. Csuros, M.,Csuros, C (1999) Microbiological examination of water and wastewater. Lewis Pub.
6. Methcalf and Eddy. Wastewater Engineering – Treatment and Reuse, 4th Edition, McGraw-Hill, 2003.

METABOLOMICS, PROTEOMICS AND GENOMICS (2+ 0)

COURSE OBJECTIVES:

To acquaint the students with structural and functional genomics, proteomics and metabolomics

COURSE CONTENTS:

Structural genomics, Organization and Structure of the Genomes, Genetic Mapping, Transcript Mapping, Structural Variation in the Genomes, Genomics and proteomics, Molecular Biology of Proteins, Posttranslational modifications, Molecular mechanisms of cellular communication/signaling pathways, Protein-Protein Interactions, receptor identification and characterization, Integral Membrane Proteins and Ion Channels, Advance techniques used in proteomics (MS, LCMS/MS, ICAT, iTRAQ). Introduction to Metabolomics, detection, profiling, analysis and engineering. Microarray and RNA interference.

RECOMMENDED TEXT BOOKS:

1. "Handbook of comparative genomics: principles and methodology" by Cecilia Saccone, Graziano Pesole (2003). Published by Wiley-Liss,
2. Functional genomics by Chris Town (2002). Published by Springer.
3. Human Molecular Genetics-3 by T. Strachan, Andrew P. Read Published by Garland Science, 2004
4. Genes IX by Benjamin Lewin . Published by Jones and Bartlett Publishers, 2007
- 5 Systems Biology by Mohamed Al-Rubeai (2006), Martin Fussenegger Published by Springer

NANOBIOTECHNOLOGY (3 + 0)

COURSE OBJECTIVES:

To acquaint the students with key integrative technologies and use of nanoparticles in biological systems.

COURSE CONTENTS:

A brief introduction to Nanotechnology, Interface between Nanotechnology and Bionanotechnology, Manipulating molecules, Carbon Fullerene, Carbon Nanotubes, Non- Carbon Nanotubes and Fullerene like materials, Quantum Dots and other Nano-particles, Nano-wires, Nano rods and other Nanomaterials, Magnetic Nanoparticles. Natural Biological assembly at Nano-Scale, Nanometric biological assemblies (complexes), Nanobionics and Bio-Inspired Nanotechnology, Applications of biological assemblies in Nanotechnology, Medical, Cosmetics, Agriculture, water and other applications of Nanobionanotechnology, Future prospect of Nanobiotechnology.

RECOMMENDED TEXT BOOKS:

1. "Plenty of room for biology at the bottom: an introduction to Bionanotechnology" by Ehud Gazit (2007). Published by Imperial College Press.
2. "Bionanotechnology: proteins to nanodevices" by Vencatesan Renugopalakrishnan, Randolph V. Lewis (2006). Published by Springer.
3. "Nanoscale technology in biological systems" by Ralph S. Greco, F. B. Prinz, Robert Lane Smith (2004). Published by CRC Press.
4. "Nanobiotechnology II: More Concepts and Applications" by Chad A. Mirkin, Christof M. Niemeyer (2007). Published by John Wiley & Sons, 2007

BIOINFORMATICS

(0 + 2)

COURSE OBJECTIVES:

To acquaint the students with bioinformatics tools, databases, algorithms and applications.

COURSE CONTENTS:

Introduction to computer hardware and software, computer applications for biotechnologists, Spreadsheet work, Word processing; Graphical and Statistical analysis packages.

Biocomputing (Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Genome Comparison, Prediction and its Implication).

Introduction to Bioinformatics, its Definition and History, Introduction to Data Mining and its Application, Database Hierarchies, Genomic and Proteomic Sequence Database and their Interpretation (UCSC Genome Database, NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc)

Bioinformatics Tools: Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Philip

RECOMMENDED TEXT BOOKS:

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S. 1998 Bioinformatics. The MIT Press.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
5. Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.

6. Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004 Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi.
7. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
8. Mont, D.W., Bioinformatics: Sequence and Genome Analysis.
9. Evens, W.J. and Grant, G.R., Statistical Methods in Bioinformatics: An Introduction.
10. Pierre Baldi and Soren Brunak, Bioinformatics: The Machine Learning Approach.
11. Jae K. Lee, Statistical Bioinformatics, John Wiley & Sons Inc.
12. Introduction to Bioinformatics. (A Theoretical and Practical Approach). A. Krawetz and D. Womble. 2002. Humana Press.

AGRICULTURAL BIOTECHNOLOGY (2+1)

COURSE OBJECTIVES:

To acquaint the students with the techniques to develop skills to produce Transgenic Crops.

COURSE CONTENTS:

The concepts of Plant Molecular Markers, Historical Back ground of Tissue Culture, Requirements for in-vitro cultures, Role of Phytohormones in somatic embryogenesis, Types of Cultures: Tissue culture and regeneration, Cell culture, Haploid Culture, Protoplast culture. Somaclonal variations as breeding tool, Somatic Hybridization, Commercial application and Issues related to tissue culture, Plant Transformation; Gene Gun Method of Transformation, *Agrobacterium*-Mediated transformation, Chloroplast Transformation, PEG mediated transformation etc, Field Evaluation and Commercialization, Transgenic crops for Herbicide, Biotic and Abiotic stress resistance, Introduction to Biofertilizers. Biosafety Concerns and Bioethics on GM crops.

Practical:

Selection of ex-plant, Medium Preparation and Callus Induction, Culturing *Agrobacterium* and Infection to plant callus, Selection of Transformants, Regeneration of Plantlets and acclimatization, Plant DNA extraction and PCR for Trans gene.

RECOMMENDED TEXT BOOKS:

1. Jitendra Prakash, R.L.M. Pierik, 1993. Plant Biotechnology: Commercial Prospects and Problems, Intercept
2. Peter M. Gresshoff, 1992. Plant Biotechnology and Development, CRC Press
3. Adrian Slater, Nigel W. Scott, Mark R. Fowler, 2008. Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
4. Sheela Srivastava, Alka Narula, S. S. Bhojwani, Inc NetLibrary, 2004

- “Plant
5. Biotechnology and Molecular Markers” publishers Springer link
6. H.S. Chawla, 2002 “Introduction to Plant Biotechnology” Second Edition, ISBN 978-1-57808-228-5; 562 Pages, Science publishers, USA
7. S Harding, 2007. Biotechnology and Genetic Engineering Reviews: V. 24, Nottingham University Press
8. Jane K Setlow, 2003. Genetic Engineering: Principles and Methods, Springer
9. National Biosafety Guidelines Biosafety rules 2005
10. Clarice Swisher, Carol Wekesser, 1996. Genetic Engineering, Lucent Books

FUNGAL BIOTECHNOLOGY (2+1)

COURSE OBJECTIVES:

To acquaint the students with the understanding of fungi and its role in industry and agriculture.

COURSE CONTENTS:

Introduction of Mycology, Production techniques used in fungal Biotechnology, Production of Biochemicals by fungi, Fungi in Medical Biotechnology, Industrial uses of Fungi, Fungal Biodeterioration & biodegradation, Fungi in food industry, Fungi in Agricultural biotechnology, Biotechnology and the control of pathogenic fungi, Postscripts: Recent application of Fungal Biotechnology, Screening of fungal metabolites.

Practical:

Morphology of fungi, Identification of pathogenic fungi, learning of sexual & asexual reproductive structures of fungi, study of oospore & zoospores infections, DNA extraction from hyphae & zoospores, study of genetical variations of different fungi by using molecular techniques

RECOMMENDED TEXT BOOKS:

1. Advances in fungal Biotechnology for industry, Agriculture and Medicine Tkacz, Jan S; Lange, Lene (Eds.)
2. Fungal Biotechnology in Agriculture food and environment applications by Joan W Bennett
3. Fungal Biotechnology, Hand book of industrial Mycology Edited by Zhiqiang
4. Mycological Research: Fungal Biotechnology Published by Elsevier
5. Advances in Fungal Biotechnology by Mahendra Rai
6. The fungi by Car lile, Watkinson & Gooday.
7. Hand book of fungal Biotechnology by Arora, Bridge & Bhatnagar
8. Molecular fungal biology by Oliver, Schweizer
9. Chemical fungal taxonomy by Frisvad, Bridge, Arora

PHARMACEUTICAL BIOTECHNOLOGY (3+0)

COURSE OBJECTIVES:

To acquaint the student with Pharmaceutics, Biological forms of Pharmaceutics, Production and potential uses.

COURSE CONTENTS:

Pharmaceuticals, biologics and biopharmaceuticals (Introduction, History and Current Status), The drug development process (Pharmacogenetics, Initial product characterization, Patenting, Delivery pathways of biopharmaceuticals, Preclinical studies, Pharmacokinetics and pharmacodynamics, Toxicity studies, The role and remit of regulatory authorities, World harmonization of drug approvals), Sources and upstream processing, Downstream processing (Initial product recovery, Cell disruption, Removal of nucleic acid, Initial product concentration, Ultrafiltration, Diafiltration, Chromatographic purification, High-performance liquid chromatography of proteins, Purification of recombinant proteins, Final product formulation) Product analysis, Product potency, Immunological approaches to detection of contaminants, Endotoxin and other pyrogenic contaminants. Antibiotics, Therapeutic hormones, Recombinant blood products and therapeutic enzymes, Antibodies, vaccines and adjuvants, Nucleic-acid- and cell-based therapeutics, Animal model metabolic studies.

RECOMMENDED TEXT BOOKS:

1. Pharmaceutical Biotechnology Concepts and application 2007. by Gary Walsh. Wiley Publisher. ISBN 978-0-470-01244-4.
2. Pharmaceutical Biotechnology by K. Sambamurthey, Ashutosh Kar. New age international Publisher.
3. Biopharmaceuticals, biochemistry and biotechnology 2003. Gary Walsh. Wiley Publisher. ISBN 0 470 84326 8.
4. Pharmaceutical Biotechnology 2004. By O. Kayser and RH Muller. ISBN 3-527-28313-7. Publisher Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.
5. Handbook of Pharmaceutical Biotechnology 2007. By Shayne Cox Gad. Publisher Wiley. ISBN: 978-0-471-21386-4.
6. Industrial Pharmaceutical Biotechnology 2002. By Heinrich Klefinz. Publisher Wiley VCH ISBN 3-527-29995-5

FOOD BIOTECHNOLOGY (2 +1)

COURSE OBJECTIVES:

To acquaint the student with the role of microorganisms in food and food industry, and also with the principles of enzymology, and food engineering.

COURSE CONTENTS:

Food composition, proximate analysis. Probiotics. Fermented foods, Food enzymes, colors and additives, Microbial Food spoilage and food born

disease, Food preservation methods, Food engineering principles, Modified atmospheric packaging, Food marketing principles. Mathematical Modeling in food technology .Microbial biotechnology of food flavors production, oil and fats, dairy products, meat and cereal foods, Food Safety and quality control.

Practical:

Estimation of moisture, ash, carbohydrates, protein, fat, crude fiber in food, Detection of proteases, amylases in milk. Determination of iodine number of fats. Determination of specific gravity of sugar. Separation of gluten from wheat flour. Detection of E.coli in drinking water. Detection of yeast and mould in dairy and bakery products. Production of cheese.

RECOMMENDED TEXT BOOKS:

1. Food Biotechnology by Ulf Stahl, Ute E.B. Donalies and Elke Nevogit, 2008.
2. Food colors, flavors and additives technology by NIIR, National Institute of industrial research, Dehli, India 2007.
3. Biotechnology and food processing by Meenakshi Paul, 2007
4. Food Biotechnology, edited by K. Shetty et al , 2nd edition, 2006.
5. Fundamentals of food Biotechnology, Dyong H.Lee, 1996Food Chemistry, lab. Manual by Dennis D. Miller, Willey Inter science. , 1998
6. Food analysis Manual by Javid Aziz Awan.2000.
7. Biotechnology and our Food by Joan Nordquist, Mass Market paper back, 2000

DOWN STREAM TECHNOLOGY

(1 + 0)

COURSE OBJECTIVES:

To acquaint the student with knowledge of potential techniques for bioseparation and purification.

COURSE CONTENTS:

Mechanical operations, Filtration, centrifugation, Flocculation, evaporation crystallization, drying. Membrane processes, Solvent extraction, Electrophoresis and electro dialysis, Operations and applications of Chromatography techniques in biotechnology), Planer, Gas, Column, Ion exchange, Gel exclusion, Affinity Perfusion chromatography, Fast performance Liquid Chromatography (FPLC). Biosensors, protein chips.

RECOMMENDED TEXT BOOKS:

1. Modern experimental biochemistry, 3rd Edition by Rodeny Boyer, 2009. Published by Dorling Kindersley (India) PVT. LTD. India.
2. Bioseparation science and engineering by Roger .G. Harrison., Paul Todd ., Scott R. Rudge and Demeteri P. Petrides. 2003, Oxford University Press.New York.
3. Protein purification protocols, 2nd Edition by Paul Culter(2004), Humana Press, Totowa, New Jersey.

BIOELECTRONICS AND BIOSENSORS

(3 +0)

COURSE OBJECTIVES:

To acquaint the student with understanding fundamentals of electron transfer and its application in biosensors.

COURSE CONTENTS:

Electrical Circuit treatment of biological environments: ionic condition, the metal-electrolyte double layer, models of the cell membrane, Electrical signal detection in biological systems: Silicon, glass and metal electrodes, amplifier design, Bioelectronic device production, microelectronic fabrication methods as adapted to bioelectronics, soft lithography, bio-compatibility of metals.

Miniaturisation and Microsystems including sensing using optical techniques, field effect transistors ion-selective and enzymatic sensitive electrodes, Amperometric biosensor based on redox enzymes potentiometric biosensors and enzyme field effect transistor (ENFET). Thermal biosensors. Optical biosensor based on redox enzymes, In direct affinity sensors, Optical and electrical biosensors based on antibodies, Direct affinity detection using surface plasmon resonance and piezoelectric biosensors.

RECOMMENDED TEXT BOOKS:

1. Bioreaction Engineering Principles by J. Nielson; J. Villadsen and G. Liden 2nd Edition, 2003, New York, Kluwer Academic / plenum publisher.
2. Fermentation Microbiology and Biotechnology by E. M. T.1 Monsi; C. F. A. Bryoce; A. L. Demain and A. R. Allman 2nd Edition 2007 CRC Press, Tolyor & Francis Group 600 Broken Sound, Parkway, N. W. Swite 300.
3. Bioelectronics by S. Bone & B. Zabba J. Wiley
4. Biosensors. E.A. Hall John Wiley & Sons.
5. Lons, Electrodes and membrane, John Koryta, John Wiley & Sons.

BIOFUEL AND BIOREFINERY

(3 +0)

COURSE OBJECTIVES:

To acquaint the student with utilization of agriculture feedstock, processing and extraction of fuel gases and liquid for socio-economic development.

COURSE CONTENTS:

Biofuels technology e.g. bioethanol, biodiesel and biogas from biomass, agro-industrial byproducts and biodegradable material, Fundamental principles of biorefineries. biorefinery systems and biobased industrial products, Green biorefinery a basic concept, Agriculture and forestry and primary refinery raw material. Lingo-cellulosic feedstock biorefinery,

Whole-crop biorefinery based on wet/dry milling and products from whole-crop biorefinery, Fundamental sugar platform and syngas platform.

RECOMMENDED TEXT BOOKS:

1. Biorefinery-Industrial Processes and Products Status, Quo and Future Directions. B. Kamm, P. R. Gruber, M. Kamm (eds.) Wiley-VCH, 2006.
2. Biotechnology of Ethanol. Meroehr (ed.) Wiley-VCH, Weinheim 2001

PRINCIPLES OF BIOCHEMICAL ENGINEERING (2 +1)

COURSE OBJECTIVES:

To acquaint the student with biological and engineering sciences.

COURSE CONTENTS:

Introduction to microorganisms and biological molecules, Principles of enzyme catalysis, Methods of enzyme and cell immobilization enzyme kinetics, Internal mass transfer effect on immobilized growth. Stoichiometry models of microbial growth, Structured model, of microbial growth. Continuous Stirred tank bioreactor, Plug-flow and packed bed bioreactors imperfect mixing, Fed batch bioreactors, Gas liquid mass transfer in bioreactors, Power requirement for bioreactor, Sterilization, Heat transfer in bioreactors, Introduction to bioproduct recovery. Manufacture of biological products, Economic analysis of bioprocesses, Case study Penicillin.

Practical:

Unstructured Microbial growth with application of Monod Model, Inhibition kinetics and nutrient uptake rate, Methods of immobilization by binding and physical retention, Yield coefficient and Stoichiometry, Production of enzymes by structured model, segregated model. Bioreactor design and analysis (Batch, Fed-batch and Continuous). Enzyme catalysis in the CSTR. Packed bed and plug flow bioreactor, Rheology of fermentation broth, mixing and gas-liquid mass transfer, Heat transfer, media and bioreactor sterilization techniques, Techno-economic analysis of a typical bioprocess.

RECOMMENDED TEXT BOOKS:

1. Biochemical Engineering by Harvey W. Blanch, S. Douglas and Clark.
2. Biochemical Engineering Fundamentals. J. E. Bailey and D. F. Olilis.
3. Biochemical Engineering. S. Aiba, A. G. Humphrey and N. F. Millis 2nd Edition (1973) Academic Press Inc. N.Y.

GENETICS

(2 +1)

COURSE OBJECTIVES:

To acquaint the student with the Mendelian inheritance, gene interaction and gene mapping.

COURSE CONTENTS:

Mendelian Genetics, principle of segregation, symbols and Terminology, Monohybrid crosses, Dominance, Recessiveness, codominance, Semidominance, Principle of independent Assortment, Dihybrid Ratios, Trihybrid Ratios, Gene interaction, Epistasis, Multiple Alleles, ABO blood Type Alleles in Humans, Rh factor Alleles in humans, Probability in Mendelian inheritance, chi-square, structure of chromosomes and Genes, Function of DNA and RNA, classes of RNA, Nucleotide units of DNA and RNA, DNA as storage of Genetic information, Friedrich Miescher Experiment, Avery, Macleod and McCarty Experiment, Hershey and chase experiment, Watson and crick DNA model, physical and chemical structure of DNA, Difference between Prokaryotic and Eukaryotic Genetic material, sex determination, identification of sex chromosomes, Environmental factors and sex determination, Linkage and crossing over.

Practicals:

Introduction to Fast plants and Drosophila. Set up a Drosophila open-ended cross, Pollinate Fast Plants, ABO blood group, Isolation of DNA from Drosophila.

RECOMMENDED TEXT BOOKS:

1. Principal of Genetics by D.Peter Snustad and Michael J. Simons
2. Principles of Genetics by Eldon John Gardner, Michael J. Simons, and D. Peter Snustad

MOLECULAR BIOLOGY-I

(2 +1)

COURSE OBJECTIVES:

To acquaint the student with the chemistry and biology of macromolecules.

COURSE CONTENTS:

Overview of Molecular Biology, Logic of Molecular Biology, Prokaryotes and Eukaryotes, bacteria, Bacteriophage, yeasts, Animal cell, Animal & plant viruses, Genetic Analysis of Molecular Biology, Macromolecules, chemical structures of the major classes of Macromolecules: Proteins, Nucleic Acids, Polysaccharides, Nucleic Acids, DNA Helix, Form of DNA Helix, Factor that determine structure of DNA, properties of Genetic Material (storage and Transmission of Genetic information by DNA). Transmission of information from parent to progeny, chemical stability of DNA, Ability of DNA to change, DNA Replication, Enzymology of DNA

Replication. Events in the Replication Fork, Initiation of synthesis of Leading and lagging strands, Okazaki fragments, importance of 3 → 5 and 5 → 3 Exonuclease activities of DNA polymerase, Rolling circular Replication, Loop Rolling circular Replication, Difference between Prokaryotic and Eukaryotic Replication, DNA Repair.

Practicals:

Isolation & Purification of DNA, Determination of Concentration of DNA using spectrophotometer. Hypochromicity determination of DNA,

RECOMMENDED TEXT BOOKS:

1. Molecular Biology by Daved Freifelder, Jones & Barlet Publisher, Boston
2. Molecular Biology of the cell by B. Alberts. D. Brag, J. Lewis. M. Raff, K. Roberts and J. D. Watson, Garland Publishers. Jones & Barlet Publisher, Boston

MOLECULAR BIOLOGY-II

(2 +1)

COURSE OBJECTIVES:

To acquaint the student with the chemistry and biology of macromolecules.

COURSE CONTENTS:

Mutations, Types of Mutations, Biochemical basis of Mutagenesis, Base-Analogue Mutagens, chemical Mutagens, Intercalating Agents, Reversion, Transcription, Basic Features of RNA synthesis, Enzymology of RNA synthesis, RNA chain synthesis Initiation, elongation and Termination, Transcription in Eukaryotes, Post-transcriptional Modifications, Translation, Genetic code, codons, Decoding system, Role of mRNA, Role of tRNA, chemical composition of Ribosomes, initiation of protein synthesis, Elongation of polypeptide chain, Termination of polypeptide chain, Difference between protein synthesis in prokaryotes and Eukaryotes, Post-translational Modifications, Regulation of Genes and gene products in prokaryotes, Regulation in Eukaryotes, Protein sorting and transport. DNA repair mechanisms.

Practicals:

Restriction digestion of DNA and preparation of restriction maps, Gel Electrophoresis, PCR, Blotting Techniques, RNA isolation and RT-PCR.

RECOMMENDED TEXT BOOKS:

1. Molecular Biology by Daved Freifelder. Jones & Barlet Publisher, Boston
2. Molecular Biology of the cell by B. Alberts. D. Brag, J. Lewis. M. Raff, K. Roberts and J. D. Watson, Garland Publishers. Jones & Barlet Publisher, Boston

ELEMENTS OF BIOTECHNOLOGY

(2 +0)

COURSE OBJECTIVES:

To acquaint the student with the importance and basic concepts of biotechnology.

COURSE CONTENTS:

The cell its organelles and their functions, growth requirements, Characteristics and Industrial importance of algae, fungi and bacteria, Glycolytic pathway and enzymes, fermentative ethanol production, High-energy compounds and coenzymes, TCA cycle and its metabolic and industrial importance, Protein structure, synthesis and function, Nucleic acids and microbial strain selection techniques, Cell growth parameters, fermentor assembly and systems, cultivation conditions, sterilization and inoculation procedures, Biomass and Single-Cell Protein production. Aerobic and anaerobic yeast fermentations: products & processes.

RECOMMENDED TEXT BOOKS:

1. Principles of Plant Biotechnology an introduction to Genetic Engineering in plants. S. H. Mantel, J. A. Mathews, R. A. Mecee, Blackwell Scientific Publication Oxford, London, Boston.
2. Biotechnology in 21st century, Ayyana, C. McGraw Hill.
3. Shuler, M.L. and F. Kargi. 1992. Bioprocess Engineering, Prentice-Hall, Englewood Cliffs, NJ.
4. Bailey, J.E. and D.F. Ollis. 1986. Biochemical Engineering Fundamentals, 2nd ed. McGraw - Hill, New York.

CELL AND TISSUE CULTURE

(2 +1)

COURSE OBJECTIVES:

To acquaint the student with the techniques to produce disease free plant material.

COURSE CONTENTS:

Cell and Plant Tissue culture, Introduction, history and importance, Methods of cell and tissue culture, callus culture, organogenesis, somatic embryogenesis, protoplast isolation and fusion, anther and pollen culture Micropropagation, improvement of Plants via Plant cell culture, production of variant plants from selected cells, selection for stress tolerance, production of disease resistant plant material.

Practicals:

Preparation of stock and working solutions, preparation of culture media (liquid) semi-liquid and semi-solid) Explants preparation, callus culture and organogenesis. Preparation and fusion of protoplasts.

RECOMMENDED TEXT BOOKS:

1. Plant Tissue culture manual. K. Lindeseg Kluwer. Academic Publisher, The Netherlands
2. Principles of Tissue Engineering, R.P. Lanza, R. Langer and J. Vacantuy. Academic Press, California, USA.

PLANT BIOTECHNOLOGY

(2 +1)

COURSE OBJECTIVES:

To acquaint the student with the molecular techniques for the yield and quality improvements of crops.

COURSE CONTENTS:

Importance of Biotechnology in Plant improvement, Biotechnology as a tool to supplement conventional systems of Plant improvement, tools of Biotechnology for plant improvement, In Vitro Technology, Micro propagation, Embryo Rescue, Haploid Development, Viral Free Plant material, Somaclonal variation, Recombinant DNA Technology and Genetic Engineering, Gene cloning, GMOs, Incorporation of Novel genes for tolerance against Biotic and Abiotic stresses, Genes for yield and quality improvement, Genes for Insect and disease Resistance. BT crops, herbicide Resistant crops, Ethical issues and public concerns regarding GMOs.

Practicals:

Plant tissue culture, DNA isolation from plants, Agrobacterium mediated transformation of plant cells.

RECOMMENDED TEXT BOOKS:

1. Plant biotechnology by M. W. fowler, G. S. Warren and M. Moo-young, Elsevier Science
2. Plant Biotechnology, S. H. Mantell, Springer-Verlag, New York

DIAGNOSTICS

(1+2)

COURSE OBJECTIVES:

To acquaint students with the molecular diagnostic techniques.

COURSE CONTENTS:

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

2D-gel electrophoresis, Western-analysis, ELISA, Immunolocalisation (incl, Detection techniques), RNA-extraction, Northern-analysis, Dot-blot, macro-en micro-arrays, In situ mRNA hybridization, DNA-hybridisation (Southern blotting, probetechnology), RNA-analysis techniques, LightCycler technology.

Practical:

All techniques can be practiced subject to the availability of facilities.

RECOMMENDED TEXT BOOKS:

1. Gene Cloning and DNA analysis. 2006. T.A Brown Blackwell Publishing.
2. Molecular Diagnostics Fundamentals, Methods, and Clinical Applications 2007. Lela Buckingham and Muribeth L. Flaws. F.A Davis Publisher.
3. Medical Biomethods 2005. Handbook edited by John M Walker Ralph Rapley Humana Press.
4. Mitochondrial DNA methods and protocols 2009. Jefferey A. Stuart. Humana Press.
5. Manual of Laboratory and diagnostic tests 2008. Deniese D Wilson. Mc Graw-Hills publisher.
6. Manual of Diagnostic Antibodies for immunohistology 1999. Anthony S-Y leong. Greenwich Medical Media Limited. Oxford University Press.

GENETIC RESOURCES AND CONSERVATION (2+1)

COURSE OBJECTIVES:

To accustom Students with bio resources of the country and conservation.

COURSE CONTENTS:

Introduction to Genetic resources and its importance, Evolution of Terrestrial and Marine biodiversity, An overview of Wild and Domesticated Genetic Resources of Pakistan, Extent of genetic diversity, Low genetic diversity in threatened species, Genotype and environment interaction, Mutation selection balance, Genetic drift, Population bottle necks, Inbreeding, Migration and gene flow, Introduction to extinctions and its causes, Threatened Animal and Plant Species, Conservation of Genetic Resources through Mapping of Existing Biological Diversity, Assessing Conservation Status, Management Strategies. Laws and Treatises of conservation, Introduction to wildlife and forest Acts, Biodiversity action plan of Pakistan, Quarantine regulations, Future Prospects of Conservation.

Practicals:

- Experiments on Diversity Studies,
- Standard methods of sample collection and preservation.

- Analysis Techniques of wild organisms and fossil Samples.
- Visits to National Parks
- Visits to Plant and Animal Genetic Resources Conservation Centers.

RECOMMENDED TEXT BOOKS:

1. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall.
2. Cunningham, A.B. 2001. Applied Ethnobotany: People, wild plant use and conservation. Earthspan Publications.
3. Cotton, C.M. 1996. Ethnobotany Principals and Application. John Willy and Sons hichester, UK.
4. De Klemm, C. 1990. Wild Plant Conservation, IUCN, Gland.
5. Dyke, F.V. 2003 Conservation Biology. Mc Graw Hill, New York.
6. Krupnick, G.A. 2005. Plant Conservation. The University of Chicago Press.
7. Mc Neely, J.A., Mc Carthy, T.M., Smith, A., Whittaker, L.O, and Wikramanayake. 2006. conservation biology in Asia. Resources Himalaya Foundation.
8. Given, D.R. 1994. Principals and practices of plant conservation Timber Press.

BIOSAFETY AND BIOETHICS

(1+0)

COURSE OBJECTIVES:

To acquaint students with principles of biosafety and ethical perspectives of Biotechnological systems.

COURSE CONTENTS:

Introduction to Biosafety (Definition, Concept, Uses and abuses of genetic information, Biohazards), Good Laboratory Practices, Risks Related to GMOs, International Rules & regulations for Biosafety & GMOs. Introduction to Bioethics, Ethical issues regarding GMOs, Euthanasia, Issues related to Reproductive & Cloning technologies, Issues to transplants and Eugenics, Patenting, Commercialization and Benefits Sharing, role of National Bioethic committees.

RECOMMENDED TEXT BOOKS:

1. WHO. 2006. Laboratory Biosafety manual third edition. AITBS publishers and distributors, India. (Available online free of cost).
2. Lewis RJ. Sax dangerous properties of Industrial materials, 10nth edition. Toronto, John Wiley and sons, 1999.
3. Lenga RE. 1988. The Sigma-Aldrich Library of chemical safety data, 2nd ed. Milwaukee, WI, Aldrich chemical company.
4. Furr AK. 2000. CRC handbook of laboratory safety 5th edition. Boca Raton, FL, CRC press.
5. United states Department Health and Human services. 1999. Biosaftey in Microbiological and biomedical laboratories. 4th edition. Centers for disease control and prevention/National institutes of Health, Washington DC.

6. Biosafety in the Laboratory: Prudent Practices for Handling and Disposal of Infectious Materials Committee on Hazardous Biological Substances in the Laboratory, National Research Council ISBN: 0-309-55920-0, (1989) available from the National Academies Press at: <http://www.nap.edu/catalog/1197.html>
7. Genes Technology and Policy. Jose Maria A. Ochave 2003 <http://www.apdip.net/publications/iespprimers/eprimer-genes.pdf>
8. Bioethics & Biosafety in Biotechnology by V Sree Krishna.

SKILL ENHANCEMENT

(0+1)

COURSE OBJECTIVES:

This course is designed to equip the student with latest trends in the field of Biotechnology. It also aims to develop skills for comprehending scientific literature, preparing scientific manuscript and designing the research project.

COURSE CONTENTS:

It shall include activities like writing an abstract, preparing posters, making oral scientific presentations, project writing and preparing scientific reviews.

DETAILS OF COMPULSORY COURSES

COMPULSORY COURSES IN ENGLISH FOR BS (4 YEAR) IN BASIC & SOCIAL SCIENCES

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents

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

Comprehension

Answers to questions on a given text

Discussion

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

Listening

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

Translation skills

Urdu to English

Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

Recommended books:

1. **Functional English**
 - a) Grammar
 1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
 2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
 - b) Writing
 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)

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing

Practice in writing a good, unified and coherent paragraph

Essay writing

Introduction

CV and job application

Translation skills

Urdu to English

Study skills

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

Academic skills

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

Presentation skills

Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended books:

Communication Skills

- a) Grammar
 1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing
 1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
 2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
 1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
 2. Reading and Study Skills by John Langan
 3. Study Skills by Richard Yorky.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing

Descriptive, narrative, discursive, argumentative

Academic writing

How to write a proposal for research paper/term paper

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

Technical Report writing

Progress report writing

Note: *Extensive reading is required for vocabulary building*

Recommended books:

Technical Writing and Presentation Skills

- a) Essay Writing and Academic Writing
 1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
 2. College Writing Skills by John Langan. Mc=Graw-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)

Introduction/Objectives

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

Course Outline

1. Historical Perspective

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

Books Recommended

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

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

ISLAMIC STUDIES

(Compulsory)

Objectives:

This course is aimed at:

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

Detail of Courses

Introduction to Quranic Studies

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

Study of Selected Text of Holly Quran

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

Study of Selected Text of Holly Quran

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

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

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

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

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

Introduction To Sunnah

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

Selected Study from Text of Hadith

Introduction To Islamic Law & Jurisprudence

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

Islamic Culture & Civilization

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

Islam & Science

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

Islamic Economic System

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

Political System of Islam

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

Islamic History

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

Social System of Islam

- 1) Basic Concepts Of Social System Of Islam
- 2) Elements Of Family
- 3) Ethical Values Of Islam

Reference Books:

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 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 Jrisprudence 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)

Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

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

Course Outline:

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

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

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.

Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.

Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books:

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

Boston (suggested text)

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

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

Course Outline:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

Limits and Continuity: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8th edition), 2005, John Wiley, New York

Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)

Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston

Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

Specific Objectives of the Course:

To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books:

Abraham S, *Analytic Geometry*, Scott, Freshman and Company, 1969

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

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

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

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

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

Contents :

1. *Algebra* : *Preliminaries*: Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices*: Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations*: Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series*: Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem*: Introduction to binomial theorem. *Trigonometry*: Fundamentals of trigonometry, trigonometric identities. *Graphs*: Graph of straight line, circle and trigonometric functions.
2. *Statistics*: *Introduction*: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean median and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

Books Recommended:

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

5. MATHEMATICS FOR CHEMISTRY

Credit Hours: 3

Prerequisites: Mathematics at Secondary level

Specific Objectives of Course:

To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real Numbers and the Real Line, *Functions and their graphs:* Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:* Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

6. MATHEMATICS FOR PHYSICS

Contents

1. Preliminary calculus.

- Differentiation

Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.

- Integration

Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions

- The need for complex numbers
- Manipulation of complex numbers
Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
- Polar representation of complex numbers
Multiplication and division in polar form
- de Moivre's theorem
Trigonometrical identities; finding the n th roots of unity; solving polynomial equations
- Complex logarithms and complex powers
- Applications to differentiation and integration
- Hyperbolic functions

Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits

- Series
- Summation of series

Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series

- Convergence of infinite series
Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
- Operations with series
- Power series
Convergence of power series; operations with power series
- Taylor series
Taylor's theorem; approximation errors in Taylor series; standard Maclaurin series
- Evaluation of limits

4. Partial differentiation

- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

5. Multiple integrals

- Double integrals
- Triple integrals

- Applications of multiple integrals
Areas and volumes; masses, centers of mass and centroids; Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals
Change of variables in double integrals;

6. Vector algebra

- Scalars and vectors
- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors
Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes
Equation of a line; equation of a plane
- Using vectors to find distances
Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

7. Matrices and vector spaces

- Vectors spaces
Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix
Properties of determinants
- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations
N simultaneous linear equations in N unknowns
- Special square matrices
Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
- Eigen vectors and eigen values
of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
- Determination of eigen values and eigen vectors
Degenerate eigen values

8. Vector calculus

- Differentiation of vectors
Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators
Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae

Vector operators acting on sums and products; combinations of grad, div and curl

- Cylindrical and spherical polar coordinates
Cylindrical polar coordinates; spherical polar coordinates

INTRODUCTION TO STATISTICS

Credit hrs: 3(3-0)

Unit 1. What is Statistics?

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

Unit 2. Presentation of Data

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

Unit 3. Measures of Central Tendency

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

Unit 4. Measures of Dispersion

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

Unit 5. Probability and Probability Distributions.

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

Unit 6. Sampling and Sampling Distributions

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

Unit 7. Hypothesis Testing

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

Unit 8. Testing of Hypothesis- Single Population

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

Unit 9. Testing of Hypotheses-Two or more Populations

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

Unit 10. Testing of Hypothesis-Independence of Attributes

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

Unit 11. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. r and R^2 . Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

Recommended Books

- 1 Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.
 - 2 Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.
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Note: General Courses from other Departments

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