



# STUDY GUIDE

BACHELOR OF SCIENCE  
IN BIOTECHNOLOGY

First Year

BS-Biotechnology



Message from the Desk of Dean  
Health Sciences  
Bahria University Health Sciences Campus

PROFESSOR DR. AMBREEN USMANI  
MBBS, PhD (Anatomy), MCPS (HPE), PGH  
(Bioethics)  
PRINCIPAL AND DEAN HEALTH SCIENCES



*My Dear Students,*

*Welcome to Bahria University Health Sciences Campus Karachi, where you will spend four years of your life in pursuit of knowledge and become qualified biotechnologists. We will facilitate you in converting the “information” given in “Books” to “knowledge” with “understanding” and how to use this knowledge ‘wisely’ for the benefit of humanity as health care provider.*

*This study guide will give you a road map for the forthcoming activities including the objectives, contents, learning strategies and assessment of your educational course; which we regard as essential. Use this study guide as a reference for your “Code of Conduct”. It gives policies and rules pertaining to examinations, electives, attendance and rotations etc. A competent team of experienced professional teaching faculty will guide you towards learning goals in different clinical settings through effective use of different tools of teaching and assessment. You will be encouraged to integrate your learning across the disciplines.*

*Advancements in biotechnology have allowed physicians to better diagnose and treat their patients since the beginning of the professional practice of medicine. Thanks to the continuous development of technology in the medical field, countless lives have been saved and the overall quality of life continues to improve over time.*

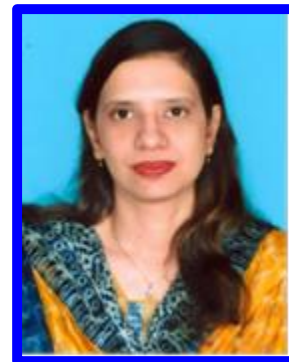
*Your social and moral values should be explanatory. It is here where you change from a technical student to a reliable, dependable professional biotechnologist, who are empathetic and take responsibility for human lives very seriously and religiously. You as student are expected to demonstrate professional and responsible behavior towards your teachers, colleagues, health professionals and patients. Communication skills and professionalism will play a vital role in your development. You are an adult and adults are responsible for their actions. We use principles of adult learning here. Your teachers are here to guide you but you are the decision makers. Results will depend on how committed, honest and hard-working you are yourself.*

*I hope you will enjoy the co-curricular activities that are planned for you. Have fun but do not forget that you are here to become a biotechnologist. I hope you will become the best biotechnologist that you can. Dress up properly and always smile.*



Message from the Desk of Principal  
Bahria University College of Allied Health  
Sciences and HOD Biotechnology  
Bahria University Health Sciences Campus

ASSOCIATE PROFESSOR DR. MEHREEN LATEEF  
BSc(H), MSc, MPhil, PhD (Biochemistry),  
PRINCIPAL BAHRIA UNIVERSITY COLLEGE OF ALLIED HEALTH SCIENCES  
HOD BIOTECHNOLOGY



*Dear Students,*

*Heartiest congratulations and welcome to Bahria University Health Sciences Campus. Selection in Biotechnology department of college is the evidence of sheer hard work, incessant struggle, and relentless efforts towards achieving the goals. State of the art facilities and adroit faculty of this college will ensure smooth transition of a student to a highly trained practitioner. The logical convergence towards the aim will be explained stepwise in the study guide which includes forthcoming activities, content, and learning strategies.*

*The highly proficient teaching faculty will provide necessary guidance related to learning objectives, effective use of teaching tools and integrated teaching methods. The study programs also support social and moral development of a BS-Biotechnology student besides achieving academic excellence. A team of highly trained and professional teachers act as mentors to guide students on social and academic related affairs.*

*The mandate of biotechnology education is to equip future professionals with requisite knowledge, skills, and attitude. As a biotechnology student it is expected of you to keep an exemplary character and honest morality. Plan and strive hard with full sincerity and devotion. This marks the beginning of your professional career where attitude defines your altitude and acts as a panacea in practical life.*



### INTRODUCTION TO BAHRIA UNIVERSITY HEALTH SCIENCES CAMPUS

Bahria University Health Sciences Campus was established in 2008 by Pakistan Navy under Bahria University and aligned with Higher Education Commission and Pakistan Medical & Dental Council. The College has a beautiful custom built basic sciences wing which also houses the Dental College, Physical Therapy School, an auditorium, a library, video link facilities, a skills laboratory and an advanced multi-disciplinary research laboratory.

The clinical teaching wing is PNS SHIFA, a tertiary care hospital, which takes care of Armed Forces Personnel, their families, parents and civilian patients. There are large variety of clinical cases for students to learn from. Emergency and intensive care facilities are available. About 1500 patients visit PNS Shifa daily. The outpatient departments in all disciplines are in full use and well organized. Where patients are seen promptly, investigations like laboratory tests, X rays and advanced imaging techniques are available on site. Doctors and biotechnologists work as a team to ensure the best care of patient.

With its advanced facilities and successful programs of MBBS, BDS, DPT, MLT, BUHSC is going to start BS-Biotechnology by providing excellent learning environment with modern techniques for biotechnologists to use it for patient diagnosis, treatment which impacts

human health, well-being of other life forms and our environment.



#### VISION STATEMENT

*To become an internationally recognized university that contributes towards development of nation through excellence in education and research.*

#### MISSION STATEMENT

*To prepare allied health professionals equipped with knowledge, skills, and innovative research expertise, attained in a collegiate environment supported through national and international linkages, for provision of high quality services in the society.*

### THE COLLEGE AIMS TO REALIZE THIS MISSION BY:

- Training the health sector workforce of the future
- Conducting research that creates new knowledge in the field of health sciences and reviews improvement in existing bodies of knowledge.
- Providing innovative, patient-oriented health care
- Contributing to the economic development and wellbeing of Pakistan through integrated programs in education, research and clinical care.

#### **Why choose BU for this Degree Program**

- *Among the top most universities of Pakistan.*
- *Aligned with the guidelines of HEC.*
- *PMDC accredited Medical and Dental College*
- *State of Art Multi-Disciplinary Laboratory with latest and advanced equipment for histopathology and molecular biology available at one place to learn.*
- *Foreign Qualified PhD Faculty*
- *Clinical labs of 700 bedded affiliated Hospital; PNS Shifa is available for students to do practice in final year.*

### BIOTECHNOLOGY PROGRAM

#### MISSION:

To prepare qualified graduates equipped with knowledge, latest technological skills and innovative research expertise in the field of biotechnology, attained in a collegiate environment supported through national and international linkages, for provision of high quality services in the society to serve community.



#### PROGRAM EDUCATIONAL

##### OBJECTIVES:

- BS-Biotechnology program is designed to
- To contribute competently in the industry related to biotechnology by applying requisite technical skills
  - To demonstrate advancement in profession by enhancing their knowledge and skills in their relevant field
  - To demonstrate commitment to ethical values and contribute positively towards the society.

- To learn the scope, concepts, and terminology of biotechnology.
- To Investigate and explain current events and advances in biotechnology.

### PROGRAM LEARNING OUTCOMES (PLOs)

- Graduates will be prepared with an ability to apply fundamental and specialized knowledge of biotechnology to the solution of complex biotechnological problems
- Graduates will be able to deliver an ability to identify, formulate, research literature, analyze complex biotechnology problems, reaching substantiated conclusions towards formulation of hypothesis using fundamental principles of biotechnology.
- The graduates will have an ability to design experimental solutions to validate biotechnology Hypothesis and design process while maintaining biotechnology standards, cultural, societal, and environmental considerations.
- An ability to investigate complex issues in biotechnology in a methodical way including literature survey, and development of systems, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.
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- literature survey, and development of systems, analysis and interpretation of
- experimental data, and synthesis of information to derive valid conclusions.
- An ability to communicate effectively, orally as well as in writing, on complex

biotechnology activities with the biotechnology community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions



### FUTURE CARRER PROSPECTUS

- This program provides excellent career opportunities to students with a quality learning experience and development of expertise in technological practices required for biotechnologist.
- Upon completing the degree, graduates will be qualified to work as a biotechnologist in
  - Research laboratories
  - Clinical/Diagnostic laboratories
  - Industries
  - Universities
- This program will provide a career path to the students and lab workers with advanced research opportunities as scientists, which can boost their professional career and enhances the promotion chances up to senior and supervisor level.

## CODE OF CONDUCT

The administration will oversee the code of conduct, discipline, dress code and educational performance. There is a Chairperson for Student Affairs and a Chairperson for Post-graduate students. The Associate Deans can be approached as appropriate regarding queries on educational matters, any breach of discipline, and referrals for electives, and advice about leave of absence or leave for medical reasons. All faculty members are also responsible for maintaining all aspects of discipline. Breaches of the university's code of conduct are routinely referred to the committee and disciplinary action is taken as it deems appropriate.

### 1. DRESS CODE:

#### MALE STUDENTS:

- Casual Trousers
- Jeans(Plain blue) without images, graphics and write ups
- Casual Shirts (Half/ Full sleeves)
- T Shirts without any messages, images, graphics and write ups
- Casual shoes or Joggers with socks
- Shalwar Qameez with shoes (only on Friday)
- Suit/ Combination
- Coat/ Pullovers/ Sweaters/ Jackets in winter

#### FEMALE STUDENTS:

- Shalwar Qameez
- Hijab, Abaya, Chaddar etc
- Full length Jeans with long shirt/ kurta (knee length)
- Light jewelry and light makeup
- Shoes, Sandals and Joggers
- Duppatta/ Scarf is compulsory with all dresses

**NOTE:** BUHSC students should wear white coat during classes, hospital rotations and other wise as appropriate.

Smoking & Drugs are strictly prohibited at campus.

### 2. Personal behavior

Your personal behavior at all times should reflect that you are an educated person who is aiming to develop good professional conduct. Please remember to greet your teachers and fellow students as is commensurate with religion and the norms dictated by our society. Politeness should be your mannerism. Tidiness and cleanliness must be adhered to at all times. Please do not litter the BUHSC premises. If you see any litter please pick it up and dispose it off in a litter bin. Rowdy and abusive behavior is to be avoided at all costs. Please report to the vice principal or your Mentor or a senior faculty member if you have experienced such behavior. Men and women will be

working closely together in BUHSC. Be polite and considerate. You should never use gender as basis for teasing or abuse. Violence against students, faculty and staff will be dealt with severely. Ethnic or religious intolerance will not be tolerated at all. Politeness towards auxiliary and support staff is expected at all times.



### 3. Punctuality

Please be prompt and punctual. Classes will start on time. A teacher may choose to mark you absent if you come late to class. Punctuality is also expected from you in the practical classes, demonstrations and ward clinics. If your teaching involves a patient then punctuality is very important because this patient, who is ill, has given you the favour of allowing you to learn from his/hersuffering. Punctuality also means being on time when using college transport. Do not keep other people waiting.

Punctuality also means that you return from holidays one day before the college re-opens so that you do not miss classes. At BUHSC education starts immediately after any holiday. There is no lag period after leave. You may have a quiz or exam on the day the college re-opens. There will be no relaxation for students who are absent. Please inform

your parents of this and make your travel arrangements accordingly. Avoid taking leave for personal reasons like weddings during the academic year.

### 4. Conduct in the library, cafeteria and common rooms

Whenever you are working or studying in the common areas or relaxing in the cafeteria your behavior should be polite, quiet and should not disrupt anybody else's work or study. Loud conversation, loud phone calls, shouting across the room are to be avoided. If you are listening to music, use headphones. Be polite to all the staff. Smoking is not permitted anywhere on BUHSC premises or the hospital.

## COLLEGE DISCIPLINARY COMMITTEE

The College Disciplinary Committee deals with the maintenance of discipline on-campus. All cases of breach of discipline will be brought before this committee. The ruling of the committee cannot be challenged. The student will be dealt with accordingly.

### Students are to avoid the following:-

- Unauthorized use of the University's name or logo that is the property of the University
- Harassment, sexual or otherwise, or intimidation of any member of the University community
- Coming late for classes. The student may be considered absent and marked accordingly.
- Improper/inappropriate dress
- Loud and disruptive or aggressive behavior in the Cafeteria or Common rooms or on



the premises of BUHSC or PNS ShifaHospital.

- f) Non clearance of bills/dues. The non-clearance of dues may cause a student to be with-held from a professional examination. The student may also be refused permission to attend classes.

### ATTENDANCE POLICY FOR REGULAR STUDENTS

Bahria University rules for undergraduate degree programs will be applicable to Biotechnology program as per HEC Criteria.

The minimum attendance requirement is 75% in each subject: attendance is for lectures and practicalsession. No shortfall in attendance will be condoned in any case by any authority.Attendance is maintained by theDepartment of Scholastic Records at BUHSC.

- Lecture Attendance is marked at the start of the class.
- Students who come more than 10 minutes late are marked absent.
- A random head count is done to ensure correct entry of attendance.
- The attendance sheet is signed by the teacher and sent to Scholastics Department.
- The attendance is entered into the spreadsheet as soon as possible on that day.
- No correction will be made later than 24 hours as the system is then locked.

The University rules permit a 25% short fall for genuine reasons of personal ill health of a life threatening nature or unavoidable circumstances such as death of a blood relative. This 25% relaxation is not so that you can take a holiday.

If you have less than 75% attendance even for reasons of health, you will be asked to repeat the year. Maintaining adequate attendance is your personal responsibility.

### ATTENDANCE POLICY FOR STUDENTS REPEATING A YEAR.

- Students who have been asked to repeat the year either because of poor attendance or failure in the professional examination or supplementary examination will attend all the classes next year.
- Their previous years' attendance will not be counted again.
- If their attendance is less than 75% in their current class they will not be allowed to appear in the next examination.

### ELIGIBILITY CRITERIA FOR APPEARING IN ANNUAL EXAMS

A student will be eligible to appear in the annual professional examination if he/she fulfills the following criteria including 75% attendance and must have cleared all financial dues.

### BRIEF DESCRIPTION OF THE PROGRAMME:

Bahria University Health Sciences Campus is offering Bachelor of Science (BS) in

Biotechnology in the field of Clinical Laboratory Science/Clinical Pathology/Clinical Chemistry / Medical Biochemistry. This is a Four-Year degree Program consisting of generalized, compulsory courses and specialized courses aligned with HEC semester rules and Bahria University rules. The program of study is as follows.

Course title	BS inBiotechnology
Course duration	4 YEARS
Study system	SEMESTER SYSTEM Regular
semesters No.	8
Semester Duration	18 weeks
Total credit hours	134
Courses per semester	5-6
Course Load per Semester	15-18 credit hours

### What will the student study in this program?

#### General Courses:

- English
- Pakistan Studies
- Islamiat
- Computer Skills

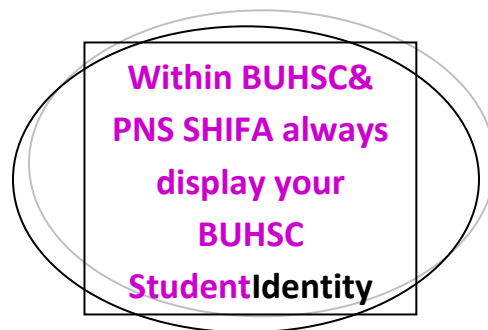
#### Basic Medical Courses:

- Anatomy
- Biochemistry
- Physiology
- Pharmacology
- Microbiology
- Pathology

#### Specialized Courses

- Histopathology
- Hematology

- Clinical Bacteriology
- Hematology
- Human Genetics
- Communication Skills
- Clinical Virology and Mycology
- Chemical Pathology
- WBCS and Platelets Disorders
- Bioinformatics
- Clinical Parasitology
- Clinical Pathology



### SEMESTER SYSTEM

There will be two regular semesters (fall, spring) in an academic year. Fall/Spring semesters will spread over 16-18 weeks (inclusive of 1 – 2 weeks for exams).

Summer Semester will be offered to remove deficiencies. It comprises of 8 – 9 weeks of concentrated study for completing remedial course

### SUBJECT DISTRIBUTION PER YEAR

Year	Semester	Course codes	Title of Course
1 <sup>st</sup>	I  Spring Semester	ENG116	English-I
		PAK101	Pakistan Studies
		MAS102	Mathematics-I (Pre-calculus)
		EBE103	Ecology, Biodiversity & Evolution-I

# Study Guide for Bachelor of Science in Biotechnology (BS-Biotechnology)

## Department of Biotechnology

year		OCH104	Organic Chemistry
		CBI105	Cell Biology
	II  <b>Fall Semester</b>	ENG 118	English-II
		ISL 103	Islamic Studies/Ethics
		BMA 106	Biomathematics
		ICH 107	Inorganic Chemistry
		OCH 108	Ecology, Biodiversity & Evolution-II
		MIC 102	Microbiology

Year	Semester	Course codes	Title of Course
2 <sup>nd</sup> year	III  <b>Spring Semester</b>	ENG 122	English-III
		CSC 107	Introduction to Computer Science
		PHC 111	Physical Chemistry
		BSC 103	Behavioral Science
		BIO 112	Biochemistry-I
		CGE 114	Classical Genetics
	IV  <b>Fall Semester</b>	BPH 207	Biological Physics
		PBI 208	Probability & Biostatistics
		SOC 209	Sociology
		ACI 210	Analytical Chemistry & Instrumentation
		BIO 210	Biochemistry-II
		MBI 206	Basics of Molecular Biology

Year	Semester	Course codes	Title of Course
3 <sup>rd</sup> year	V  <b>Spring Semester</b>	BIT 301	Introduction to Biotechnology
		IMM 302	Immunology
		MMB 303	Methods in Molecular Biology
		PBE 304	Principles of Biochemical Engineering
		BIN 305	Bioinformatics
	VI  <b>Fall Semester</b>	GRC 306	Genetic Resources & Conservation
		MBT 307	Microbial Biotechnology
		AGB 308	Agriculture Biotechnology
		FBT 309	Food Biotechnology

			Elective-I*
		RMS 311	Research Methodology & Skill Enhancement

Year	Semester	Course codes	Title of Course
4 <sup>th</sup> year	VII  <b>Spring Semester</b>	HBT 405	Health Biotechnology
		SMR 409	Seminar-I
		EMB 403	Environmental Biotechnology
		GPR 404	Genomics and Proteomics
			Elective-II*
		RPT 407	Research Project-I
	VIII  <b>Fall Semester</b>		Elective-III*
			Elective-IV*
		SEM 410	Seminar-II
		IMB 404	Industrial Biotechnology
		RPT 408	Research Project-II
		BET 406	Biosafety & Bioethics
		INT 407	Internship (9 weeks non-credit hrs)

### \*LIST OF ELECTIVES:

	Course codes	Title of Course
Elective I (anyone)	VIR 310	Virology
	CTC 311	Cell and tissue culture
	MOD 312	Molecular Diagnostics
	BIS 313	Biosensors
Elective II (anyone)	WWT 401	Water and waste water treatment
	HWM 402	Hospital waste management
	RAB 403	Radiobiology
	BFB 404	Biofuels and bio refineries
Elective III (anyone)	MBT 410	Marine biotechnology
	ABT 411	Animal biotechnology
	FBT 412	Fungal biotechnology
Elective IV (anyone)	PBT 413	Pharmaceutical biotechnology
	NBT 414	Nano biotechnology
	FBT 415	Fermentation biotechnology

A weekly schedule will be placed on the notice board regarding the time table.

## **MODE OF ASSESSMENT AND EXAMINATION**

Assessment and examination will be based on HEC and BU rules. In each semester, students may be required to appear in quizzes, tests, midterms, final examinations, presentations (individual/group), group discussion, and submits projects/assignments/lab reports, etc. These assessment marks (to be determined by the teacher concerned) will have different weightage contributing towards the overall assessment in percent marks. This weightage may be determined based on following guidelines:

There will be no Supplementary/Special Examination in a Semester System; if a student fails in a course, s/he is required to repeat it

## **STUDENTS' SUPPORT CENTRE**

The Students' support centre coordinates administrative co-curricular and extracurricular activities. Students are advised to approach the Manager, Student Support Centre for any academic or non-academic matter.

## **LIAISON WITH PARENTS**

The Students Support Centre also serves as a bridge between the College Administration and parents.

Students' progress reports will be mailed to parents on request at the conclusion of every term and annual examination. Similarly, the issue of short attendance, college discipline, and violation of college rules and regulations are handled by this Office.

## **CLUBS FOR EXTRACURRICULAR ACTIVITIES**

Different clubs for extracurricular activities are established for students to participate.

1. Literary and debate society
2. Arts and dramatics society
3. Adventure club
4. Event club
5. Community support club
6. Sports club
7. Media club
8. Music club

## **WHOM TO CONTACT?**

### **ADMINISTRATION BUCAHS**

<b>Nature of Exam</b>	<b>Weightage</b>
Quiz	5 - 10%
Mid Term	20 - 25%
Assignments/Presentations/ Practical	5 - 25%
Sessional Examination	10 - 15%
Final Examination	35 - 40%

- Professor Dr. Ambreen Usmani, Dean Health Sciences & Principal Medical BUHSC
- Sr. Associate Professor, Dr. Mehreen Lateef, Principal Bahria University College of Allied Health Sciences
- Ms. Ayesha Hilal, Sr. Clerk,
- Mr. M. Sameer, Clerk and PA to Principal

## **CODE OF CONDUCT FOR PROTECTION AGAINST HARASSMENT OF WOMAN AT THE WORK PLACE**



1. An informal approach to resolve a complaint of harassment may be through mediation between the parties involved and by providing advice and counseling on a strictly confidential basis.
2. A complainant or a staff member designated by the complainant for the purpose may report an incident of harassment informally to her supervisor, or a member of the Inquiry committee, in which case the supervisor or the committee member may address the issue at her discretion in the spirit of this Code. The request may be made orally or in writing.
3. If the incident or the case reported does constitute harassment of a higher degree and the officer or a member reviewing the case feel that its needs to be complainant, the case can be taken as a formal complaint.
4. A complainant does not necessarily have to take a complaint of harassment through the informal channel. She can launch a formal complaint at any time.
5. The harassment usually occurs between colleagues when they are alone, therefore usually it is difficult to produce evidence. It is strongly recommended that staff should report offensive behavior immediately to someone they trust, even if they do not wish to make a formal complaint at the time.

**Harassment Complaint Cells . Focal Persons at BUHSC (K) are as follows:**

- (1) Prof. Dr. Khalid Mustafa
- (2) Prof. Dr. Shazia Shakoor

### **Inquiry Committee**

3. Inquiry committee for sexual harassment at BUHSC (K) is as follows:

- (1) Prof. Dr. Shama Asghar
- (2) Prof. Dr. Nasim Karim

- (3) Dr. Aini Samreen

### **MENTORING SYSTEM**

BUHSC has student assisting programs such as mentoring. Mentors have been already assigned at the start of the teaching program in the first year. The students will meet the assigned mentor in the mentor's office to discuss academic, non-academic, experiences, problems for advice and guidance.

Following students will be supervised by mentors as follows:

Mentor Supervisor: Dr. Mehreen Lateef

1. Dr. Madiha Kanwal, First Batch

Mentors will report to supervisors and then



to in-charge mentor

### **DEPARTMENT OF BIOTECHNOLOGY**

It comprises of well trained and experienced biotechnologist, Biochemist, Microbiologist, and Medical Lab Technologist as faculty members.

The Department of Biotechnology is developed under Bahria University College of Allied Health Sciences, and Multidisciplinary Research Laboratory at Bahria University Health Sciences Campus (BUHSC) Karachi.

MDRL is located on the second floor of Bahria University Health Sciences Campus with advanced research instruments. The main objective of MDRL is to strengthen research environment in medical college for faculty, students and researchers (undergraduates and postgraduates) by providing scientific instrumentation and technical expertise under one umbrella. With the help of MDRL, clinicians, and scientists will be enabled to explore diagnostic and various treating ways in basic and clinical research and in this way overall health care system can be improved.

It comprises of well trained and experienced PhD faculty members.

### Head of Department

- Dr. Mehreen Lateef, PhD  
Associate Professor
- Dr. Laraib Liaquat, PhD  
Assistant Professor
- Dr. Madiha Kanwal, Senior Scientific Officer
- Ms. Shafaq Mehmood, Senior Lecturer
- Ms. Humera Ghouri, Senior Lecturer
- Ms. Hiba Saleem, Lecturer
- Ms. Syeda Shabana Nasir, Lecturer
- Ms. Minza Ahmed, Clinical Laboratory Technologist

Senior professors and faculty members from Anatomy, Pharmacology, Physiology and

Biochemistry and Pathology will be part of Biotechnology Department as shared faculty members and will deliver their expertise through lectures and demonstrations.

Prof. Dr. Ambreen Usmani HOD Anatomy

Prof. Dr. Yasmeen Taj HOD Pathology

Prof. Dr. Nasim Karim HOD Pharmacology

Prof. Dr. Nighat Rukhsana HOD Physiology

Prof. Dr. Hassan Ali HOD Biochemistry

Prof. Dr. Khalid Mustafa, Pharmacology

## FIRST YEAR BS-BIOTECHNOLOGY

### SEMESTER I COURSES

1. ENG 116 English-I
2. PAK 101 Pakistan Studies
3. MAS 102 Mathematics-I (Pre-calculus)
4. EBE 103 Ecology, Biodiversity & Evolution-I
5. OCH 104 Organic Chemistry
6. CBI 105 Cell Biology

### ENG-116 ENGLISH –I(3+0) (Functional English)

#### Course 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

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. 3rd Edition. Oxford University Press. 1997. ISBN 0194313492
- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

##### b) Writing

- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019435405 7 Pages 20-27 and 35-41.

##### c) Reading/Comprehension

- Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 019453402 2.

##### d) Speaking

## PKS-101 PAKISTAN STUDIES (2+0) (Compulsory)

### Course 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 Contents:

#### 1. Historical Perspective

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

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

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

#### 3. Contemporary Pakistan

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

### Recommended Books:

- Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.

- Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
- S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
- Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
- Wilcox, Wayne. The Emergence of Bangladesh. Washington: American Enterprise, Institute of Public Policy Research, 1972.
- Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat- e-Islamia, Club Road, nd.
- Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
- Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson & sons Ltd, 1980.
- Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
- Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
- Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
- Aziz, K.K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
- Muhammad Waseem, Pakistan under Martial Law, Lahore: Vanguard, 1987.
- Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.

### MAS-102 MATHEMATICS-I (3+0) (Pre-calculus)

#### Course Objectives:

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

**Specific Objectives of the Course:** To prepare the students, notmajoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

#### Course Contents:

**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



## **EBE-103 ECOLOGY, BIODIVERSITY & EVOLUTION-I (3+0)**

### **Course Objectives:**

This course aims to introduce students to the fundamentals of ecology, biological diversity and evolution – key areas that are pertinent to modern day biology.

### **Course Contents:**

Introduction; ecosystem and ecological pyramids; role of environment on phenotype of organisms; food chain, webs and trophic levels; factors influencing environment; impact of urbanization and industry on environment; population: air, water, land, thermal, radiation and noise; community ecology; atmosphere – composition and cycles; pollution; climate change (greenhouse effect and global warming); ozone layer – composition and state across the globe; waste and sewerage processing and disposal; microbes, plants and animal species; comparative study of life forms; features and characteristics of bacteria, archaea and eukaryotes; phylogenetic relationships between the three kingdoms; evolution of different members belonging to each of the three domains of life (with specific examples); models of speciation; causes and consequences of extinction.

### **Recommended Books:**

- Davet P, 2004. Microbial ecology of soil and plant growth. Science Publishers.
- Nico et al., 2006. An Introduction to Ecological Genomics. 1st Edition; Oxford University Press.
- Aston et al., 2004. Ecological Genetics: Planning and Application. Blackwell Science (UK).
- Costa LG, and Eaton DL, 2006. Gene-Environment Interactions: Fundamentals

of Ecogenetics. 1st Edition; John Wiley and Sons.

- Freeland JR, 2005. Molecular Ecology. 1st Edition; John Wiley and Sons.
- Wenz PS, 2001. Environmental Ethics Today. Oxford University Press.
- Louis P and Pojman LP, 2007. Environmental Ethics: Readings in Theory and Application. 5th Edition; Wadsworth Publishing.
- Light A, and Rolston III H, 2002. Environmental Ethics. 1st Edition; Wiley Blackwell Publishing.
- Raven PH, and Berg LR, 2005. Environment. 5th Edition; John Wiley and Sons.

## **CBI-105 CELL BIOLOGY (2+1)**

### **Course Objectives:**

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

### **Course Contents:**

Introduction to cell theory including historical perspective; overview of membrane structure and chemical constituents of the cell; function, isolation and molecular organization of cellular organelles specifically the endoplasmic reticulum, lysosome, micro-bodies, mitochondrial ultra-structure and function, chloroplast ultra-structure and the mechanism of photosynthesis; composition and structure of membranes; membrane receptors and transport mechanisms; cell movement - structure and function of cytoskeleton, centriole, cilia and flagella; nucleus; structure and function of

chromosomes; cell cycle, mitosis and meiosis.

### Practical:

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

### Recommended Books:

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

## SEMESTER II COURSES

1. ENG 118 English-II
2. ISL 103 Islamic Studies/Ethics
3. BMA 106 Biomathematics
4. ICH 107 Inorganic Chemistry
5. OCH 108 Ecology, Biodiversity & Evolution-II
6. MIC 102 Microbiology

### ENG-118 English-II (3+0) (Communication Skills)

#### Course 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

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. 3rd Edition. Oxford University Press 1986. ISBN 0194313506.

###### b) Writing

- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0194354057 Pages 45-53 (note taking).
- Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0194354065 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

###### c) Reading

- Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 4534030.
- Reading and Study Skills by John Langan
- Study Skills by Riachard Yorky.

### ISL-103 ISLAMIC STUDIES (2+0) (Compulsory)

#### Course 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 Quran Studies

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

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

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

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

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

- 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No- 1,14)

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

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

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

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

##### Introduction to Sunnah

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

##### Selected Study from Text of Hadith

##### Introduction to Islamic Law & Jurisprudence

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

##### Islamic Culture & Civilization

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

##### Islam & Science

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

### Islamic Economic System

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

### Political System of Islam

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

### Islamic History

- 1) Period of Khlaft-E-Rashida
- 2) Period of Umayyads
- 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

### Recommended Books:

- Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- Hameed ullah Muhammad, "Muslim Conduct of State"
- Hameed ullah Muhammad, 'Introduction to Islam
- Mulana Muhammad Yousaf Islahi, "Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)

- Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

## BMA-106 BIOMATHEMATICS (3+0)

### Course Objectives:

This course aims to provide students with the essential concepts of biomathematics and how these can be employed for analyzing real data.

### Course Contents:

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities, binomial theorem and its use.

*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. Application and importance of calculus for biotechnology; the exponential growth curve and growth equation.

### Recommended Books:

- Helfgott M, and Moore D, 2011. Introductory Calculus for the Natural Sciences. Create Space Independent Publishing Platform, USA.
- Neuhauser C, 2010. Calculus for Biology and Medicine. Prentice Hall
- Anton H et al., 2005. Calculus: A New Horizon. John Wiley, New York.
- Thomas GB and Finney AR, 2005. Calculus. Addison-Wesley, Reading, USA.



- Kumar A, 2011. Mathematics for biologist. First Edition; Alpha science international.

### OCH-108 ECOLOGY, BIODIVERSITY & EVOLUTION – II (2+1)

#### Course Objectives:

This course is a continuation of Ecology, Biodiversity & Evolution – I and offers advanced concepts in these areas.

#### Course Contents:

Introduction to animal kingdom: features of protists, protozoa, annelids, arthropods, myriapods, echinoderms, chordates, amphibians, reptiles and birds. Plant biodiversity – history, importance, usefulness and evolution; importance of plants, their conservation and domestication; improvement of crops; impact of environment on loss of genetic diversity and speciation; in situ and ex situ conservation; evolution of microbes, plants and animals; origin of life; methods of studying evolution; construction of phylogenetic trees on basis of morphology and molecular markers; environmental ethics.

#### Practical:

Shape and structure of different classes of microbes, plants and animals by light microscopy; study of euglena, amoeba, entamoeba, plasmodium and paramecium (from slides); sponges and their various body forms; cnidaria; platyhelminths; nematodes; molluscs; annelids; pisces; amphibians; reptilian; aves; mammalia; pond freshwater ecosystem; vegetation profile; grassland, rangeland and forest; biotic and abiotic factors of grassland, rangeland and aquatic ecosystem including methods of

sampling; analysis of plant communities by different methods and decomposition of leaf litter by organisms.

#### Recommended Books:

- Davet P, 2004. Microbial ecology of soil and plant growth. Science Publishers.
- Nico et al., 2006. An Introduction to Ecological Genomics. 1st Edition; Oxford University Press.
- Aston et al., 2004. Ecological Genetics: Planning and Application. Blackwell Science (UK).
- Costa LG, and Eaton DL, 2006. Gene-Environment Interactions: Fundamentals of Ecogenetics. 1st Edition; John Wiley and Sons.
- Freeland JR, 2005. Molecular Ecology. 1st Edition; John Wiley and Sons.
- Wenz PS, 2001. Environmental Ethics Today. Oxford University Press.
- Louis P and Pojman LP, 2007. Environmental Ethics: Readings in Theory and Application. 5th Edition; Wadsworth Publishing.
- Light A, and Rolston III H, 2002. Environmental Ethics. 1st Edition; Wiley Blackwell Publishing.
- Raven PH, and Berg LR, 2005. Environment. 5th Edition; John Wiley and Sons.

### MIC-102 MICROBIOLOGY (2+1)

#### Course Objectives:

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

#### Course Contents:

Overview and history of microbiology including microbial diversity (Archaea, bacteria, fungi, algae, protozoa), nutrition,

growth, metabolism; cultivation; viruses; control of microorganisms: sterilization and disinfection, antimicrobial agents, antibiotics, antibiotic resistance and susceptibility, antifungal and antiviral agents; cell death; symbiosis, carbon, nitrogen, sulfur and phosphorus cycles; microbiology of soil, freshwater and seawater.

### Practical:

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

### Recommended Books:

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

## SECOND YEAR BS-BIOTECHNOLOGY

### SEMESTER III COURSES

1. ENG 122 English-III

2. CSC 107 Introduction to Computer Science
3. PHC 111 Physical Chemistry
4. BSC 103 Behavioral Science
5. BIO 112 Biochemistry-I
6. CGE 114 Classical Genetics

### ENG-122 English III (3+0) (Technical Writing and Presentation Skills)

#### Course 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

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

### BIO-112 BIOCHEMISTRY- I (2+1)

#### Course Objectives:

This course aims to provide students with fundamental knowledge of the molecules of life, as well as their function in the context of a living cell.

#### Course Contents:

Introduction to biochemistry; water, pH, buffers, and biochemical composition of cells; carbohydrates - structure and classification; proteins - overview with emphasis on their composition and structure, classification and function; lipids - structure, classification and biological significance; enzymes - properties, nomenclature, classification, and factors affecting enzyme activity including inhibitors and potentiators, basic kinetics, derivation of  $K_m$  and  $V_{max}$ ; coenzymes and vitamins; nucleic acids - structure and function.

#### Practical:

Preparation of laboratory solutions and pH determination; qualitative and quantitative tests for carbohydrates, proteins and lipids; enzyme assays and the effect of pH, temperature and substrate concentration on enzyme activity.

#### Recommended Books:

- Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. 6<sup>th</sup> Edition; WH

Freeman, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))

- Stryer et al., 2006. Biochemistry. 6<sup>th</sup> Edition; WH Freeman, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- Voet D and Voet TG, 2008. Biochemistry. 4<sup>th</sup> Edition; John Wiley and Sons, New York.
- Murray et al., 2012. Harper's Illustrated Biochemistry. 29<sup>th</sup> Edition; McGraw-Hill Medical Publishing.
- Ferrier DR, 2013. Lippincott's Biochemistry. 6<sup>th</sup> Edition; Lippincott Williams & Wilkin Publishing Company.
- Schantz JT, 2007. A Manual for Biochemistry Protocols. World Scientific Publishing. (available online)

### CGE-114 CLASSICAL GENETICS (2+1)

#### Course Objectives:

To acquaint students with classical aspects of genetics.

#### Course Contents:

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

### Recommended Books:

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

### 4<sup>TH</sup> SEMESTER COURSES

1. BPH 207 Biological Physics
2. PBI 208 Probability & Biostatistics
3. SOC 209 Sociology
4. ACI 210 Analytical Chemistry & Instrumentation
5. BIO 210 Biochemistry-II
6. MBI 206 Basics of Molecular Biology

### BPH-207 BIOLOGICAL PHYSICS (3+0)

#### Course Objectives:

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

#### Course Contents:

Essentials of thermodynamics; concept of entropy, enthalpy and Gibb's free energy; order and disorder in biological systems; molecules, diffusion, random walks and friction; methods of studying macromolecules; interactions of molecules in 3-D space – determining binding and dissociation constants;

molecular motors; sedimentation; Reynold's number; chemical forces and self- assembly; physics of ion channels.

### Recommended Books:

- Nelson P, 2004. Biological Physics, Energy, Information and Life. First Edition; WH Freeman & Company.
- Kirsten et al., 2010. Introduction to Biological Physics for the Health and Life Sciences. Second Edition; John Wiley & Sons.
- Davidovits P, 2013. Physics for Biology & Medicine. Fourth Edition; Academic Press.
- Newman, 2008. Physics of the Life Sciences. Springer.
- Duncan, 1975. Physics for Biologist. Blackwell Science.

### PBI-208 PROBABILITY AND BIOSTATISTICS (3+0)

#### Course Objectives:

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

#### Course Contents:

Frequency distribution, exercise frequency distribution, measures of central tendency, measures of dispersion and measures of location. Second part of the study will cover the areas of statistical hypothesis and significance, null and alternative hypothesis, confidence interval, tests involving binomial distribution, tests involving normal distribution, F-distribution, student's t-distribution, chi-square test, tests of independence and contingency tables. In the third part lectures will cover the following topics: Analysis of Variance (ANOVA), LSD test, experimental designs, Completely Randomized Design (CRD), Randomized



Complete Block Design (RCBD), Latin Square Design, Markov chains and Models and their applications in Bioinformatics such as gene predication, sequence analysis, profile HMMs, probabilistic approaches to phylogeny, etc.

**Recommended Books:**

- Mann PS, 2010. Introductory Statistics. 7th Edition; John Wiley and Sons.
- Freund JE and Perles MB, 2005. Modern Elementary Statistics; 12th Edition. Pearson.
- Chaudhry SM, 2005. Introduction to statistical theory. 6th Edition; Markazi Kutub Khana, Lahore.
- Chernick MR and Friis RH, 2003. Introductory Biostatistics for the Health Sciences: Modern Applications Including Bootstrap. First Edition; Wiley Inter science.
- Le CT, 2003. Introductory Biostatistics. First Edition; Wiley Inter science.

**ACI-210 ANALYTICAL CHEMISTRY AND INSTRUMENTATION (2+1)****Course Objectives:**

To acquaint students with key analytical chemistry concepts involving identification and analysis at the molecular level by introducing a variety of analytical chemistry techniques and their applications at the molecular level; designing analytical chemistry methods to obtain analysis data with the high precision and accuracy from experiments; demonstrating biochemical laboratory techniques and explaining the theory and background behind these techniques.

**Course Contents:**

Introduction to various analytical techniques; principles and applications of various types of chromatography including paper, thin layer, gel filtration, ion-exchange, affinity, high performance liquid chromatography (HPLC), gas chromatography, GC-MS and LC-MS; spectroscopy types including nuclear magnetic resonance (NMR), visible, ultraviolet, luminescence, flame, atomic absorption, fluorescence, emission and inductively coupled plasma emission spectroscopy (ICPMS); principles and applications of flow cytometry; introduction to X-ray diffraction; general analytical instrumentations and methods of fractionation and characterization of proteins and nucleic acids including dialysis, ultra-filtration, lyophilisation, ultracentrifuge and amino acid analyzer.

**Practical:**

Separation of biomolecules by paper, column and thin layer chromatography; determination of molecular weight of proteins by gel filtration; identification of sugars, proteins, electrolytes etc. by UV/Visible spectrophotometer; determination of sodium and potassium content in blood serum by flame photometer and mineral analysis of plant tissues using atomic absorption spectrophotometer.

**Recommended Books:**

- Boyer RF, 2011. Biochemistry Laboratory: Modern Theory and Techniques. Second Edition; Prentice Hall
- Wilson K, 2010. Principles and Techniques of Biochemistry and Molecular Biology. Seventh Edition; Cambridge University Press.

- Christian GD, 2003. Analytical Chemistry. Sixth Edition, John Wiley and Sons, New York.
- Chung et al., 2005. Analytical Methods validation and Instrument Performance verification. First Edition; John Wiley and Sons, New York.
- Sharma BK, 2005. Instrumental Method of Chemical analysis. First Edition; Meerut Goel Publishing House, India.
- Harris DC, 2010. Quantitative Chemical analysis. Eighth Edition; WH Freeman, New York.

### BIO-210 BIOCHEMISTRY- II (2+1)

#### Course Objectives:

This course is a continuation of Principles of Biochemistry I, and aims to familiarize students with the key concepts of intermediary metabolism of proteins, nucleic acids, carbohydrates and lipids.

#### Course Contents:

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

control; urea cycle; integration of metabolism.

#### Practical:

Basic biochemical methods such as iodine test for polysaccharides, 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 plant tissue/seed and lipid separation from different tissues; fractionation by thin layer chromatography (TLC).

#### Recommended Books:

- Nelson DL and Cox MM, 2012. Lehninger Principles of Biochemistry. 6<sup>th</sup> Edition; WH Freeman, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- Stryer et al., 2006. Biochemistry. 6th Edition; WH Freeman, New York. (available at [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov))
- Voet D and Voet TG, 2008. Biochemistry. Fourth Edition; John Wiley and Sons, New York.
- Murray et al., 2012. Harper's Illustrated Biochemistry. 29th Edition; McGraw-Hill Medical Publishing.
- Ferrier DR, 2013. Lippincott's Biochemistry. 6th Edition; Lippincott Williams & Wilkin Publishing Company.
- Schantz JT, 2007. A Manual for Biochemistry Protocols. World Scientific Publishing. (available online)

### MBI-206 BASICS OF MOLECULAR BIOLOGY (3+0)

#### Course Objectives:

To acquaint students with the chemistry and biology of macromolecules.

**Course Contents:**

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

**Recommended Books:**

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

**THIRD YEAR BS-BIOTECHNOLOGY**

**5<sup>TH</sup> SEMESTER COURSES**

1. BIT 301 Introduction to Biotechnology
2. IMM 302 Immunology
3. MMB 303 Methods in Molecular Biology
4. PBE 304 Principles of Biochemical Engineering
5. BIN 305 Bioinformatics

**BIT-301 INTRODUCTION TO BIOTECHNOLOGY (3+0)**

**Course Objectives:**

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

**Course Contents:**

Biotechnology- definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (food, livestock, fisheries, algae, fungi, etc.); protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world

**Recommended Books:**

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

### IMM-302IMMUNOLOGY (3+0)

#### Course Objectives:

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

#### Course Contents:

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

#### Practical:

Agglutination tests; enzyme-linked immunosorbent assay (ELISA); blood group determination (ABO and Rh); Western blot; Ouchterlony analysis

#### Recommended Books:

- Kuby J, 2007. Immunology. 6th Edition; WH Freeman, New York.
- Janeway et al., 2001. Immunobiology - The immune system in health and disease. 5th Edition; Garland Science Publisher, New York.

- Anderson WL, 1999. Immunology. 1st Edition; Wiley-Blackwell.
- Delves PJ et al., 2012. Roitt's Essential Immunology. 12th Edition. Wiley-Blackwell
- Abbas AK and Lichtman AH, 2010. Basic Immunology: Functions and Disorders of the Immune System. Third illustrated Edition; Saunders Publisher.
- Harlow E and David L, 1988. Antibodies, A laboratory Manual. 1st Edition; Cold Spring Harbor laboratory Press.

### MMB-303 METHODS IN MOLECULAR BIOLOGY (1+2)

#### Course Objectives:

To acquaint students with the experimental aspects of molecular biology

#### Course Contents:

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

#### Practical:

Preparation of stock and working solutions; isolation of nucleic acids and their

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

**Recommended Books:**

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

**PBE-305                      PRINCIPLES                      OF  
BIOCHEMICAL ENGINEERING (2+1)****Course Objectives:**

To acquaint students with fundamentals of biochemical engineering.

**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; bioreactors - continuous stirred tank bioreactors, plug-flow and packed bed bioreactors, imperfect mixing, fed batch bioreactors, gas liquid mass transfer in bioreactors, power requirement for bioreactor, sterilization and heat transfer in bioreactors; introduction to bioproduct recovery; biological product manufacturing; 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 via binding and physical retention; yield coefficient and stoichiometry; production of enzymes by structured and segregated models; 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 Books:**

- Douglas SC and Blanch HW, 1997. Biochemical Engineering. 2<sup>nd</sup> Edition; CRC Publishers.
- Bailey et al., 1986. Biochemical Engineering Fundamentals. 2<sup>nd</sup> Edition; McGraw-Hill
- Aiba et al., 1973. Biochemical Engineering. 2<sup>nd</sup> Edition; Academic Press.
- Katoh S and Yoshida F, 2009. Biochemical Engineering, a textbook for engineers, chemists and biologists. Wiley VCH
- Clark DS and Blanch HW, 1997. Biochemical Engineering, 2<sup>nd</sup>



Edition(Chemical Industries). 2nd Edition;  
CRC Press.

### **BIN-305 BIOINFORMATICS (1+2)**

#### **Objectives:**

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

#### **Course Contents:**

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

#### **Recommended Databases and Tools:**

- NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc.
- Bioedit, Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscrip, Treeview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0 etc.

#### **Recommended Books:**

- Claverie JM and Notredame C, 2006. Bioinformatics for Dummies. 2<sup>nd</sup> Edition; Wiley Publishing.
- Xiong J, 2006. Essential Bioinformatics. 1st Edition; Cambridge University Press.

- Xia X, 2007. Bioinformatics and the Cell: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics. 1st Edition. Springer
- Mathura V and Kanguane P, 2009. Bioinformatics: A Concept-Based Introduction. Springer.
- Mount DW, 2004. Bioinformatics Sequence and Genome Analysis. 2<sup>nd</sup> Edition; Cold Spring Harbor Laboratory Press.
- Sperschneider V, 2008. Bioinformatics: Problem Solving Paradigms. Springer.

### **6<sup>TH</sup> SEMESTER COURSES**

1. GRC 306 Genetic Resources & Conservation
2. MBT 307 Microbial Biotechnology
3. AGB 308 Agriculture Biotechnology
4. FBT 309 Food Biotechnology
5. Elective-I\*
6. RMS 311 Research Methodology & Skill Enhancement

### **GRC-306 GENETIC RESOURCES AND CONSERVATION (3+0)**

#### **Course Objectives:**

To acquaint students with importance of bio-resources and their conservation especially in relation to Pakistan.

#### **Course Contents:**

Introduction to genetic resources and their significance; plant genetic resources utilization, opportunities and constraints; strategic role of plant genetic resources in achieving global food security and sustainable agriculture; overview of wild and domesticated genetic resources of Pakistan; genetic diversity in endangered species; genotype-environment interactions; gene pools and genetic boundaries; genetic drift,

inbreeding, migration and gene flow; introduction to extinction 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 treaties of conservation; quarantine regulations; future prospects of genetic conservation.

**Recommended Books:**

- Primack RB, 2012. A Primer of Conservational Biology. 5th Edition; SinauerAssociates Inc.
- Virchow D, 1999. Conservation of Genetic Resources: Costs and Implications for a Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Springer.
- Mills LS, 2012. Conservation of Wildlife Populations: Demography, Genetics, and Management. 2nd Edition; Wiley-Blackwell.
- Kamau EC and Winter G, 2009. Genetic Resources, Traditional Knowledge and the Law: Solutions for Access and Benefit Sharing. 1st Edition; Earthscan.
- Primack RB, 2010. Essentials of Conservational Biology. 5th Edition; SinauerAssociates Inc.
- Frankham R, 2010. Introduction to Conservation Genetics. 2nd Edition;Cambridge University Press.

**MBT-307 MICROBIAL BIOTECHNOLOGY (3+0)****Course Objectives:**

To acquaint students with how modern methods may be employed to enhance the characteristics of microbes that are commonly used in various industries

including food, agriculture and pharmaceutical.

**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, fermentation, pharmaceutical and other industries; vaccine development and production; microbiological mining, biofuels and use of microbes in petroleum industry; plant-microbe interactions; bio-fertilizers, biopesticides, composting; antimicrobials; significance of microbial biotechnology in the economic development of Pakistan.

**Practical:**

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

**Recommended Books:**

- Glick BR et al., 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition; ASM Press.
- Mukhopadhyay SN, 2004. Process Biotechnology Fundamentals. 2<sup>nd</sup> Edition. Anshan Publisher.
- Goodsell DS, 2004. Bionanotechnology: Lessons from Nature. John Wiley and Sons.
- Ray RC, 2005. Microbial Biotechnology in Agriculture and Aquaculture. NBN International.
- Kreuzer H and Massey A, 2005. Biology and Biotechnology Science, Applications, and Issues. 1st Edition; ASM Press.

- Harding SE, 2010. Biotechnology and Genetic Engineering Reviews. 1<sup>st</sup> Edition. Nottingham University Press.

### **AGB-308 AGRICULTURE BIOTECHNOLOGY (3+0)**

#### **Course Objectives:**

To acquaint students with techniques and skills employed for producing transgenic crops.

#### **Course Contents:**

Agriculture biotechnology and its applications in crop improvements; cell and plant tissue culture methodology; improvement of plants via plant cell culture; plant molecular biomarkers; direct and indirect methods of plant and animal transformation: gene gun method of transformation, Agrobacterium mediated transformation, chloroplast transformation and polyethylene glycol (PEG) mediated transformation; transgenic crops with herbicide, biotic and abiotic stress resistance; problems related to transgenic plants; genetically modified organisms (GMOs); field evaluation and commercialization of GMOs; possible effects of releasing GMOs into the environment; bio-fertilizers, bio-pesticides and their types; non-symbiotic nitrogen fixers; present and future prospects of biofertilizers.

#### **Practical:**

Preparation of Murashige and Skoog medium and stocks of macronutrients, micronutrients, and hormones; selection of ex-plant, medium preparation and callus induction; culturing Agrobacterium and using it to infect plant callus; selection of trans formant's; regeneration of plantlets and acclimatization; plant DNA extraction

and PCR for detecting introduction of foreign DNA into plants.

#### **Recommended Books:**

- Qaim M, 2010. Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Poor. Springer.
- Kemp Ken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
- Herren RV, 2012. Introduction to Agricultural Biotechnology. 2<sup>nd</sup> Edition; Delmar Cengage Learning.
- Slater A, 2008. Plant Biotechnology: The Genetic Manipulation of Plants. 2<sup>nd</sup> Edition; Oxford University Press, USA.
- Altman A, 2011. Plant Biotechnology and Agriculture: Prospects for the 21<sup>st</sup> Century. 1<sup>st</sup> Edition; Academic Press.

### **FBT-309 FOOD BIOTECHNOLOGY (3+0)**

#### **Course Objectives:**

To acquaint students with the role of microorganisms in food and the food industry in addition to principles of enzymology, and food engineering

#### **Course Contents:**

Food composition, probiotics, fermented foods, food enzymes, colors and additives; overview of metabolic engineering of bacteria for food ingredients; techniques used for production of food ingredients by microbes; genetic modification of plant starches for food applications; biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables; microbial foodspoilage and food borne diseases; detection and control of

food borne bacterial pathogens; food safety and quality control; international aspects of quality and safety assessment of food derived by modern biotechnology.

### Practical:

Pure culture study of fermented products such as yogurt, bread, pickles, acetic acid etc.; isolation and handling of microbial flora of fermented products as Lactobacilli, Saccharomyces, Aspergillus, Acetobacter etc.; preparation of fermented products using pure cultures; effect of pH on the microbial flora of different fermented products.

### Recommended Books:

- Joshi VK, 2012. Food Biotechnology. 1st Edition; I K International Publishing House.
- Campbell-Platt G, 2009. Food Science and Technology. 1st Edition; Wiley- Blackwell.
- Singh RP, 2008. Introduction to Food Engineering. 4th Edition; Academic Press
- Belitz HD, 2009. Food Chemistry. 4th Edition; Springer.
- Nielsen SS, 2010. Food Analysis. 4th Edition; Springer.

## ELECTIVE-I COURSES

### VIR-301 VIROLOGY (3+0)

#### Course Objectives:

Aim of this course is to provide a generalized overview of virology as it stands today.

#### Course Contents:

Historical perspective; general properties of viruses; classification and nomenclature; virus structure and assembly; replication cycle and genetics of viruses; animal and plant viruses; propagation, detection and

quantification of viruses; pathogenesis and immune response of viral infections; laboratory diagnosis of viral diseases; vaccines and antiviral drugs; epidemiology; tumorviruses; viral vectors and gene therapy; emerging viruses; specific aspects of selected viral diseases

### Recommended Books:

- Flint et al., 2009. Principles of Virology. ASM Press, USA.
- Lal S, 2007. The Biology of Emerging Viruses. Wiley-Blackwell, USA.
- Carter J Saunders V. Virology: Principles and Applications. First Edition; Wiley.
- Wagner et al., 2007. Basic Virology. Third Edition; Wiley-Blackwell
- Flint SJ, 2009. Principles of Virology, Vol. 2: Pathogenesis and Control. 3<sup>rd</sup> Edition; AMS Press

## CTC-311 CELL AND TISSUE CULTURE (2+1)

### Course Objectives:

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

### Course Contents:

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

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

### Recommended Books:

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

## MOD-312 MOLECULAR DIAGNOSTICS (3+0)

### Course Objectives:

To acquaint students with modern techniques used in molecular diagnostics.

### Course Contents:

Introduction and applications of molecular diagnostics techniques in agriculture and

forensic sciences; polymerase chain reaction (PCR); detection of mutations and single nucleotide polymorphisms (SNPs) by restriction fragment length polymorphisms (RFLPs); DNA sequencing; blotting techniques (e.g., Southern, Northern and Western); enzyme-linked immunosorbant assays (ELISA); immunofluorescence staining and immunohistochemistry; micro-arrays; in situ hybridization; molecular cytogenetics.

### Practical:

ELISA; PCR. Visits to various diagnostic, pathology laboratories and/or research institutes.

### Recommended Books:

- Debnath et al., 2010. Molecular Diagnostics: Promises and Possibilities. Springer
- Deniese D Wilson, 2008. Manual of Laboratory and diagnostic tests. McGraw-Hills publisher.
- Brown TA, 2010. Gene Cloning and DNA analysis. 6th Edition. Wiley- Blackwell Publishing.
- Buckingham et al., 2007. Molecular Diagnostics Fundamentals, Methods, and Clinical Applications. First Edition. FA Davis Publisher.
- Walker JM and Rapley R, 2005. Medical Biomethods Handbook. Humana Press.

## BIS-313 BIOSENSORS (3+0)

### Course Objectives:

To acquaint students with fundamentals of sensors that are capable of specifically detecting minute quantities of various individual biomolecules or those displayed on cellular or viral surfaces.



### Course Contents:

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

### Recommended Books:

- Nielson et al., 2003. Bioreaction Engineering Principles. 2nd Edition; Kluwer Academic / Plenum Publisher, New York.
- Monsi et al., 2011. Fermentation Microbiology and Biotechnology. 3<sup>rd</sup> Edition; CRC Press.
- Bone S and Zaba B, 1992. Bioelectronics. 1st Edition; Wiley.
- Hall EAH, 1991. Biosensors. John Wiley & Sons.
- Koryta J, 1993. Ions, Electrodes and Membranes. 2nd Edition; John Wiley & Sons.

## RMS-311 RESEARCH METHODOLOGY & SKILL ENHANCEMENT (3+0)

### Course Objectives:

To familiarize students with various methods used for conducting research and latest trends in the field of biotechnology through reading and understanding scientific literature, preparing scientific manuscripts,

designing research projects and presenting them.

### Course Contents:

Introduction; unethical academic practices (plagiarism); need of research and research types; extraction and review of literature; identifying a research problem and formulating a hypothesis; designing a study; data collection, interpretation and analysis; writing a research report, project, thesis and/or research article or review; preparing posters; making scientific presentations; intellectual property.

### Recommended Books:

- Bryman A, 2001. Social research methods. 2nd Edition; Oxford University Press.
- Awan JA, 2003. Scientific Presentation. Unitech Communication, Faisalabad, Pakistan.
- Kumar R, Kindersley D, 2010. Research Methodology: A step by step guide for beginners. Third Edition; SAGE Publications.
- Kothari CR, 2004. Research Methodology: Methods and Techniques. Second Revised Edition; New Age International Publishers, New Delhi.
- Durrani SA, 2004. Technical Writing. Higher Education Commission, Islamabad.

## FOURTH YEAR BS-BIOTECHNOLOGY

### 7<sup>TH</sup> SEMESTER COURSES

1. HBT 405 Health Biotechnology
2. SMR 409 Seminar-I
3. EMB 403 Environmental Biotechnology
4. GPR 404 Genomics and Proteomics
5. Elective-II\*
6. RPT 407 Research Project-I

**HBT-405 HEALTH BIOTECHNOLOGY (3+0)****Course Objectives:**

To acquaint students with biotechnology in healthcare including diagnostic tools, immunization and therapeutics.

**Course Contents:**

Introduction to health biotechnology; social acceptance of medical biotechnology; molecular basis of disease; molecular and genetic markers; detection of mutations and infectious agents; active and passive immunization; vaccines (live, killed, recombinant DNA vaccines, subunit vaccines, DNA vaccines, edible vaccines); organ transplantation; applications of transgenic animals (animal models of diseases, farming and enhancement of farm animals); drug delivery systems; blood transfusion and grafting techniques; pharmacogenetics; gene therapy; biopharmaceuticals from plants; stem cell technology.

**Recommended books:**

- Pongracz J. and Keen M. 2009. Medical Biotechnology. 1st Edition; Elsevier Health Sciences.
- Schacter B. Z. 2005. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publishers.
- Chetan DM and Dinesh KP, 2006. Health and Pharmaceutical Biotechnology. Firewall Media.
- Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine). Nova Science Publication.
- Dogramatzis, 2010. Health care Biotechnology. 1st Edition; CRC Press.

**EMB-403 ENVIRONMENTAL BIOTECHNOLOGY (3+0)****Course Objectives:**

To acquaint students with conservation and reclamation of environment through biotechnology

**Course Contents:**

Introduction to environmental biotechnology; fundamentals of biological interventions; genetic manipulation strategies in environmental biotechnology; pollution indicators and pollution control strategies; bioreactors; domestic waste water treatment; industrial effluent treatment; sludge treatment; contaminated land and bioremediation; phytoremediation; landfills and composts; concept of integrated environmental biotechnology; biodegradation and biotransformation of hazardous chemicals; 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 and field study for pollution indicators (e.g., plants, microorganisms and air).

**Recommended Books:**

- Fluker MH, 2010. Environmental Biotechnology. CRC Press.
- Faster CF and Wase J, 2004. Environmental Biotechnolog. John Wiley & Sons.
- Evans GM and Furlong JC, 2010. Environmental Biotechnology Theory and Application. 2nd Edition; Wiley-Blackwell Publishers.

- Srinivas T, 2008. Environmental Biotechnology. 1st Edition; New Age International Publishers.
- Spencer JFT and Spencer ALR, 2004. Environmental Microbiology: Methods and Protocols (Methods in Biotechnology). 1st Edition; Humana Press.
- Hurst et al., 2007. Manual of Environmental Microbiology. 3rd Edition; ASM Publishers.

### **GPR-404 GENOMICS AND PROTEOMICS (3+0)**

#### **Course Objectives:**

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

#### **Course Contents:**

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

interference; proteomics; cellular communication/signalling pathways; protein-protein interactions and validation - yeast two hybrid system, affinity purification-mass spectrometry (AP-MS), tandem affinity purification (TAP) tagging, fluorescence resonance energy transfer (FRET) and coimmunoprecipitation.

#### **Recommended Books:**

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

### **ELECTIVE-II COURSES**

#### **WWT-401 WATER AND WASTE WATER TREATMENT (2+1)**

#### **Course Objectives:**

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

#### **Course Contents:**

Water and wastewater sources and characteristics; drinking water treatment process; industrial effluent treatment process; novel treatment processes and recycling technology; 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; role of microorganisms in waste treatment; utilization and management of waste; microbial characterization.

### Practical:

Designing individual aerobic and anaerobic unit processes; physicochemical characteristics of drinking water and waste water; analytical analysis of drinking and waste water for detecting heavy metals and minerals.

### Recommended Books:

- Metcalf and Eddy, 2003. Waste water Engineering: Treatment, Disposal, and Reuse. 4th Edition; McGraw-Hill.
- Clark N and Crull A, 1997. Bioremediation of Hazardous Wastes, Waste Water and Municipal Waste. Business Communication
- Maier et al., 1999. Environmental Microbiology. Academic Press Inc.
- Bitton G, 2011. Wastewater Microbiology. 4th Edition; Wiley-Blackwell.
- Csuros M and Csuros C, 1999. Microbiological Examination of Water and Wastewater. 1st Edition; CRC Press.

## HWM-402 HOSPITAL WASTE MANAGEMENT (2+1)

### Course Objectives:

To acquaint students with the principles and applications of clinical waste management.

### Course Contents:

An introduction to the management of infectious materials/waste; various types of infectious material and methods of their handling and disposal; laboratory and

hospital acquired infections - possible sources and causes; hazardous microorganisms; basic containment rules and laboratory contamination levels, control measures; guidelines for workers in microbiology and pathology labs, and post-mortem rooms; rules for safe conduct during field work and outdoor activities; risk assessment including recognition of hazards; competence and elimination of hazards; collection of data, etc.; risk group personnel and their education, training and monitoring; radiation hazards and disposal of radioactive waste.

### Practical:

Techniques for waste minimization; waste sorting; anaerobic and aerobic composting; industrial and hospital waste treatment processes.

### Recommended Books:

- LaGrega et al., 2001. Hazardous Waste Management. 2nd Edition; McGraw- Hills.
- McDougall et al., 2001. Integrated Solid Waste Management: A Life Cycle Inventory. 2nd Edition; Blackwell Publishers.
- WHO Biosafety Manual, World Health Organization, 2001. WHO, Geneva.
- Garvin ML, 1995. Infectious Waste Management: A Practical Guide. Lewis Publishers, Inc.
- Wayne LT, 1995. Biohazardous Waste: Risk Assessment, Policy, and Management. Lewis Publishers, Inc.
- Hickman HL and Anderson WC, Principles of Integrated Solid Waste Management. MSW Management

### **RAB-403 RADIOBIOLOGY (3+0)**

#### **Course Objectives:**

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

#### **Course Contents:**

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

#### **Practical:**

To enhance awareness of radiation use, visits to different medical centers/hospitals will be arranged for students for studying different types of radiation in use for treating various conditions; visit to different stations/offices where any type of radio waves, electromagnetic waves etc. are in continuous use and collecting data about any harmful effects.

#### **Recommended Books:**

- Wambersie A, 2007. Introduction to Radiobiology. Tylor and Francis.
- Nias AHW, 2007. Introduction to Radiobiology. Academic Press.
- Forshier CM, 2008. Essentials of Radiation, Biology and Protection. 2<sup>nd</sup> Edition. Cengage Learning Press

- Washington CM, 2009. Principles and Practice of Radiation Therapy. Elsevier Health Sciences
- Dder Kogel AV and Joiner M, 2009. Basic Clinical Radiobiology. 4th Edition; A Hodder Arnold Publication

### **BFB-404 BIOFUELS AND BIOREFINERIES (3+0)**

#### **Course Objectives:**

To acquaint students with the sources of biomass and their extraction and processing for common use.

#### **Course Contents:**

Biofuels - introduction, types and sources; agro-industrial byproducts and biodegradable materials; genomics of biofuels; metabolic engineering; biorefineries; biobased industrial products; basics of green bio-refineries; agriculture, forestry and primary refinery raw material; lingo-cellulosic feedstock bio-refinery; whole-crop bio-refinery based on wet/dry milling and products from whole-crop bio-refinery; fundamental sugar platform and syngas platform.

#### **Recommended Textbooks:**

- Kamm et al., 2006. Biorefinery-Industrial Processes and Products Status Quo and Future Directions. Wiley-VCH.
- Meroehr, 2001. Biotechnology of Ethanol. Wiley-VCH
- Verts et al., 2010. Biomass to Biofuels: Strategies for Global Industries. 1<sup>st</sup> Edition; Wiley.
- Lee S and Shah YT, 2012. Biofuels and Bioenergy: Processes and Technologies (Green Chemistry and Chemical Engineering). First Edition; CRC Press.



### 8<sup>TH</sup> SEMESTER COURSES

1. Elective-III\*
2. Elective-IV\*
3. SEM 410 Seminar-II
4. IMB 404 Industrial Biotechnology
5. RPT 408 Research Project-II
6. BET 406 Biosafety & Bioethics
7. INT 407 Internship (9 weeks non-credit hrs)

### ELECTIVE-III COURSES

#### MBT-410 MARINE BIOTECHNOLOGY (3+0)

##### Course Objectives:

To acquaint students with recent advancements in the field of marine biotechnology and how molecular techniques may be applied for studying marine organisms.

##### Course Contents:

Introduction to marine microorganisms and marine biotechnology; marine flora/phytoplankton; aquaculture techniques; marine microbes of biotechnological importance; primary and secondary metabolites (e.g., antibiotics, organic acids, toxins, etc); role of marine microbes in global carbon cycling; genomics of marine organisms; recent progress in discovery of drugs and enzymes from marine sources.

##### Recommended Books:

- Gal YL, 2010. Marine Biotechnology I (Advances in Biochemical Engineering Biotechnology). Springer.
- Gal YL, 2010. Marine Biotechnology II (Advances in Biochemical Engineering Biotechnology). Springer.

- Kim SK, 2011. Handbook of Marine Microalgae: Biotechnology and Applied Physiology. 1st Edition; Wiley.
- Johansen MN, 2011. Microalgae: Biotechnology, Microbiology and Energy. Nova Science Pub Inc.
- Buchholz R, 2012. Microalgae Biotechnology. Walter De Gruyter Inc.
- Gal YL 2010. New Developments in Marine Biotechnology. Springer

#### ABT-411 ANIMAL BIOTECHNOLOGY (2+1)

##### Course Objectives:

To acquaint students with techniques for engineering transgenic animals and embryonic micromanipulations.

##### Course Contents:

Introduction and history of transgenic animals; role of synthetic peptides/proteins in animal health; use of monoclonal antibodies as a diagnostic/therapeutic agents; cytokines and their potential therapeutic value as applicable to the diagnosis of microbial infections; micromanipulations of farm animal embryos; use of biotechnological techniques in animal breeding strategies; gene transfer through embryo microinjection; ethical and social issues in animal biotechnology.

##### Practical:

Aquaculture methods and various DNA recombinant techniques for animal biotechnology.

##### Recommended Books:

- Freshney IR, 2010. Culture of animal cells: A manual of basic techniques and

specialized application. 6th Edition; Wiley-Blackwell

- Masters JR, 2000. Animal cell culture. 3rd Edition; Oxford University Press.
- Lanza et al., 2001. Methods of tissue engineering Academic Press Inc.
- Doyle et al., 1998. Cells and tissue culture: Laboratory procedures in biotechnology. Wiley, John and Sons.
- Barnum S, 2004. Biotechnology: An Introduction (with Infotrac) Brooks/Cole.
- Tourte Y and Catherine TC, 2005. Genetic Engineering and Biotechnology: Concepts, Methods, and Agronomic Applications. Science Publishers.
- Houdebine LM, 2003. Animal Transgenesis and Cloning. 1st Edition; JohnWiley and Sons.

### **FBT-412 FUNGAL BIOTECHNOLOGY (3+0)**

#### **Course Objectives:**

To acquaint students with the understanding of fungi and their utilization in industry and agriculture

#### **Course Contents:**

Introduction to mycology; production techniques used in fungal biotechnology; metabolites produced by fungi; utilization of fungi in medical and agricultural biotechnology; industrial uses of fungi including food manufacturing; bio-deterioration and biodegradation; biotechnology and the control of pathogenic fungi; current applications of fungal biotechnology and screening of fungal metabolites; mycotoxins.

#### **Practical:**

Fungal morphology; identification of fungi; sexual and asexual reproductive structures

of fungi; DNA extraction from hyphae and zoospores; molecular techniques for detecting genetic variations among different fungi.

#### **Recommended Books:**

- Tkacz JS and Lange L, 2004. Advances in fungal Biotechnology for Industry, Agriculture and Medicine. 1st Edition; Springer.
- Arora et al., 2003. Fungal Biotechnology in Agricultural, Food and Environmental Applications. 1st Edition; CRC Press.
- An Z, 2004. Handbook of Industrial Mycology. 1st Edition; CRC Press
- Sati SC, 2007. Recent Mycological Research: Fungal Biotechnology. IK International Publishing House.
- Rai M, 2009. Advances in Fungal Biotechnology. IK International PublishingHouse
- Carlile et al, 2001. The Fungi. 2nd Edition; Academic Press
- Arora et al., 2003. Handbook of Fungal Biotechnology. 2nd Edition; CRC Press.
- Oliver RP and Schweizer M, 1999. Molecular Fungal Biology. 1st Edition; Cambridge University Press.
- Frisvad et al., 1998. Chemical Fungal Taxonomy. 1st Edition; CRC Press.

### **ELECTIVE-IV COURSES**

#### **PBT-413 PHARMACEUTICAL BIOTECHNOLOGY (3+0)**

#### **Course Objectives:**

To familiarize students with the general process of drug development, basic concepts of biopharmaceuticals and how they are better than conventional drugs.

**Course Contents:**

Introduction and basic concepts of pharmaceutical biotechnology; properties of an effective drug; drug development process; selection of a lead molecule from available pool, lab scale studies, pilot scale studies and clinical trials (Phase I, II and III); drug toxicity; impact of genomics and other related technologies on drug discovery; use of DNA and protein microarrays in identification of disease targets and for monitoring effectiveness of drugs; pharmacogenomics; plants and microorganisms as sources of drugs; polymers: classification, polymerization and characterization; controlled drug release system and its advantages and disadvantages over conventional release methods; legal and regulatory issues.

**Recommended Books:**

- Kayser O, 2012. Pharmaceutical Biotechnology: Drug Discovery and Clinical Application. 2nd Edition; Wiley-Blackwell.
- Kokate C, 2012. Textbook of Pharmaceutical Biotechnology. ELSEVIER
- Crommelin et al., 2007. Pharmaceutical Biotechnology: Fundamentals and Applications. 3rd Edition. Informa Healthcare.
- am Ende DJ, 2010. Chemical Engineering in the Pharmaceutical Industry: R&D to Manufacturing. 1st Edition; Wiley
- Subramanian G, 2012. Biopharmaceutical Production Technology. 1<sup>st</sup> Edition. Wiley-VCH.

**NBT-414  
(3+0)****NANOBIOTECHNOLOGY****Course Objectives:**

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

**Course Contents:**

Introduction; interface between nanotechnology and bio-nanotechnology; manipulating molecules; carbon fullerenes and nanotubes; non-carbon nanotubes and fullerene-like materials; quantum dots; nanowires, nanorods and other nanomaterial's; magnetic nanoparticles; natural biological assembly at the nanoscale and nanometric biological assemblies (complexes); nanobionics and bio-inspired nanotechnology; applications of biological assemblies in nanotechnology; medical, cosmetics, agriculture, water and other applications of nano-biotechnology; future prospects of nano-biotechnology; use of nanotechnology for diagnosing and curing disease.

**Recommended Books:**

- Gazit E, 2007. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. 1st Edition; Imperial College Press.
- Renugopalakrishnan V and Lewis RV, 2006. Bio-nanotechnology: Proteins to Nano devias. Springer.
- Greco et al., 2004. Nano Scale Technology in Biological Systems. CRC Press.
- Mirkin CA and Niemeyer CM, 2007. Nano-biotechnology II: More Concepts and Applications. John Wiley & Sons.
- Niemeyer CM and Mirkin CA, 2004. Nano-biotechnology. 1st Edition; Wiley VCH.

### **FBT-415                      FERMENTATION BIOTECHNOLOGY (2+1)**

#### **Course Objectives:**

To acquaint students with theoretical and experimental techniques used for fermentation.

#### **Course Contents:**

Overview of fermentation technology: definition, economics, applications; strain development and improvement: isolation of microorganisms - plating, criteria for selection and improvement through genetic engineering; growth requirement of various organisms and media preparation; stoichiometry of microbial growth; preparation of inoculum; microbial growth kinetics in batch culture; continuous culture; sterilization: modes & kinetics of sterilization, design of batch and continuous sterilization process, air sterilization & theory of fibrous filters; fluid rheology: classification, Newtonian & non-Newtonian factors effecting KLa in fermentation vessel; design of bioreactors and configuration for free and immobilized cells; waste treatment; tissue engineering for plant and animal cell cultures; aeration and agitation; product recovery; scaling-up of fermentation process

#### **Practical:**

Initiation of a bacterial/plant or animal cell/tissue culture in a simple conical flask or in a fermenter depending on availability and its handling according to the techniques introduced in theory as sterilization, media formulation, growth kinetics, product recovery etc.

#### **Recommended Books:**

- Doran PM, 2012. Bioprocess Engineering Principles. 2<sup>nd</sup> Edition; Academic Press.

- McNeil B, 2008. Practical Fermentation Technology. John Wiley & Sons
- El-Mansi et al., 2007. Fermentation Microbiology and Biotechnology. CRC Press.
- Shuler ML and Kargi F, 2002. Bioprocess Engineering: Basic concept. Prentice Hall.

### **IMB-404                      INDUSTRIAL BIOTECHNOLOGY (3+0)**

#### **Course Objectives:**

To provide students with a broad-based introduction to the field of industrial biotechnology.

#### **Course Contents:**

Industrial biotechnology – introduction and scope; microorganisms commonly used in industry; media and nutritional requirements of industrial organisms; screening for productive strains and strain improvement; culture collections; fermentation and fermenters; extraction of fermented products; production of beer, wines, spirits and vinegar; use of single cell proteins as food products; biocatalysts; microbial insecticides; production of metabolites: organic acids and amino acids; vaccines and antibiotic production.

#### **Practical:**

Isolation of lactobacillus from dairy products, fruit juices, etc.; fermentation of different sugars by bacteria (or other microorganisms); identification of proteases/ amylases producing bacteria; extraction of hydrolytic crude enzymes from microbes; effect of environmental factors (e.g., pH, temperature, salt, etc.) on activity of crude enzymes.

**Recommended Books:**

- Okafor N, 2007. Modern Industrial Microbiology and Biotechnology. 1<sup>st</sup> Edition; Science Publishers, USA.
- Waites et al., 2001. Industrial Microbiology: An Introduction. Blackwell Science Ltd.
- Shara et al., 2009. Industrial Biotechnology. 1<sup>st</sup> Edition; Nova Science Publishers.
- Abhilasha MS, 2009. Industrial Biotechnology. ANE Books.
- Singh R and Ghosh S, 2004. Industrial Biotechnology. Global Vision Publishing House.

**BET-406 BIOSAFETY AND BIOETHICS (2+0)**

**Course Objectives:**

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

**Course Contents:**

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

**Recommended Books:**

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

