

Criterion 1: PROGRAM, OBJECTIVES AND OUTCOMES

Introduction:

In spite of their very small size, the impact of microbes on the planet is so extensive that life without them is almost impossible. Microbiology is an exceptionally diverse science which deals with the study of microorganisms in relation to disease, industry, medicine, environment and modern biotechnology. The study of microorganisms cannot be overemphasized as they are necessary for the production of bread, cheese, antibiotics, vitamins, organic acids, enzymes, biologics, sera and vaccines. Over and above, microbes also serve as the basis and the major tools in the fields of Molecular Biology, Modern Biotechnology and Genetic Engineering. They are indispensable components of our ecosystem. Unfortunately some microbes cause all the known diseases in humans, animals and plants causing heavy morbidity and mortality.

Department of Microbiology is one of the newly established departments in Government College University Faisalabad. It was established in November 2011 for the teaching of undergraduate & post graduate courses and research in the field of Microbiology. Initially a 4-year BS Microbiology program was started in 2011 and later on 2-year M. Phil Program in Microbiology was also launched in Fall 2012 followed by PhD in Microbiology in Fall 2014. Currently department has 17 highly competent and skillful faculty members striving hard to achieve the highest level of excellence for this relatively newly established department under the able guidance of Prof. Dr. Muhammad Hidayat Rasool. Department of Microbiology is focusing on academic and research collaborations with different National and International teaching and research institutes as well as with local industries through internship programs and combined research projects. The key focus is to conduct applied and problem solving research in various fields of this broad discipline of Microbiology.

Microbiology is a broad discipline which has both basic and applied aspects. Many microbiologists are interested primarily in the biology of the microorganisms themselves whereas others may be interested in particular functional processes. Some microbiologists may have an applied orientation and would be interested in practical problems in the fields of medical, pharmaceutical, food, dairy and public health Microbiology. With WTO agreement in offering, every agro-based industry and the industry involved in production and export of biopharmaceuticals, biologics, vaccines, sera and diagnostics will be required to hire a Microbiologist / Immunologist at its strength to satisfy ISO certification needs. Therefore the graduates and post graduate students from Department of

Microbiology; Government College University Faisalabad will have a very bright and attractive career ahead in public as well as private sector.

Standard 1.1:

Mission:

The mission of BS Program in Microbiology within the Department of Microbiology at Government College University Faisalabad, Pakistan is to provide students with a comprehensive background in the field of Microbiology

For this, undergraduate students are introduced to wide range of specialties including bacteriology, virology, clinical microbiology, immunology, microbial genetics, molecular biology, veterinary microbiology, environmental and applied microbiology.

Vision:

The knowledge of the theoretical and practical aspects of Microbiology is exigent for the development of the country; therefore our vision is to produce knowledgeable, skilled and competent microbiologists, trained in all fields of microbiology particularly for the academic world, research arenas, food & pharmaceutical industry, hospitals and clinical & diagnostic laboratories.

Program Objectives:

- To create an environment conducive for learning through quality teaching and research.
- To produce competent and skilled professionals in the field of Microbiology to full fill the future needs of educational institutes.
- To prepare researchers to meet the challenges of industry, research organizations, science and technology.
- To develop the department as a model department of Microbiology in the country for undergraduate and postgraduate teaching and research.

Standard 1.2:

Program Outcomes:

1. To produce highly skillful and competent professionals.
2. To fulfil the needs of industry and academia in the field of Microbiology.
3. To produce ideal environment for teaching and research for the students.

Standard 1.3:

The courses of BS Microbiology program are revised every three years as per university and HEC rules and approved from University Statutory Bodies including Departmental Board of Studies, Board of Faculty and Academic Council. The BOS of Department of Microbiology comprises of following members.

- A. Prof. Dr. Muhammad Hidayat Rasool (Convener)
Chairman,
Department of Microbiology, Government College University, Faisalabad.
- B. Professor(s) and Associate Professor(s) of the Department
Nil
- C. Two Experts (Nominated by the Vice Chancellor)
 - a. Prof. Dr. Sajjad-ur-Rahman (Member)
Director, Institute of Microbiology, University of Agriculture, Faisalabad
 - b. Dr. Mudasser Habib (Member)
Principal Scientist / Microbiologist, Animal Science Division, NIAB, Faisalabad
- D. Three Teachers / Experts other than University teachers
 - a. Prof. Dr. Aftab Ahmad Anjum (Member)
Department of Microbiology, University of Veterinary and Animal Sciences, Lahore
 - b. Dr. Muhammad Salah-ud-Din (Member)
Senior Scientist / Microbiologist, Animal Science Division, NIAB, Faisalabad
 - c. Dr. Muhammad Ashraf (Member)
Assistant Professor, Institute of Microbiology, University of Agriculture, Faisalabad
- E. Assistant Professor of the Department
 - a. Dr. Muhammad Asif Zahoor (Member)
Assistant Professor, Department of Microbiology, Government College University, Faisalabad
- F. Lecturer of the Department
 - a. Dr. Muhammad Usman Qamar (Member)
Lecturer, Department of Microbiology, Government College University, Faisalabad

Standard 1.4:

Department of Microbiology, Government College University, Faisalabad

a) Student enrolment:

Year	Undergraduate	Student faculty ratio	Average GPA
2011	54	11:1	-
2012	56	5:1	-
2013	62	7:1	-
2014	70	4:1	-
2015	106	6:1	-
2016	83	5:1	-
2017	123	8:1	-
2018	100	8:1	-

b) Overall performance of the department:

	Journal publication (HEC recognized only)	Ongoing projects	Faculty awarded excellence in research award	Conference publication
Total No.	70	11	Nil	35

Criterion 2: CURRICULUM DESIGN AND ORGANIZATION

Currently Department of Microbiology is offering three programs i.e. BS Microbiology (Undergraduate) and M.Phil Microbiology & PhD Microbiology (Post-graduate). The curriculum of Undergraduate Program has been designed keeping in view the guidelines of Higher Education Commission (HEC) and Government College University, Faisalabad.

BS Microbiology

Semester # 1

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-301	3(2-1)	Core	-
2	MIC-303	3(3-0)	Core	-
3	BOT-301	4(3-1)	Core	-
4	BCH-301	4(3-1)	Core	-
5	PST-321	2(2-0)	-	Pakistan Studies
6	ENG-321	3(3-0)	-	English
7	ISL-321	2(2-0)	-	Islamic studies
8	ISL-322	2(2-0)	-	Ethics (For Non-Muslims)

Semester # 2

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-302	3(3-0)	Core	-
2	MIC-304	3(2-1)	Core	-
3	MIC-306	3(2-1)	Core	-
4	ZOL-301	4(3-1)	Core	-
5	ENG-322	3(3-0)	-	English

6	MTH-321	3(3-0)	-	Mathematics
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Semester # 3

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-401	3(2-1)	Core	-
2	MIC-403	3(2-1)	Core	-
3	MIC-405	3(2-1)	Core	-
4	MIC-407	3(2-1)	Core	
5	ENG-422	3(3-0)	-	English
6	CSI-421	3(2-1)	-	Computer Application

Semester # 4

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-402	3(2-1)	Core	-
2	MIC-404	3(2-1)	Core	-
3	MIC-406	3(2-1)	Core	-
4	MIC-408	3(3-0)	Core	-
5	MIC-410	2(0-2)	Core	-
6	STA-507	3(3-0)	-	Biostatistics

Semester # 5

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-501	3(2-1)	Core	-
2	MIC-503	3(2-1)	Core	-
3	MIC-505	3(3-0)	Core	-
4	MIC-507	3(2-1)	Core	-
5	MIC-509	3(2-1)	Core	-
6	MIC-511	3(2-1)	Core	-

Semester # 6

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-502	3(2-1)	Core	-
2	MIC-504	3(2-1)	Core	-
3	MIC-506	3(2-1)	Core	-
4	MIC-508	3(2-1)	Core	-
5	MIC-510	3(3-0)	Core	-
6	BIN-422	3(2-1)	-	Bioinformatics

Semester # 7

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-601	3(3-0)	Core	-
2	MIC-603	3(2-1)	Core	-
3	MIC-605	3(2-1)	Core	-
4	MIC-607	4(3-1)	Core	-
5	MIC-609	3(2-1)	Core	-
6	MIC-611	2(2-0)	Core	-

Semester # 8

S. No.	Course No.	Credit hours	Core / Elective course	Others
1	MIC-631	3(0-3)	Core	Project
2	MIC-632	3(0-3)	Core	Internship

Standard 2-1:

Courses	Objectives			
BS Microbiology	1	2	3	4
	Strongly	Strongly	Strongly	Moderately

Standard 2-2:

Elements	Courses
Theoretical background	MIC-301, MIC-302, BCH-301, BOT-301, MIC-302, MIC-304, MIC-306, ZOL-301, MIC-401, MIC-402, MIC-403, MIC-404, MIC-405, MIC-406, MIC-407, MIC-408, MIC-410
Problem analysis	MIC-501, MIC-503, MIC-505, MIC-507, MIC-509, MIC-511, BIN-422
Solution Designee	MIC-502, MIC-504, MIC-506, MIC-508, MIC-510, MIC-601, MIC-603, MIC-605, MIC-607, MIC-609, MIC-611

Standard 2-3:

The life sciences offer opportunities for revolutionizing human welfare activities. Enriched by inputs from genomic research, biotechnology is a major force for development in all countries. Entwined with culture and socio-ethical values, microbiology contributes to solving problems of multiple directions that impede national development. The lack of facilities and professional skills in microbiology limits R&D initiatives in the development of a country. Microbiology is an exceptionally broad discipline encompassing specialties as diverse as biochemistry, cell biology, genetics, taxonomy, pathogenic bacteriology, food and industrial microbiology, and ecology. A microbiologist must be acquainted with many biological disciplines and with all major groups of microorganisms: viruses, bacteria, fungi, algae, and protozoa

Program	Math & Basic	Engineering	General Topics	Others / Bio
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	Sciences	Topics		Sciences
BS Microbiology	21	Nil	Nil	114

Standard 2-4:

The curriculum for the BS Microbiology has been designed keeping in view the guidelines of Higher Education Commission (HEC) and fulfills its major requirements. It satisfies the core requirements of courses including theoretical background & its applied aspects along with IT contents and oral & written communication skills.

Standard 2-5:

In order to harness the skills and expertise of the learners at the highest possible level in the field of Microbiology, the proposed curriculum covers the all aspect of microbiology. By bringing international compatibility to the qualification held from Pakistani universities/DAIs for promotion of student's mobility and job seekers around the globe, we can achieve the desirable results in co-ordinate scale. The unified template was aimed to augment the knowledge base for several multidisciplinary subjects in addition to the main discipline of study. Furthermore, the curriculum fulfills all the requirements laid down by Higher Education Commission (HEC) for the award of degree i.e. BS Microbiology.

Standard 2-6:

Course	IT Contents
CSI-321	Introduction to Computing Application,

Standard 2-7:

Course	Oral and Written Communication skills
ENG-321, ENG-322, ENG-422,	Functional English, English Comprehension and Composition, Technical Writing

Criterion 3: LABORATORIES AND COMPUTING FACILITIES

Lab title	Undergraduate Lab-I, Under-graduate Lab-II, Post-graduate Research Lab I, Post-graduate Research Lab II, Post-graduate Research Lab III and Post-graduate Research Lab IV
Location and area	Liaquat Block, 2 nd Floor, Department of Microbiology
Objectives	To enable students to understand Basic as well as modern techniques used in Microbiology
Adequacy of Instruments	The purchase of basic, modern and sophisticated research instruments is in process for postgraduate research laboratories under the PARF Project. About 30 equipment had already been received in the Department.
Courses taught	MIC-301, MIC-302, MIC-303, MIC-304, MIC-305, MIC-306, MIC-401, MIC-402 etc
Software available	Not applicable
Major apparatus	Bio-Safety cabinet, Vertical and Horizontal Laminar air flow, Thermal Cyclers, Vertical and Horizontal Gel Electrophoresis, Gel Documentation System, ELISA reader etc.
Major equipment	Incubator, Orbital shaker, Centrifuge, Refrigerator, Microscopes (Binocular, Dark Field, Phase Contrast, Fluorescent), Autoclave, Colony Counter, Hot air Oven, Water distillation unit etc.
Safety regulation	Precautionary measures/ Biosafety rules in the laboratories are strictly followed

Standard 3.1:

The laboratory manuals to carry out different microbiological procedures and instructions for the use of instruments are available and accessible to both faculty members as well as students.

Standard 3.2:

Currently only one laboratory attendant is available in the department.

Standard 3.3:

Total numbers of computers for students	50 (facility is available in central computer lab of the block)
Total numbers of computers for faculty	6
Number of computers with internet facility	6
Total numbers of printers	5

Criterion 4: STUDENT SUPPORT AND ADVISING

Standard 4-1:

Type of course	Courses offered BS	Repetition of courses (term-wise)
Major	36	-
Minor	10	-
Elective	Nil	-

Standard 4-2 & Standard 4-3:

Questions	Completely	To some extent	No
To ensure effective interaction b/w student and faculty	Yes		
To inform the students about program requirements	Yes		
To exist students-advising system (Effectively)	Yes		
To ensure student (professional) counseling system	Yes		

Criterion 5: PROCESS CONTROL

Standard 5-1: Admission criteria

Department of Microbiology	Condition/ Criteria/ Policy
Admission	At least 45% marks in F. Sc (Pre Medical) as per university rules
Transfer of students from outside university	As per University rules

Standard 5-2: Student registration criteria

Process	policy/Criteria
Process by which students are registered	As per university rules
Monitoring of the students' Academic Progress	The work and progress of individual students are monitored through the advisory committees of the department.
Both process are evaluated	As per university rules

BS Microbiology

GENERAL GUIDELINES FOR ADMISSION IN BS MICROBIOLOGY

1. The BS Microbiology program is of four years (Eight semester) duration.
2. There are 46 courses for BS Microbiology program. During the first seven semesters, there will be six courses per semester. In addition to this, the 8th semester will be accomplished with an Internship and Project of 6 credit hours. Where ever needed (as mentioned in detailed curriculum), the course will consist of a theory and a practical paper. The total credit hours for BS Microbiology program will be 135.
3. Each credit hour will be of 20 marks. The evaluation of the theory paper will be done according to the following formula:

Mid Exam = 30 % of the total marks

Final Exam = 50% of the total marks

Class assessment = 20% of the total marks

The pass percentage and divisions shall be as for other BS programs of the Government College University Faisalabad.

4. Eligibility criteria

(a) The admission to BS Microbiology program will be as per guidelines of Government College University Faisalabad and Higher Education Commission (HEC), Pakistan.

(b) The candidate should have passed FSc. (Pre Medical/Agriculture) or equivalent certificate in biological sciences from a recognized Board/University with at least second division (45%) or equivalent grade. Fresh candidates will be preferred for admission.

(c) The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the admission will be purely provisional subject to the condition that he/she has to produce a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

5. The tuition fee and other charges will be as per University rules.

6. Note: The basic frame work for courses of BS Microbiology is same as recommended by HEC for BS (4Year Program).

HEC Criteria

1. Total numbers of Credit hours = 133
2. Duration = 4 years
3. Semester duration = 16-18 weeks
4. Semesters = 8
5. Total credit hours per semester = 15-18 Cr hr.
6. Number of courses per semester = 4-6

Standard 5.3: Recruitment of faculty members

Faculty	Policy	Process
Recruitment	As per HEC guidelines and University statutes.	Through proper advertisement followed by selection board and approval from syndicate.
Evaluation	As per HEC guidelines, evaluation by student through QEC, TTS evaluation committee and foreign evaluation by subject experts.	Online Evaluation by students (At the end of each semester)
Training	Nil	Nil

Criterion 6: FACULTY

Standard 6-1:

Program Area	Number of faculty members in each area	Number of faculty with Ph.D Degree
BS	14	10

Standard 6-2:

Standards	Y/N/To some extent
Faculty resume has prepared in line with HEC	Yes
Full time faculty have sufficient time for scholarly activities and professional development	Yes
Any faculty development program is conducted	No
Faculty programs are evaluated	Yes
Evaluation results of faculty are used for improvements	Yes

Standard 6-3:

Out of 14 faculty members 10 holds PhD degree and all the faculty members are fully motivated and devoted for the betterment and excellence in the field of Microbiology.

Criterion 7: INSTITUTIONAL FACILITIES

Standard 7-1:

University is managing to have basic facilities and infrastructure which support the recent trends in learning in the form of e-learning with the conference hall facility available for interactive learning.

Standard 7-2:

Currently, no departmental library is available in the department of microbiology, but recently about 500 books have been purchased and are being maintained in central library of the university.

Standard 7-3:

Sr.no	Issues/Items	Total	Remarks
1	Departmental infrastructure to support new trends in learning	-	Well developed and in the process of equipping Labs
2	The library an up-to-date possess technical collection relevant to the program	489	Fulfills basic requirement of BS Microbiology
3	Class rooms for students	4	
4	Labs	2 Undergraduate 4 Postgraduate	
5	Computer labs	None	Not available
6	Offices for faculty	10	

Criterion 8: INSTITUTIONAL SUPPORT

Standard 8-1:

Level of adequacy regarding institutional support	Items/Issues	Remarks
Secretarial support	Not available	Not sufficient
Technical staff	1 (Staff members)	Not sufficient
Office equipment	6 computer 6 printer	Not sufficient

Standard 8-2:

Year	Undergraduate	Student faculty ratio
2011	54	11:1
2012	56	5:1
2013	62	7:1
2014	70	4:1
2015	106	6:1
2016	83	5:1
2017	123	8:1
2018	100	8:1

Standard 8-3:

Resources	Items	Quantities	Remarks
Library	Books	489	Sufficient
	Journals	Nil	
	Microfilms	Nil	
Laborites(computer Lab)	Computers	6	Insufficient
	Printers	6	
	scanner	2	
Computing facilities	Internet	4	sufficient
	Software (BMDP,SPSS)	Nil	

COURSE OUTLINES

Semester 1			
S. No	Course Code	Course Title	Credit Hour
1	MIC-301	Introductory Microbiology	3(2-1)
2	MIC-303	Microbial Taxonomy	3(3-0)
3	BCH-301	Introductory Biochemistry	4(3-1)
4	BOT-301	Diversity of Plants	4(3-1)
5	ISL-321	Islamic Studies	2(2-0)
6	ISL-322	Ethics (For Non-Muslim only)	2(2-0)
7	PST-321	Pakistan Studies	2(2-0)
8	ENG-321	Functional English	3(3-0)
		Total Credit	21
Semester 2			
S. No	Course Code	Course Title	Credit Hour
1	MIC-302	Cell Biology	3(3-0)
2	MIC-304	Microbial Anatomy and Physiology	3(2-1)
3	MIC-306	Human Physiology	3(2-1)
4	ZOL-301	Principles in Animal Life-I	4(3-1)
5	ENG-322	English Comprehension and Composition	3(3-0)
6	MTH-321	Algebra and Trigonometry	3(3-0)
		Total Credit	19

Semester 3			
S. No	Course Code	Course Title	Credit Hour
1	MIC-401	Basic Pathology	3(2-1)
2	MIC-403	Bacteriology	3(2-1)
3	MIC-405	Mycology	3(2-1)
4	MIC-407	Biosafety and Risk Management	3(2-1)
5	ENG-422	Technical Writing	3(3-0)
6	CSI-321	Introduction to Computing Applications	3(2-1)
		Total Credit	18
Semester 4			
S. No	Course Code	Course Title	Credit Hour
1	MIC-402	General Virology	3(2-1)
2	MIC-404	Immunology	3(2-1)
3	MIC-406	Parasitology	3(2-1)
4	MIC-408	Epidemiology, Public Health and Bioethics	3(3-0)
5	MIC-410	Laboratory Animals and Model Organisms	2(0-2)
6	STA-507	Biostatistics	3(3-0)
		Total Credit	17

Semester 5			
S. No	Course Code	Course Title	Credit Hour
1	MIC-501	Systemic Virology	3(2-1)
2	MIC-503	Cell and Tissue Culture	3(2-1)
3	MIC-505	Microbial Genetics	3(3-0)
4	MIC-507	Molecular Biology and Biotechnology	3(2-1)
5	MIC-509	Food Microbiology	3(2-1)
6	MIC-511	Infectious Waste Management	3(2-1)
		Total Credit	18
Semester 6			
S. No	Course Code	Course Title	Credit Hour
1	MIC-502	Vaccinology	3(2-1)
2	MIC-504	Environmental Microbiology	3(2-1)
3	MIC-506	Medical Microbiology	3(2-1)
4	MIC-508	Veterinary Microbiology	3(2-1)
5	MIC-510	Microbial Enzymology	3(3-0)
6	BIN-422	Introduction to Bioinformatics	3(2-1)
		Total Credit	18

Semester 7			
S. No	Course Code	Course Title	Credit Hour
1	MIC-601	Diagnostic Microbiology	3(2-1)
2	MIC-603	Soil and Agricultural Microbiology	3(2-1)
3	MIC-605	Marine and Fresh Water Microbiology	3(2-1)
4	MIC-607	Pharmaceutical and Industrial Microbiology	4(3-1)
5	MIC-609	Genetic Engineering	3(2-1)
6	MIC-611	Research Methodology	2(2-0)
		Total Credit	18
Semester 8			
S. No	Course Code	Course Title	Credit Hour
1	MIC-631	Project	3(0-3)
2	MIC-632	Internship	3(0-3)
		Total Credit	6
		Grand Total	135

MIC-301 Introductory Microbiology 3(2-1)

Course Title	Introductory Microbiology
Course Code	MIC-301
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Hidayat Rasool
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Learning Objectives of the Course

1	Course is designed to introduce students to the Science of Microbiology and microorganisms.
2	To give them an overview about the microbial world, scope and branches of microbiology and basic knowledge of different microorganisms.
3	To theoretically and practically equip them with basic techniques used in Microbiology.
4	To impart some preliminary knowledge about how to control microbial life and brief overview of antimicrobial agents and antimicrobial drug resistance.
5	After this course students will be able to understand the detail knowledge and techniques with respect to different microorganisms during specific courses in future semesters.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction and scope of Microbiology
	Lecture-2	Branches of Microbiology and an overview of Microorganisms
	Practical-1	Laboratory Safety: Containment and decontamination
2 nd	Lecture-3	Historical Development in Microbiology
	Lecture-4	Historical Development in Microbiology (Continued)
	Practical-2	Introduction to Microscopy: Parts and working of an ordinary bright field light microscope
3 rd	Lecture-5	Microscope & Microscopy: Principles, functions and differences of various types of light and electron microscopes
	Lecture-6	Classification and brief introduction of Microorganisms: Bacteria, Fungi, Algae, Protozoa, Parasites, Viruses etc.
	Practical-3	Introduction to Materials and equipments used in Microbiology
4 th	Lecture-7	Nomenclature and general morphology (size, shape & arrangement) of microorganisms (bacteria)
	Lecture-8	Quiz
	Practical-4	Introduction to Materials and equipments used in Microbiology (Continued)
5 th	Lecture-9	Cellular morphology of Bacteria: structures external to cell wall & cell wall
	Lecture-10	Cellular morphology of Bacteria: structures internal to cell wall
	Practical-5	Moist heat sterilization: Use of Autoclave
6 th	Lecture-11	Bacterial growth and growth curve
	Lecture-12	Growth rate, generation time and their calculations

	Practical-6	Dry heat sterilization: Use of Hot air oven
7 th	Lecture-13	Assignment
	Lecture-14	Growth requirements of bacteria (Physical)
	Practical-7	Preparation and sterilization of culture media
8 th	Lecture-15	Growth requirements of bacteria (Chemical/Nutritional)
	Lecture-16	Growth characteristics of bacteria on agar and in broth media
	Practical-8	Preparation and sterilization of glass ware
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Culture Media: Classification, composition and use of culture media with examples
	Lecture-18	Bacterial spores and toxins
	Practical-9	Isolation of bacteria: Pour plate and spread plate methods
11 th	Lecture-19	Phosphorylation: Substrate level phosphorylation, photo phosphorylation, oxidative phosphorylation
	Lecture-20	General methods of studying microorganisms: cultivation, purification, identification and characterization
	Practical-10	Isolation of bacteria: Streak plate method
12 th	Lecture-21	Quiz
	Lecture-22	Control of microorganisms by physical and chemical methods
	Practical-11	Staining of bacteria: Preparation and fixation of bacterial smears
13 th	Lecture-23	Basic properties of fungi, protozoa and algae
	Lecture-24	A brief introduction to viruses: classification, symmetries, cultivation and propagation
	Practical-12	Gram's staining
14 th	Lecture-25	Bacteriophages: structure, life cycle, cultivation and identification
	Lecture-26	Assignment
	Practical-13	Spore staining
15 th	Lecture-27	Introduction to chemotherapeutic agents and antibiotics: mechanisms of action of antibiotics
	Lecture-28	Mechanisms of action of antibiotics (Continued)
	Practical-14	Acid Fast staining
16 th	Lecture-29	Antimicrobial susceptibility testing: disc diffusion / agar well diffusion methods
	Lecture-30	Antimicrobial susceptibility testing/ MIC determination: micro broth dilution method and e-test
	Practical-15	Enumeration of bacteria: Total count through Bread's smear method
17 th	Lecture-31	Presentation
	Lecture-32	Revision and question answer session
	Practical-16	Viable count: Plate count method
18 th	Final Term Examination/ Result Submission/	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

	Enrolment	
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Learning sources/ Recommended Books/Manuals

1. Tortora, G.J., Christine, L. Case, C.L. Funke, B.R., Funke, B., Case, C., 2016. Microbiology: An Introduction, 9th Ed., Pearson Education, USA.
2. Talaro, K.P., 2006. Foundations in Microbiology: Basic Principles. McGraw Hill. Companies.
3. Kathleen P. T., and Arthur, T. 2001. Foundations in Microbiology: Basic Principles, McGraw-Hill Companies.
4. Alcamo, I. E., 2001. Fundamentals of Microbiology, Jones and Bartlett Publishers, USA.
5. Black, J. G., 2005. Microbiology: principles and explorations, 6th Ed., J. Wiley & Sons, USA.
6. Cappuccino, J.G. and Sherman, N. 2004, Microbiology: a laboratory manual. Pearson Education, USA.
7. Awan, J.A. and S.U. Rahman, 2002. Microbiology Manual. Unitech Communications, Faisalabad.

MIC- 303 Microbial Taxonomy 3(3-0)

Course Title	Microbial Taxonomy
Course Code	MIC-303
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Ayesha Sarwar
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Learning Objectives of the Course

1	To give basic concepts and aims of classification of Microorganisms
2	To identify traits used to classify Microorganisms
3	To be able to locate microorganisms in the living world

Week	Lecture/ Practical	Course Contents Covered
1 st	Lecture-1	General introduction and overview of Microbial Evolution and Diversity
	Lecture-2	Taxonomic Ranks
	Lecture -3	Taxonomic classification systems
2 nd	Lecture-4	Classical and molecular characteristics
	Lecture-5	Assessing Microbial Phylogeny
	Lecture-6	Polyphasic Taxonomy
3 rd	Lecture-7	The Major Divisions of Life (domain & kingdom system)
	Lecture-8	Quiz
	Lecture-9	Introduction to Bergey's Manual of Systematic Bacteriology
4 th	Lecture-10	Introduction to Archea and its general characters
	Lecture-11	Phylum Crenarcheota

	Lecture -12	Phylum Euryarcheota
5 th	Lecture-13	Bacteria (Deinococci and Non protobacteria)
	Lecture-14	Quiz
	Lecture -15	Phylum Aquificae & Phylum Thermotogae
6 th	Lecture-16	Phylum Deinococcus Thermus & Photosynthetic bacteria
	Lecture-17	Phylum Planctomycetes
	Lecture -18	Phylum Chlamydiae & Phylum Spirochates
7 th	Lecture-19	Assignment
	Lecture-20	Phylum Bacteroidetes
	Lecture -21	Protobacteria(Alpha Protobacteria)
8 th	Lecture-22	Class Beta and Gamma protobacteria
	Lecture-23	Class Delta & Epsilon Protobacteria
	Lecture-24	The Low G+C Gram positive bacteria (Class Mollicutes)
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-17	Class Clostridia & Class Bacilli
	Lecture-18	The high G+C Gram positive Bacteria
	Lecture -19	Suborder Actinomycinae & Micrococcinae
11 th	Lecture-20	Suborder Corynebacterianae & Micromonosporinae
	Lecture-21	Suborder Propionbacterinae & Streptomycinae
	Lecture-22	Suborder Frankineae & Order Bifidobacteriales
12 th	Lecture-23	Quiz
	Lecture-24	The fungi (Oomycota) Slime molds & Water molds
	Lecture-25	Distribution, importance, structure, Nutrition, metabolism & Reproduction of Fungi
13 th	Lecture-26	Division Zygomycota and Ascomycota
	Lecture-27	Division Basidiomycota and Deutromycota
	Lecture-28	Slime molds (Division Zygomycota & Acrasiomycota)
14 th	Lecture-29	Division Oomycota
	Lecture-30	Distribution, classification, nutrition, structure & Reproduction of Algae
	Lecture-31	Chlorophyta, Charophyta, Euglenophyta, Charophyta
15 th	Lecture-32	Assignment
	Lecture-33	Phaeophyta and Rhodophyta
	Lecture-34	Distribution, classification, nutrition, structure & Reproduction of Protozoa
16 th	Lecture-35	Phylum Sarcomastigophora & Labyrinthomorpha
	Lecture-36	Phylum Apicomplexa & Microspora
	Lecture-37	Phylum Ascetospora & Myxozoa
17 th	Lecture-38	General characteristics, reproduction of Viruses
	Lecture-39	Taxonomic classification of Viruses

	Lecture -40	Revision and question answer session
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective)

Useful web links and additional learning resources	
1	Nigel, J. J., Dimmock, N. J. J., Keith, L., Andrew, E., 2001. Introduction to Modern Virology. Blackwell Science, Inc.
2	Garrity, G. M., Krieg, N. R., Brenner, D. J., 2006. Bergey's Manual of Systematic Bacteriology: The Protobacteria, Vol. 2. Williams and Wilkins Co, Baltimore.
3	Ogunseitan, O., 2000. Microbial diversity. John Wiley and Sons.
4	Willey, J. M., Sherwood, L., Woolverton, C. J., & Prescott, L. M. 2008. Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

BCH-301 Introductory Biochemistry 4(3-1)

Course Title	Introductory Biochemistry
Course Code	BCH-301
Credit Hours	4(3-1)
Total Marks	80
Contact Hours	5 Hours Per Week (3 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Waseem/ Muhammad Atif Nisar
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Learning Objectives of the Course:

1. To equip students with the basic knowledge of biomolecules.
2. To give the concepts of the chemical basis of life.
3. To understand all the mechanisms involved in harvesting of energy.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Water and molecular interactions in aqueous system
	Lecture-2	Chemical nature of carbohydrates
	Lecture-3	Monosaccharides and stereoisomerism
	Practical-1	Preparation of standard solutions
2 nd	Lecture-4	Oligosaccharides and polysaccharides (homo-polysaccharides and hetero-polysaccharides)
	Lecture-5	Glycoconjugates (proteoglycans)
	Lecture-6	Glycoconjugates (glycosphingolipids and glycoproteins)

	Practical-2	Preparation of molar and molal solutions
3 rd	Lecture-7	Biochemistry of storage lipids (triacylglycerols)
	Lecture-8	Structural lipids (phospholipids, sphingolipids)
	Lecture-9	Steroids and its derivatives
	Practical-3	Preparation of normal and percentage solutions
4 th	Lecture-10	Introduction of amino acids (types, chemical nature and isomerism)
	Lecture-11	Amino acids titration curve
	Lecture-12	Formation and structure of peptide bond
	Practical-4	Preparation of working (dilute) solution from stock solution
5 th	Lecture-13	Primary structure of proteins
	Lecture-14	Protein secondary structure (α and β conformations)
	Lecture-15	Protein tertiary and quaternary structures
	Practical-5	Application of Henderson–Hasselbalch equation for preparation of buffer solution
6 th	Lecture-16	Protein Denaturation and Folding
	Lecture-17	Structure and types of DNA
	Lecture-18	Structure and types of RNA
	Practical-6	Preparation of tris buffer solution
7 th	Lecture-19	Basic concept of bioenergetics
	Lecture-20	ATP as energy packet
	Lecture-21	Glycolysis
	Practical-7	Preparation of citrate buffer solutions
8 th	Lecture-22	Fermentation (acidic and alcoholic)
	Lecture-23	Regulation of Glycolysis
	Lecture-24	Substrate level phosphorylation
	Practical-8	Preparation of phosphate buffer solutions
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Gluconeogenesis
	Lecture-26	Pentose phosphate pathway
	Lecture-27	Biosynthesis of Acetyl CoA
	Practical-9	Instrumentation for centrifugation (low speed and ultra-speed)
11 th	Lecture-28	Krebs cycle
	Lecture-29	Amphibolic nature of Krebs cycle (catabolic role in cell)
	Lecture-30	Amphibolic nature of Krebs cycle (anabolic role in cell)
	Practical-10	Verification of Beer-Lambert law using spectrophotometer
12 th	Lecture-31	Oxidation of saturated even chained fatty acids (β -oxidation)
	Lecture-32	Oxidation of unsaturated even chained fatty acids
	Lecture-33	Oxidation of odd chained fatty acids

	Practical-11	Measurement of absorbance and transmittance of given sample using spectrophotometer
13 th	Lecture-34	Ketone Bodies
	Lecture-35	Amino acid metabolism (transamination reaction)
	Lecture-36	Amino acid metabolism (urea cycle)
	Practical-12	Calculation of λ_{max} of given sample using spectrophotometer
14 th	Lecture-37	Structure of mitochondria
	Lecture-38	Oxidative phosphorylation
	Lecture-39	Chemiosmotic theory
	Practical-13	Spectroscopic quantification of proteins (absorbance measurement at wavelength 280 nm)
15 th	Lecture-40	Electrochemical gradient and membrane potential
	Lecture-41	Universal electron carriers
	Lecture-42	Electron transport chain structure
	Practical-14	Proteins quantification by Bradford assay (standard curve preparation in Excel work sheet)
16 th	Lecture-43	Electron-transfer reactions in mitochondria
	Lecture-44	Proton motive force
	Lecture-45	Structure of ATP synthetase
	Practical-15	Proteins quantification by Lowry assay (standard curve preparation in Excel work sheet)
17 th	Lecture-46	ATP synthesis by ATP synthetase
	Lecture-47	Uncouplers and thermogenesis
	Lecture-48	Regulation of metabolic pathways
	Practical-16	Spectroscopic quantification of DNA (absorbance measurement at wavelength 260 nm)
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective) Practical Exam of 20 Marks

Recommended Books:

1. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (Edition 7). Macmillan.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level. New York: Wiley.
3. McKee, T., & McKee, J. R. (2012). Biochemistry: The Molecular Basis of Life (Edition 5). WCB/McGraw-Hill.
4. Boyer, R. F., & Boyer, R. (2006). Biochemistry laboratory: modern theory and techniques (pp. 255-255). San Francisco: Benjamin Cummings.

BOT-301 Diversity of Plants 4(3-1)

Course Title	Diversity of Plants
Course Code	BOT-301
Credit Hours	4(3-1)

Total Marks	80
Contact Hours	5 Hours Per Week (3 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Botany
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Learning Objectives of the Course	
1	To introduce the students to the diversity of plants and their structures and significance.
2	Comparative study of life form, structure, reproduction and economic significance.
3	Basic concept of evolution in plant diversity.
4	To highlight diseases of plants caused by microbes.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to plant diversity
	Lecture-2	Scope of classification of plants
	Lecture-3	Domain classification systems, taxonomic hierarchy based on evolution
	Practical-1	Introduction to botany laboratory, facility required for botany laboratory and their significance
2 nd	Lecture-4	Domain Archea and Eubacteria: Phylum Cyanobacteria
	Lecture-5	Domain Archea and Eubacteria: Phylum Bacteria
	Lecture-6	Domain Archea and Eubacteria: Sub Kingdom Algae
	Practical-2	Estimation of relative water content in plant leaves
3 rd	Lecture-7	Domain Archea and Eubacteria: Fungi like Protists
	Lecture-8	Kingdom Fungi: Phylum Zygomycota & Basidiomycota
	Lecture-9	Kingdom Fungi: Phylum Ascomycota & Deutromycota, Lichens
	Practical-3	Estimation of relative water content in plant leaves (continued)
4 th	Lecture-10	Kingdom Plantae: Bryophytes
	Lecture-11	Kingdom Plantae: Mosses
	Lecture-12	Kingdom Plantae: Tracheophytes
	Practical-4	Early Blight of Potato (<i>Alternaria solani</i>)
5 th	Lecture-13	Flowering and non flowering plants
	Lecture-14	Basic concept of evolution of plant diversity
	Lecture-15	Photosynthetic bacteria (genus Nostoc), structure, reproduction
	Practical-5	Early Blight of Potato (<i>Alternaria solani</i>) (continued)
6 th	Lecture-16	Photosynthetic bacteria (genus Nostoc), Classification, photosynthesis mechanisms
	Lecture-17	Industrial, economic & ecological importance of cynaobacteria

	Lecture-18	General cellular structure of algae, classification
	Practical-6	Yellow vein mosaic of bhendi (<i>Hibiscus Virus</i>)
7 th	Lecture-19	Mode of reproduction in algae, economic importance and uses in agriculture
	Lecture-20	Occurrence of chlamydomonas, structure
	Lecture-21	Occurrence of chlamydomonas reproduction and economic significance
	Practical-7	Yellow vein mosaic of bhendi (<i>Hibiscus Virus</i>)
8 th	Lecture-22	Fresh water plants: Xanthophyta, types, general cellular structure
	Lecture-23	Fresh water plants: Xanthophyta, reproduction and significance
	Lecture-24	Fungi: types on the basis of mode of nutrition
	Practical-8	Black stem rust of wheat (<i>Puccinia tritici</i>)
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Fungi: mode of reproduction
	Lecture-26	Fungi: classification and ecologic importance
	Lecture-27	Role of fungi in agriculture (Plant diseases, animal/ livestock diseases, crop improvements etc)
	Practical-9	Black stem rust of wheat (<i>Puccinia tritici</i>) (continued)
11 th	Lecture-28	Plasmodiophoromycota: general structure, types and life cycle
	Lecture-29	Plasmodiophoromycota: general structure, types and life cycle
	Lecture-30	Mucor: general structure, types and life cycle
	Practical-10	False smut of rice (<i>Ustilaginoideavirens</i>)
12 th	Lecture-31	Quiz
	Lecture-32	Economic importance of Mucor, heterokaryosis and para sexuality in ascocarp
	Lecture-33	Penicillium: general structure, occurrence, significance
	Practical-11	False smut of rice (<i>Ustilaginoideavirens</i>) (continued)
13 th	Lecture-34	General life cycles (reproduction)
	Lecture-35	Saccharomyces: general structure, occurrence, significance
	Lecture-36	General life cycles (reproduction)
	Practical-12	False smut of rice (<i>Ustilaginoideavirens</i>) (continued)
14 th	Lecture-37	Ustilago (Smut): general structure, occurrence, significance
	Lecture-38	General life cycles (reproduction)
	Lecture-39	Puccinia (Rust): general structure, occurrence, significance
	Practical-13	Bunchy top of banana (<i>BananaBunchyTopVirus</i>)
15 th	Lecture-40	Assignment
	Lecture-41	General life cycles (reproduction)
	Lecture-42	Fungal diseases of plants
	Practical-14	Bryophyte: Funaria; occurrence, general structure
	Lecture-43	Bryophyte: Funaria; life cycle, reproduction and dispersal

16 th	Lecture-44	Pteridophyta (ancient plants) structure, life cycles and reproduction
	Lecture-45	Origin of Pteridophyta: from algae, Bryophytes
	Practical-15	Bunchy top of banana (<i>BananaBunchyTopVirus</i>)
17 th	Lecture-46	Presentation
	Lecture-47	Gymnosperms: occurrence, structure & reproduction
	Lecture-48	Angiosperms: occurrence, structure & life cycles
	Practical-16	General discussion and course revision
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective) Practical Exam of 20 Marks

Useful Web links and Additional Learning Resources	
1	Diversity of Plants by I.A Khan and R.H. Ramay. 2016-17 Ilmi publishers
2	Plants: Evolution and Diversity, M. Ingrouille and W. Eddie 2006, Cambridge University Press ISBN-13 978-0-521-79097-0

ISL-321 Islamic Studies 2(2-0)

Course Title	Islamic Studies
Course Code	ISL-321
Credit Hours	2(2-0)
Total Marks	40
Contact Hours	2 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Islamic Studies
Session	2018-22
Semester (Morning/ Evening)	1 st [(ISL-322 Ethics 2(2-0) will be offered to Non-Muslims)]
Program	BS Microbiology

Learning Objectives of the Course

1	To provide Basic information about Islamic Studies
2	To enhance understanding of the students regarding Islamic Civilization
3	To improve Student's 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

Course Contents

Introduction to Quranic Studies

- Basic Concepts of Quran
- History of Quran
- Uloom-ul-Quran

Study of Selected Text of Holly Quran

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

Study of Selected Text of Holly Quran

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

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

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

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

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

Introduction to Sunnah

- Basic Concepts of Hadith
- History of Hadith
- Kinds of Hadith
- Uloom –ul-Hadith
- Sunnah & Hadith
- Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence

- Basic Concepts of Islamic Law & Jurisprudence
- History & Importance of Islamic Law & Jurisprudence
- Sources of Islamic Law & Jurisprudence
- Nature of Differences in Islamic Law
- Islam and Sectarianism
- Islamic Culture & Civilization
- Basic Concepts of Islamic Culture & Civilization
- Historical Development of Islamic Culture & Civilization
- Characteristics of Islamic Culture & Civilization
- Islamic Culture & Civilization and Contemporary Issues

Islam & Science

- Basic Concepts of Islam & Science

- Contributions of Muslims in the Development of Science
- Quranic & Science
- Islamic Economic System
- Basic Concepts of Islamic Economic System
- Means of Distribution of wealth in Islamic Economics
- Islamic Concept of Riba
- Islamic Ways of Trade & Commerce

Political System of Islam

- Basic Concepts of Islamic Political System
- Islamic Concept of Sovereignty
- Basic Institutions of Govt. in Islam
- Islamic History
- Period of Khlaft-e-Rashida, Period of Ummayyads, Period of Abbasids

Social System of Islam

- Basic Concepts of Social System of Islam, Elements of Family, Ethical Values of Islam

Recommended Books

1. Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
2. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
3. Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

PST-321 Pakistan Studies 2(2-0)

Course Title	Pakistan Studies
Course Code	PST-321
Credit Hours	2(2-0)
Total Marks	40
Contact Hours	2 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Pakistan Studies
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Aims and objectives

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

Course Contents

1. Historical Perspective
 - a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
 - b. Factors leading to Muslim separatism

- c. People and Land
 - i. Indus Civilization
 - ii. Muslim advent
 - iii. Location and geo-physical features.

2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
 - b. 1958-71
 - c. 1971-77
 - d. 1977-88
 - e. 1988-99
 - f. 1999 onward
- ## 3. Contemporary Pakistan
- a. Economic institutions and issues
 - b. Society and social structure
 - c. Ethnicity
 - d. Foreign policy of Pakistan and challenges
 - e. Futuristic outlook of Pakistan

Recommended Books

1. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
2. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
3. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.

ENG-321 Functional English 3(3-0)

Course Title	Functional English
Course Code	ENG-321
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of English
Session	2018-22
Semester (Morning/ Evening)	1 st
Program	BS Microbiology

Learning objectives

To enhance language skills and develop critical thinking among students.

Course Contents

- Introducing ourselves
- Describing things
- Getting and giving information

- Recounting past events
- Talking about facts and opinions
- Agreeing and disagreeing
- Compare and Contrast
- Cause and effect
- Using your imagination
- Reporting
- Writing Essays
- Presentation skills
- Assessment

Recommended Books

1. Eastwood, J. (2004). English Practice Grammar (New edition with tests and answers). Karachi: Oxford University Press.
2. Howe, D.H, Kirkpatrick, T.A., & Kirkpatrick, D.L. (2004). Oxford English for Undergraduates. Karachi: Oxford University Press.
3. Murphy, R. (2003). Grammar in Use. Cambridge: Cambridge University Press.
4. Fisher, A. (2001). Critical thinking. CUP
5. Goatly, A. (2000). Critical Reading and Writing: An Introductory Course. London: Taylor & Francis

MIC- 302 Cell Biology 3(3-0)

Course Title	Cell Biology
Course Code	MIC-302
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Atif Nisar
Session	2018-22
Semester (Morning/ Evening)	2 nd
Program	BS Microbiology

Learning Objectives of the Course	
1	To learn about the cell and its organization of architecture and the unified role it plays for ultimate sustainability of the organism.
2	To learn the various ultra-structure of the cell.
3	To understand the molecular and functional aspects of the cells.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Cell Biology
	Lecture-2	Difference between Prokaryotes and Eukaryotes

	Lecture -3	Structure external to cell wall
2 nd	Lecture-4	Basic composition of Cell wall
	Lecture-5	Structure internal to the cell wall
	Lecture-6	Chemical composition and molecular structure of Chromosome
3 rd	Lecture-7	Cell phases
	Lecture-8	Quiz
	Lecture-9	The cell cycle
4 th	Lecture-10	Cell Reproduction
	Lecture-11	Prokaryotic and eukaryotic reproduction
	Lecture -12	Difference of mitosis and meiosis in animal and plant cell
5 th	Lecture-13	<i>E. coli</i> and Yeast as representative prokaryotic and Eukaryotic models for molecular differentiation
	Lecture-14	Quiz
	Lecture -15	The central dogma
6 th	Lecture-16	Basic composition of Nucleic acid
	Lecture-17	Structure of DNA
	Lecture -18	Why DNA taken as hereditary material
7 th	Lecture-19	Assignment
	Lecture-20	The organization of DNA in cells
	Lecture -21	DNA replication
8 th	Lecture-22	Patterns of DNA synthesis
	Lecture-23	Mechanism of DNA Replication
	Lecture-24	The Genetic Code
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-17	Establishment of Genetic code
	Lecture-18	Organization of genetic code
	Lecture -19	Gene Structure
11 th	Lecture-20	Genes that codes for Proteins, tRNA and rRNA
	Lecture-21	DNA Transcription or RNA synthesis
	Lecture-22	Transcription in Prokaryotes and Eukaryotes
12 th	Lecture-23	Quiz
	Lecture-24	Protein synthesis, tRNA and amino acid activation
	Lecture-25	Initiation and Elongation of polypeptide chain
13 th	Lecture-26	Termination of protein synthesis
	Lecture-27	Protein folding and Molecular Chaperons
	Lecture-28	Protein Splicing
	Lecture-29	Regulation of mRNA synthesis

14 th	Lecture-30	Induction and repression mechanism
	Lecture-31	Mutation and its Chemical basis
15 th	Lecture-32	Assignment
	Lecture-33	Types of Mutation
	Lecture-34	The Expression of Mutation
16 th	Lecture-35	Detection of mutation
	Lecture-36	Regulation of gene expression in prokaryotes and Eukaryotes
	Lecture-37	Process of Recombination
17 th	Lecture-38	Types of Recombination
	Lecture-39	Presentation
	Lecture -40	Revision and question answer session
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective)

Useful Weblinks and Additional Learning Resources	
1	Alberts. B., 2007. Molecular Biology of the Cell. Taylor and Francis, Inc.
2	Pollard, T.D., Lippincott-Schwartz., Earnshaw, W.C., 2007. Cell Biology: Saunders W.B.Co.
3	Lodish, H., 2011. Solutions Manual for Molecular Cell Biology.7 th Edition. W.H. Freeman &Company.
4	Willey, J. M., Sherwood, L., Woolverton, C. J., & Prescott, L. M. 2008. Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

MIC- 304 Microbial Anatomy and Physiology 3(2-1)

Course Title	Microbial Anatomy and Physiology
Course Code	MIC-304
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Atif Nisar
Session	2018-22
Semester (Morning/ Evening)	2 nd
Program	BS Microbiology

Learning Objectives of the Course

1. To understand the basic cellular components of prokaryotic cells.
2. To learn various metabolic strategies ranging from utilization of biomolecules to synthesis of biomolecules of microbes important for their survival in different ecological niches.

Week	Lecture/ Practical	Course Contents
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1 st	Lecture-1	Structure and synthesis of peptidoglycan
	Lecture-2	Special components of bacterial cell wall (teichoic acids, lipoteichoic acids, lipopolysaccharide and porins) and cell membrane
	Practical-1	Gram's and Ziehl-Neelsen staining
2 nd	Lecture-3	Chemical nature and structure of capsule and slime layers
	Lecture-4	Structure and synthesis of bacterial flagella
	Practical-2	Capsule and spore staining
3 rd	Lecture-5	Chemotaxis and bacterial motility (swarming, gliding, twitching and spirochetes endoflagella)
	Lecture-6	Bacterial secretion systems and protein trafficking (type I, type II, type III, type IV, Sec and TAT pathways)
	Practical-3	Motility testing and swarming assay
4 th	Lecture-7	Overview of central metabolic pathways (Embden-Meyerhof-Parnas, Entner-Doudoroff and phosphoketolase pathway)
	Lecture-8	Overview of central metabolic pathways (Kreb's and glyoxylate cycle)
	Practical-4	Carbohydrate (monosaccharides and disaccharides) utilization tests
5 th	Lecture-9	Bacterial fermentation (acetic acid, butyric acid, lactic acid, propionic acid and mixed acid)
	Lecture-10	Fermentation in yeast
	Practical-5	Triple sugar iron, methyl-red and Voges-Proskauer tests
6 th	Lecture-11	Fatty acid biosynthesis in bacteria
	Lecture-12	Bacterial respirasome (aerobic respiration)
	Practical-6	Catalase, oxidase and nitrate reduction tests
7 th	Lecture-13	Bacterial respirasome (anaerobic respiration: iron reduction, nitrate reduction and fumarate respiration)
	Lecture-14	Bacterial respirasome (anaerobic respiration: sulfate respiration and sulfur reduction)
	Practical-7	Starch, casein, fat, urea and tryptophan hydrolysis tests
8 th	Lecture-15	Metabolism in methylotrophic and methanogenic bacteria
	Lecture-16	Nitrogen fixation in free living and symbiotic bacteria (role of nitrogenase enzyme)
	Practical-8	H ₂ S production, citrate utilization, phenylalanine deamination, gelatin hydrolysis and litmus milk reaction biochemical test
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Photosynthesis and carbon fixation in cyanobacteria (light-dependent reactions)
	Lecture-18	Photosynthesis and carbon fixation in cyanobacteria (light-independent reactions)
	Practical-9	Effect of salt concentration on bacterial growth (spectrophotometric studies)

11 th	Lecture-19	Bacterial communication (inter and intra species quorum sensing)
	Lecture-20	Formation and structure of bacterial biofilms
	Practical-10	Effect of temp. on microbial growth (spectrophotometric studies)
12 th	Lecture-21	Osmotic stress and osmoregulation in bacteria
	Lecture-22	pH stress and acid tolerance in bacteria
	Practical-11	Effect of pH on bacterial growth (spectrophotometric studies)
13 th	Lecture-23	Thermal stress and the heat shock response in bacteria
	Lecture-24	Oxidative stress and its management in bacteria
	Practical-12	Bacterial growth curve (spectrophotometric studies)
14 th	Lecture-25	Nutrient stress and the starvation stress response in bacteria
	Lecture-26	Structural features of acidophiles and alkaliphiles to survive in harsh environmental conditions
	Practical-13	Bacterial growth curve (colony counting method)
15 th	Lecture-27	Structural features of thermophiles and halophiles to survive in harsh environmental conditions
	Lecture-28	Cell division in Gram negative bacteria
	Practical-14	Isolation of cyanobacteria from water
16 th	Lecture-29	Cell division in gram positive bacteria
	Lecture-30	Mechanism of sporulation in <i>Bacillus</i>
	Practical-15	Isolation of nitrogen fixing bacteria from fertile soil
17 th	Lecture-31	Myxobacterial developmental cycle
	Lecture-32	Differentiation in <i>Caulobacter</i> (stalked bacteria)
	Practical-16	Isolation of starch hydrolyzing bacteria from fertile soil
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books:

1. Madigan, M. T., Martinko, J. M., & Parker, J. (2017). Brock biology of microorganisms (Edition 14). Pearson.
2. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). Prescott's Microbiology (Edition 10). McGraw-Hill.
3. James, C., & Natalie, S. (2014). Microbiology. A laboratory manual. Pearson Education.
4. Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism. Cambridge university press.
5. El-Sharoud, W. (2008). Bacterial physiology. Springer.
6. Harley, J. P. (2008). Microbiology Lab Manual. McGraw-Hill Science.
7. Brown, A. E. (2007). Benson's microbiological applications: Laboratory manual in General Microbiology.
8. Moat, A. G., Foster, J. W., & Spector, M. P. (Eds.). (2003). Microbial physiology. John Wiley & Sons.

MIC- 306 Human Physiology 3(2-1)

Course Title	Human Physiology
Course Code	MIC-306
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Asif Zahoor
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To impart the concepts and mechanisms of integration in the different functional systems of humans.
2	To understand coordination among various systems.
3	To study the details of physiological systems maintaining the homeostasis.
4	To study details of nervous and hormonal coordination at molecular and cellular levels

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to organization of human body
	Lecture-2	Tissue: Structure and function
	Practical-1	Methods of obtaining blood samples
2 nd	Lecture-3	Epithelial, Connective, Muscle and Nervous tissues, Bone and Cartilage
	Lecture-4	Adaptive cellular and tissue behavior
	Practical-2	Anticoagulants and preservation of blood
3 rd	Lecture-5	Hyperplasia, Hypertrophy, Atrophy and Genetic abnormalities
	Lecture-6	Blood: Physical characteristics and components of blood
	Practical-3	Blood grouping
4 th	Lecture-7	Origin and development of blood cells, Structure and function of RBC, WBC, Platelets, Clotting Cascade, Blood groups and Homeostasis
	Lecture-8	Cardiovascular System: Cardiac Cycle, Heart Sounds, Cardiac Conduction System
	Practical-4	Determination of the Clotting Time
5 th	Lecture-9	Quiz
	Lecture-10	Structure and Function of Blood Vessels
	Practical-5	Examination of thin and thick smear of blood
6 th	Lecture-11	Lymphatic System: Overview of Lymph, Structure and function of lymphatic tissues and organs
	Lecture-12	Antibodies and Immune cells. Specific and nonspecific immune reactions
	Practical-6	Determination of total leukocytes count (TLC)

7 th	Lecture-13	Respiratory System: Lung volumes and capacities
	Lecture-14	Non-respiratory air movements, Alveolar ventilation; mechanism of alveolar gas exchange
	Practical-7	Determination Differential leukocytes count (DLC)
8 th	Lecture-15	Digestive System: Structure and function of the digestive organs, Salivary glands and their secretions
	Lecture-16	Gastric and pancreatic juice and Digestion, absorption and movements of GIT
	Practical-8	Determination of the specific gravity and viscosity of blood and plasma
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Excretory system: System organization, Kidneys, Urine formation
	Lecture-18	Glomerular filtration, Processes of tubular re-absorptions and secretion
	Practical-9	Determination of human blood pressure
11 th	Lecture-19	Endocrine System: Cellular secretions and their types
	Lecture-20	Structure and function of endocrine glands, Basic mechanism of hormone action, Control of hormone secretion by Hypothalamus-pituitary axis
	Practical-10	Determination of the normal chemical composition of human saliva
12 th	Lecture-21	Secretions of non-endocrine glands of body
	Lecture-22	Reproductive System: Female reproductive system, Oogenesis, Menstrual cycle: Phases of menstruation, hormonal regulation, Overview of secondary sex characteristics, external genitalia and mammary glands
	Practical-11	Determination of physical and chemical properties of urine sample
13 th	Lecture-23	Male reproductive system, Testes and Spermatogenesis
	Lecture-24	Male sex hormones and their role in spermatogenesis
	Practical-12	Spectrophotometric determination of urinary calcium/ Uric acid Concentration
14 th	Lecture-25	Accessory sex glands and composition of semen
	Lecture-26	Musculo-skeletal System: Structure and function of muscle, neuromuscular junction
	Practical-13	Spectrophotometric determination of urinary phosphate concentration
15 th	Lecture-27	Nervous System: Structure and function of neuron, Membrane potential and nerve impulse, Synaptic transmission, Sensory and motor system
	Lecture-28	Spinal Cord: Nerve Pathways, Sensory and motor tracts and Spinal nerves, Reflexes and reflex arc
	Practical-14	Liver function tests
16 th	Lecture-29	Brain: Functional areas of brain and cranial nerves
	Lecture-30	Formation and regulation of cerebrospinal fluid, Cerebral blood flow and blood brain barrier, Receptors and their classification
	Practical-15	Presentations
	Lecture-31	Presentations

17 th	Lecture-32	Presentations
	Practical-16	Presentations
18 th	Final Term	Sessional including Quizzes, assignments, presentations etc. (08 Marks)
	Examination/	Final Term of 20 Marks (08 Objective) and (12 subjective)
	Result	Practical of 20 Marks
	Submission/	
	Enrolment	

Useful Weblinks and Additional Learning Resources	
1	Guyton, A. C. and Hall, J. E. 2005. Textbook of Medical Physiology, 12th ed; W. B Saunders.

ZOL-301 Principles in Animal Life-I 4(3-1)

Course Title	Principles in Animal Life-I
Course Code	ZOL-301
Credit Hours	4(3-1)
Total Marks	80
Contact Hours	5 Hours Per Week (3 Hours Theory + 2 Hours Practicals)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Zoology
Session	2018-22
Semester (Morning/ Evening)	2 nd
Program	BS Microbiology

Learning Objectives of the Course	
1	To know the concept and status of Zoology in life sciences.
2	To understand the common processes of life through its chemistry, biochemical and molecular processes.
3	To learn the structure and function of cell organelle and how common animal cell diversified in various tissues, organs and organ systems.
4	To study the animals and their relationship with their environment.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Place of Zoology in Science, brief introduction
	Lecture-2	A one-world view: genetic unity, the fundamental unit of life
	Lecture-3	Evolutionary oneness and the diversity of life, environment and world resources
	Practical-1	Brief introduction of animal laboratory, its requirements, safety precautions etc.
2 nd	Lecture-4	What is Zoology? The classification of animals; the scientific method.
	Lecture-5	The Chemical Basis of Animal Life.
	Lecture-6	Atoms and elements: building blocks of all matter; compounds and molecules: aggregates of atoms; acids, bases, and buffers.

	Practical-2	Testing for presence of carbohydrates: Starch
3 rd	Lecture-7	The molecules of animals: fractional account of carbohydrates
	Lecture-8	lipids
	Lecture-9	lipids (continued)
	Practical-3	Testing for presence of carbohydrates: Starch
4 th	Lecture-10	Nucleotides and nucleic acids based on their structural aspects.
	Lecture-11	Cells, Tissues, Organs of animals
	Lecture-12	Organ System of Animals Structure and functions
	Practical-4	Testing for presence of carbohydrates: Reducing sugars
5 th	Lecture-13	Significance of various cellular parts in life: Cell Membrane
	Lecture-14	Significance of various cellular parts in life: Cytoplasmic inclusions
	Lecture-15	Significance of various cellular parts in life: Ribosomes, Golgi bodies, mitochondria etc
	Practical-5	Testing for presence of carbohydrates: Reducing sugars
6 th	Lecture-16	Significance of various cellular parts in life: cilia and flagella, centrioles and microtubules, and vacuoles based on their structural aspects.
	Lecture-17	The nucleus: nuclear envelope, chromosomes and nucleolus.
	Lecture-18	Tissues: diversity in epithelial tissue.
	Practical-6	Test for Proteins: Biuret Test
7 th	Lecture-19	Tissues: diversity in connective tissue, muscle tissue and nervous tissue to perform various functions.
	Lecture-20	Structural integrations for functions in organs and organ systems.
	Lecture-21	General Discussion & course revisions
	Practical-7	Test for Proteins: Xanthoproteic Test
8 th	Lecture-22	Energy and Enzymes; Life's Driving and Controlling Forces Energy and the laws of energy transformation
	Lecture-23	Activation energy; enzymes: structure
	Lecture-24	function and factors affecting their activity; cofactors and coenzymes
	Practical-8	Test for Fats: Sudan III Test
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	ATP: how cells convert energy? An overview.
	Lecture-26	How Animals Harvest Energy Stored in Nutrients
	Lecture-27	Glycolysis: the first phase of nutrient metabolism; fermentation: "life without oxygen"; aerobic respiration
	Practical-9	Test for Fats: Sudan III Test
11 th	Lecture-28	Kreb's Cycle
	Lecture-29	Metabolism of fats
	Lecture-30	Metabolism of proteins
	Practical-10	Test for Fats: Paper Spot Test
	Lecture-31	Quiz

12 th	Lecture-32	Ecology of animals
	Lecture-33	Individuals and Populations Animals and their abiotic environment; populations; interspecific interactions.
	Practical-11	Test for Fats: Paper Spot Test
13 th	Lecture-34	Different animal communities in ecosystems.
	Lecture-35	Community structure and diversity; ecosystems; ecosystems of the earth; ecological problems
	Lecture-36	Human population growth, pollution, resource depletion and biodiversity.
	Practical-12	Study of the prepared slides of epithelial tissue
14 th	Lecture-37	Approaches of animal behavior
	Lecture-38	Anthropomorphism
	Lecture-39	Development of behavior; learning; control of behavior
	Practical-13	Study of the prepared slides of connective tissue
15 th	Lecture-40	Communication; behavioral ecology; social behavior.
	Lecture-41	Biodiversity of animals; On the Basis of Shape and Size
	Lecture-42	Biodiversity of animals; On the basis of Symmetry
	Practical-14	Study of nervous and muscle tissue
16 th	Lecture-43	Biodiversity of animals; On the basis of habitat
	Lecture-44	Biodiversity of animals; On the basis of feeding habits
	Lecture-45	Biodiversity of animals; On the basis of mode nutrition
	Practical-15	Plasmolysis and deplasmolysis in blood.
17 th	Lecture-46	Biodiversity of animals; On the basis of vertebral column and economic importance
	Lecture-47	Rules for modern or natural classification of animals
	Lecture-48	Assignment Presentations/ revisions
	Practical-16	Ecological notes on animals of few model habitats
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective) Practical Exam of 20 Marks

Useful Weblinks and Additional Learning Resources	
1	Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, Edition (International), 2004. Singapore: McGraw Hill.
2	Miller, S.A. and Harley, J.B. Zoology, 6 Edition (International), 2005. Singapore: McGraw Hill.
3	Molles, M.C. Ecology: Concepts and applications. 2005. McGraw Hill, New York, USA.

ENG-322 English Comprehension and Composition 3(3-0)

Course Title	English Comprehension and Composition
Course Code	ENG-322
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of English
Session	2018-22
Semester (Morning/ Evening)	2 nd
Program	BS Microbiology

Learning Objectives:

To enable the students to:

- Read the lines (literal understanding of text), read between the lines (to interpret text) and read beyond the lines (to assimilate, integrate knowledge etc.)
- Write well organized academic texts including examination answers with topic/thesis statement/supporting details
- Write argumentative essays and course assignments

Course Contents:

Reading and Critical Thinking

1. Read academic texts effectively by:

- Using appropriate strategies for extracting information and salient points according to a given purpose
- Identifying the main points supporting details, conclusions in a text of intermediate level
- Identifying the writer's intent such as cause and effect, reasons, comparison and contrast, exemplification
- Interpreting charts and diagrams
- Making appropriate notes using strategies such as mind maps, tables, lists, graphs.
- Reading and carrying out instructions for tasks, assignments and examination questions

2. Enhance academic vocabulary using skills learnt in Compulsory English I course

3. Acquire efficient dictionary skills such as locating guide words, entry words, choosing appropriate definition, and identifying pronunciation through pronunciation key, identifying part of speech, identifying syllable division and stress patterns

Writing Academic Texts

Students will be able to:

1. Plan their writing: identify audience, purpose and message (content)
2. Collect information in various forms such as mind maps, tables, charts, lists
3. Order information such as:
 - Chronology for a narrative
 - Stages of a process
 - From general to specific and vice versa
 - From most important to least important
 - Advantages and disadvantages
 - Comparison and contrast

- Problem solution pattern

4. Write argumentative and descriptive forms of writing using different methods of developing ideas like listing, comparison, and contrast, cause and effect, for and against

Write good topic and supporting sentences and effective conclusions

Use appropriate cohesive devices such as reference words and signal markers

5. Redraft checking content, structure and language, edit and proof read

Grammar in Context

- Phrase, clause and sentence structure
- Combining sentences
- Reported Speech

Recommended Readings:

1. Eastwood, J. (2004). English Practice Grammar (New edition with tests and answers). Karachi: Oxford University Press.
2. Howe, D.H, Kirkpatrick, T.A., & Kirkpatrick, D.L. (2004). Oxford English for Undergraduates. Karachi: Oxford University Press.
3. Murphy, R. (2003). Grammar in Use. Cambridge: Cambridge University Press.
4. Fisher, A. (2001). Critical thinking. CUP
5. Goatly, A. (2000). Critical Reading and Writing: An Introductory Course. London: Taylor & Francis

MTH-321 Algebra and Trigonometry 3(3-0)

Course Title	Algebra and Trigonometry
Course Code	MTH-321
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Mathematics
Session	2018-22
Semester (Morning/ Evening)	2 nd
Program	BS Microbiology

Learning objectives

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

Course Contents

- Limits and continuity.
- Derivative of a function and its applications.
- Optimization problems.
- Mean value theorem (Taylor's theorem and the infinite Taylor series with applications) and curve sketching; anti-derivative and integral.
- Definite integral and applications.

- The fundamental theorem of Calculus.
- Inverse functions (Chapters 1-6 of the text)

Recommended Books

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

MIC-401 Basic Pathology 3(2-1)

Course Title	Basic Pathology
Course Code	MIC-401
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Saqalein
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives of the Course

1	Knowledge capability (understanding the general principles, terminology, diagnostic procedures, and basic concepts of pathology)
2	Technical capability (identifying pathological processes at the cellular and gross anatomical level and correlating these with the clinical symptoms and signs)
3	Professional work practices (demonstrating correct handling and disposal of biological materials and maintaining a high standard of ethics, informed consent and consultation)
4	Application of a basic understanding of histopathology and morbid anatomy to the examination of microscopic sections and gross specimens, respectively, displaying pathological processes.
5	Application of the diagnostic procedure in pathology, through introduction of the differential diagnostic methods at the clinical level.
6	Correlation of the basic disease states studied at a cellular and gross anatomical level with the overt clinical signs and symptoms seen in those disorders
7	Relate ways in which pathology contributes to the understanding of patient presentation in a clinical setting

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Pathology
	Lecture-2	Scope and Concepts of disease
	Practical-1	Laboratory Safety Measures
2 nd	Lecture-3	Language of Pathology
	Lecture-4	Definitions and Terminologies
	Practical-2	Sample Collection and Types of Clinical Samples
3 rd	Lecture-5	Cell Injury and its Causes
	Lecture-6	Responses of cell to injury
	Practical-3	Labeling, Packaging, Transportation, Storage and Preservation of Samples

4 th	Lecture-7	Types of Cell adaptation
	Lecture-8	Quiz
	Practical-4	Blood Examination
5 th	Lecture-9	Types of Cell Injuries
	Lecture-10	Molecular Mechanism of Cell injury
	Practical-5	Urine Examination
6 th	Lecture-11	Cellular Accumulations
	Lecture-12	Cell Death
	Practical-6	Stool Examination
7 th	Lecture-13	Assignment
	Lecture-14	Necrosis and its Types
	Practical-7	CSF Examination
8 th	Lecture-15	Apoptosis, Extrinsic Pathway
	Lecture-16	Intrinsic Pathway of Apoptosis
	Practical-8	Semen, Synovial Fluid Examination
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Inflammation
	Lecture-18	Acute Inflammation and its Causes
	Practical-9	Tissue processing for histopathology
11 th	Lecture-19	Steps of acute inflammation
	Lecture-20	Cells and Chemical Mediators of acute inflammation
	Practical-10	Tissue processing for histopathology
12 th	Lecture-21	Quiz
	Lecture-22	Outcomes of acute inflammation
	Practical-11	Study of Pathological Slides of various Pathological Conditions
13 th	Lecture-23	Outcomes of acute inflammation
	Lecture-24	Chronic Inflammation
	Practical-12	Study of Pathological Slides of various Pathological Conditions
14 th	Lecture-25	Cells of Chronic Inflammation
	Lecture-26	Assignment
	Practical-13	Tests for Endocrine abnormalities
15 th	Lecture-27	Virulence factors of fungi
	Lecture-28	Human Fungal Pathogens
	Practical-14	Indirect Evidences of Disease (Chemistry)
16 th	Lecture-29	Hypersensitivity Reactions
	Lecture-30	Neoplasia
	Practical-15	Cytology

17 th	Lecture-31	Presentation
	Lecture-32	Revision and question answer session
	Practical-16	Indirect Evidences of Disease (Chemistry)
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Kumar, V., Abbas, A. K., & Aster, J. C. (2017). Robbins Basic Pathology E-Book. Elsevier Health Sciences.
2. Klatt, E. C. (2015). Robbins and Cotran atlas of pathology. Elsevier Health Sciences.
3. Pathology Practical Note Book. Allied Publishing Company.
4. Wilson, D. D. (2007). McGraw-Hill Manual of laboratory and diagnostic tests. McGraw Hill Professional.
5. Kemp, W., Burns, D. K., & Brown, T. G. (2007). Pathology: the big picture. McGraw Hill Professional.
6. Mills, S. E. (2007). Histology for pathologists. Philadelphia.
7. Cheesbrough, M. (2006). District laboratory practice in tropical countries. Cambridge university press.

MIC- 403 Bacteriology 3(2-1)

Course Title	Bacteriology
Course Code	MIC-403
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practicals)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Abu Baker Siddique
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives of the Course

1	To Learn the properties, morphological, biochemical and molecular characteristics of bacteria.
2	To know the virulent factors and pathogenesis of pathogens.
3	To learn the isolation and identification techniques of bacteria from specimen samples.
4	To become competent enough to deal with collection, transportation and identification of bacteria from clinical samples.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Bacteriology
	Lecture-2	Characteristics of bacteria (Structural)
	Practical-1	Preparation and Sterilization of Different Culture Media
	Lecture-3	Characteristics of bacteria (Cultural)

2 nd	Lecture-4	Sporulation
	Practical-2	Different Staining techniques (Gram's Staining, Spore Staining, Flagella Staining, Capsule Staining, Spore Staining)
3 rd	Lecture-5	Bacterial Virulence factors
	Lecture-6	Bacterial Pathogenesis
	Practical-3	Pure Culture Techniques (Pour Plate, Spread Plate, Streak Plate)
4 th	Lecture-7	Staphylococcus
	Lecture-8	Methicillin Resistant Staphylococcus
	Practical-4	Biochemical Test (Catalase, Coagulase)
5 th	Lecture-9	Streptococcus (Group A & B)
	Lecture-10	Streptococcus (Group C, D & Viridans)
	Practical-5	Biochemical Test (Casein hydrolysis test, Gelatin Liquefaction test)
6 th	Lecture-11	Neisseria
	Lecture-12	Bacillus
	Practical-6	Biochemical Test (Oxidase, Indole Test)
7 th	Lecture-13	Assignment / Quiz
	Lecture-14	Clostridium
	Practical-7	Biochemical Test (Voges Proskauer Test)
8 th	Lecture-15	Corynebacterium and Listeria
	Lecture-16	Mycobacterium
	Practical-8	Biochemical Test (Citrate Utilization Test)
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Enterobacteriaceae
	Lecture-18	Escherichia
	Practical-9	Determination of Motility
11 th	Lecture-19	Salmonella
	Lecture-20	Shigella
	Practical-10	Total Bacterial Count
12 th	Lecture-21	Proteus / Klebsiella
	Lecture-22	Brucella
	Practical-11	Viable Bacterial Count
13 th	Lecture-23	Quiz
	Lecture-24	Helicobacter
	Practical-12	Collection and transportation of ear, nose, throat samples
14 th	Lecture-25	Campylobacter
	Lecture-26	Pseudomonas
	Practical-13	Collection and transportation of GIT, UGT & Eye samples

15 th	Lecture-27	Vibrio
	Lecture-28	Bordetella
	Practical-14	Microbiological examination of Water samples
16 th	Lecture-29	Vibrio
	Lecture-30	Mycoplasma
	Practical-15	Microbiological examination of Milk samples
17 th	Lecture-31	Spirochetes
	Lecture-32	Spirochetes
	Practical-16	Microbiological examination of soil samples
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Useful Weblinks and Additional Learning Resources / Books	
1	Hawkey, P and Lewis, D., 2004. Medical Bacteriology: A Practical Approach. 2 nd Edition .Oxford University Press
2	Mims, C Dockrell, H., Goering, R., Roitt, I Wakelin, D. and Zuckerman, M., 2004. Medical Microbiology. 3 rd Edition. Mosby.
3	Cowan, S. T., Steel, K. J., Barrow, G. I and Feltham, R. K. A., 2004. Cowan and Steel's Manual for the Identification of Medical Bacteria. 3 rd Edition CMICROridge University Press.

MIC-405 Mycology 3(2-1)

Course Title	Mycology
Course Code	MIC-405
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Saqalein
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives of the Course	
1	To know about basic concepts of fungal cell biology
2	To study the importance of fungi in various ecological roles

3	To give them an understanding of how fungi impact human affair
4	Description of the higher taxonomy of the fungi and how the fungi relate to other organisms
5	Discuss the characteristics of the major classes and orders within the fungal kingdom
6	How fungi grow and reproduce, and where and how they can be isolated?
7	Role of fungi in animal and plant diseases
8	Role of fungi in fermentation and industrial processes

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Mycology
	Lecture-2	Beneficial and Harmful effects of fungi
	Practical-1	Laboratory Safety Measures
2 nd	Lecture-3	How fungi differ from other microbes, ecological role
	Lecture-4	Fungal Cell Structure and functions
	Practical-2	Sample Collection and Types of Samples
3 rd	Lecture-5	Fungal Cell Structure and functions
	Lecture-6	Classification of fungi
	Practical-3	Labeling, Packaging, Transportation, Storage and Preservation of Samples
4 th	Lecture-7	Morphology of fungi, Thermal Dimorphism
	Lecture-8	Quiz
	Practical-4	Isolation techniques for fungi
5 th	Lecture-9	Types of hyphae and various modifications
	Lecture-10	Types of Spores
	Practical-5	Media used for isolation of fungi
6 th	Lecture-11	Modes of reproduction in molds
	Lecture-12	Vegetative modes of reproduction
	Practical-6	Various Stains for fungi
7 th	Lecture-13	Assignment
	Lecture-14	Physical Growth requirements of fungi
	Practical-7	Preparation and sterilization of culture media
8 th	Lecture-15	Chemical Growth requirements of fungi
	Lecture-16	Fungal Cellular Metabolism
	Practical-8	Preparation and sterilization of glass ware
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Fungal Cellular Metabolism
	Lecture-18	Fungal Cellular Metabolism (Continued)
	Practical-9	Isolation of fungi

11 th	Lecture-19	Fermentation
	Lecture-20	Yeast alcohol fermentation and Mushroom Cultivation
	Practical-10	Culture Characteristics of fungi
12 th	Lecture-21	Quiz
	Lecture-22	Uses of fungi in various industries
	Practical-11	Direct Microscopic Examination
13 th	Lecture-23	Uses of fungi in various industries
	Lecture-24	Fungal Biotechnology
	Practical-12	Slide Culture Technique
14 th	Lecture-25	Fungal Plant Pathogens
	Lecture-26	Assignment
	Practical-13	Effect of temperature and pH on fungal cultures
15 th	Lecture-27	Virulence factors of fungi
	Lecture-28	Human Fungal Pathogens
	Practical-14	Yeast Alcohol Fermentation
16 th	Lecture-29	Mechanisms of action of antifungal drugs
	Lecture-30	Mycotoxins
	Practical-15	Antifungal Susceptibility for molds
17 th	Lecture-31	Presentation
	Lecture-32	Revision and question answer session
	Practical-16	Antifungal Susceptibility for yeast
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Kavanagh, K. (Ed.). (2017). Fungi: biology and applications. John Wiley & Sons.
2. Chander, J. (2017). Textbook of medical mycology.
3. JP Medical Ltd. Oei, P. (2003). Mushroom cultivation: appropriate technology for mushroom growers (No. Ed. 3). Backhuys Publishers.
4. Procop, G. W. (2014). Medically Important Fungi: A Guide to Identification–5th Edition.
5. Joanne, W.(2017). Prescott's Microbiology 10th Edition. McGraw-Hill Education.
6. Awan, J.A. and S.U. Rahman, 2002. Microbiology Manual. Unitech Communications, Faisalabad.

MIC-407 Biosafety and Risk Management 3(2-1)

Course Title	Biosafety and Risk Management
Course Code	MIC-407
Credit Hours	3(2-1)
Total Marks	60

Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Usman Qamar
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives of the Course	
1	To reduce the safety and security risks associated with handling, storage, transportation and disposal of biological agents.
2	To give basic knowledge of biosafety & Biosecurity and to minimize risk to researchers, community and the environment that may be exposed to biological materials.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to biosafety and its importance in biological sciences
	Lecture-2	Definitions and terminologies, primary controls of Biosafety
	Practical-1	Demonstration of proper hand washing technique.
2 nd	Lecture-3	Codes and contents of the Laboratory
	Lecture-4	Laboratory hazards: bio hazards, chemical hazards, fire hazards, electric hazards, radiations hazards etc.
	Practical-2	Demonstration of personal protective equipments (PPEs)
3 rd	Lecture-5	Biorisk or Risk groups: Importance and understanding of list of microorganisms in different risk groups I, II, III, IV.
	Lecture-6	Biosafety Levels 1, 2
	Practical-3	Donning and doffing of PPEs of BSL 2
4 th	Lecture-7	Biosafety Levels 3
	Lecture-8	Biosafety Levels 4
	Practical-4	Donning of PPEs of BSL 3
5 th	Lecture-9	Biological safety cabinets: Class I
	Lecture-10	Biological safety cabinets: Class II (AI, AII)
	Practical-5	Doffing of PPE of BSL 3
6 th	Lecture-11	Biosafety Class II (BI, BII)
	Lecture-12	Biosafety Class III
	Practical-6	Demonstration to work in biosafety cabinet.
7 th	Lecture-13	Laboratory animal facilities: Animal facility – Biosafety Level 1.
	Lecture-14	Laboratory animal facilities: Animal facility – Biosafety Level 2 and 3.
	Practical-7	Demonstration of cleaning and disinfection of biosafety cabinets.
8 th	Lecture-15	Laboratory animal facilities: Animal facility – Biosafety Level 4.
	Lecture-16	Quiz

	Practical-8	Demonstration of cleaning and disinfection of working premises.
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Introduction to Laboratory Biosecurity.
	Lecture-18	Four primary controls of Biosecurity.
	Practical-9	Demonstration of how to handle spills and aseptic handling.
11 th	Lecture-19	Concept of transport of infectious materials: International transport regulations.
	Lecture-20	The basic triple packaging system, spill clean-up procedure risk analysis process.
	Practical-10	Demonstration of transportation of biological material
12 th	Lecture-21	Introduction to contingency plan.
	Lecture-22	Emergency procedures for microbiological laboratories
	Practical-11	Emergency response exercise
13 th	Lecture-23	Introduction Biorisk Management
	Lecture-24	Four pillars of Biorisk management
	Practical-12	Demonstration of how to handle spills and aseptic handling.
14 th	Lecture-25	Infectious waste management
	Lecture-26	Collection, types and disposal of lab waste.
	Practical-13	Demonstration of infectious waste management
15 th	Lecture-27	Good microbiology techniques
	Lecture-28	Safe handling and use of various lab equipments.
	Practical-14	Needle stick injury
16 th	Lecture-29	Disinfections and sterilization.
	Lecture-30	Risk assessment with SOP writing, evaluation and validation
	Practical-15	Demonstration of bottie dance
17 th	Lecture-31	Genetically modified organisms (GMOs)
	Lecture-32	Role of Biosafety officer in laboratories
	Practical-16	Biosafety signage in the laboratory
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

- Biosafety in Microbiological and Biomedical Laboratories, 5th Edition, U.S. Department of Health and Human, CD (<https://www.cdc.gov/biosafety/publications/bmbl5/bmbl.pdf>).
- Laboratory biosafety manual, Third edition, World Health Organization, Geneva, 2004 (<http://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf>).

- Biorisk management Laboratory Biosecurity guidance 2006.
(http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006_6.pdf).
- Biosafety Resource Book: 2011(<http://www.fao.org/docrep/014/i1905e/i1905e.pdf>).
- Laboratory Biorisk management: Strategies Framework for action 2012-2016
(http://apps.who.int/iris/bitstream/handle/10665/70878/WHO_HSE_2012.3_eng.pdf?sequence=1).
- Environmental Protection Department, Pakistan (http://epd.punjab.gov.pk/rules_regulations).

ENG-422 Technical Writing 3(3-0)

Course Title	Technical Writing
Course Code	ENG-422
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of English
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives:

To enable the students to

- Read Academics text critically
- Write well organized academic text e.g. assignments, examination answers
- Write narrative, descriptive, argumentative essays and reports (assignments)

Course Contents:

1. Critical Reading

Advanced reading skills and strategies building on Foundations of English I & II courses in semesters I and II of a range of text types e.g. description, argumentation, comparison and contrast

2. Advanced Academic Writing

Advanced writing skills and strategies building on English I & II in semesters I and II:

Writing summaries of articles

Report writing

Analysis and synthesis of academic material in writing

Presenting an argument in assignments/term-papers and examination answers

Recommended Readings:

1. Eastwood, J. (2004). English Practice Grammar (New edition with tests and answers). Karachi: Oxford University Press.
2. Howe, D.H, Kirkpatrick, T.A., & Kirkpatrick, D.L. (2004). Oxford English for Undergraduates. Karachi: Oxford University Press.
3. Murphy, R. (2003). Grammar in Use. Cambridge: Cambridge University Press.
4. Fisher, A. (2001). Critical thinking. CUP
5. Goatly, A. (2000). Critical Reading and Writing: An Introductory Course. London: Taylor & Francis

CSI-321 Introduction to Computing Applications 3(2-1)

Course Title	Introduction to Computing Applications
Course Code	CSI-321
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Computer Science
Session	2018-22
Semester (Morning/ Evening)	3 rd
Program	BS Microbiology

Learning Objectives:

1. To equip the students with basic knowledge of computer and its use.
2. To enhance the practical skills of students on the use of different computer programs

Course Contents:

Generation of computer

1st to 4th generation with their characteristics.

Basic concept of computer:

Introduction, different components of computer, basic design of computer.

Introduction to operating system

Introduction to OS, different management (processor, memory, device, file),

Processor management-Process concept, Threads, CPU Scheduling

Process scheduling, Deadlocks, Process synchronization.

Memory management- Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory.

Device management, File management.

Office operation

Microsoft word: concept of toolbar, character, paragraph & document formatting, drawing tool bar, header, footer, document editing, page setup, short cut keys, text & graphics.

Microsoft excel: concept of spread sheets, creating worksheet ,well formatted documents, concept of row, column ,cell & formula bar, using function ,using shortcuts ,chart, conditional formatting, goal seek, validation rule.

Microsoft power point: slide presentation, slide layout & design, custom animation, image importing, slide transition.

Practical

Usage of MS DOS commands: basic concept of internal & external commands, directory & file commands, copying, erasing, renaming, displaying files, introduction to pipes & filters, concept of batch file. Windows operation: Customizing the interface, windows explorer, computer upkeep & utilities

Recommended Readings:

1. Torbe Lag Frandsen (2007). Microsoft Office Excel 2007, Book boon ISBN: 978-87-7681-675-9 1 edition.
2. Howard Gould (2009). System Analysis and Design, ISBN: 978-87-403-1417-5 1 edition.

MIC- 402 General Virology 3(2-1)

Course Title	Virology
Course Code	MIC-402
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Shafique
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To identify major components of viruses
2	To study different systems used for classification of viruses
3	To learn Virus cultivation methods
4	Describe how viruses interact with cells
5	Examine the ways that viruses persist in host cells

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	General introduction of Virology and viruses
	Lecture-2	Why we study viruses? Symmetry of viruses
	Practical-1	Cultivation of viruses
2 nd	Lecture-3	Classification of viruses
	Lecture-4	Classification of viruses (continued)
	Practical-2	Different methods of virus cultivation
3 rd	Lecture-5	Cell culture: for cultivation of viruses (plants and animals)
	Lecture-6	Cell culture: various types of cell culture
	Practical-3	Detection and quantification of viruses
4 th	Lecture-7	Nature of animal and plant viruses
	Lecture-8	Quiz
	Practical-4	Chick embryo inoculation
5 th	Lecture-9	Replication of DNA viruses
	Lecture-10	Replication of DNA viruses (continued)
	Practical-5	Hemagglutination assay
6 th	Lecture-11	Replication of RNA viruses
	Lecture-12	Replication of RNA viruses (continued)
	Practical-6	Hemagglutination assay (performance)
7 th	Lecture-13	Assignment
	Lecture-14	Principles of electron microscopy

	Practical-7	Hemagglutination Inhibition assay
8 th	Lecture-15	Types of electron microscope
	Lecture-16	Sample preparation for electron microscopy
	Practical-8	Hemagglutination Inhibition assay (performance)
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Prion diseases
	Lecture-18	Viroids
	Practical-9	Plaque assay
11 th	Lecture-19	Satellites RNAs
	Lecture-20	Introduction to bacterial viruses.
	Practical-10	Electron microscopy
12 th	Lecture-21	Quiz
	Lecture-22	Receptors for bacteriophages
	Practical-11	Transmission electron microscopy (field trip)
13 th	Lecture-23	Adsorption sites for bacteriophages
	Lecture-24	Mode of replication of bacteriophages
	Practical-12	Sample preparation for electron microscopy
14 th	Lecture-25	Principles of viral diagnostic procedures
	Lecture-26	Assay of Viruses
	Practical-13	Isolation and identification of phages from various sources
15 th	Lecture-27	Assignment
	Lecture-28	Plaque Assay
	Practical-14	Isolation and identification of phages from various sources (performance)
16 th	Lecture-29	Effect of Physical and chemical agents on viruses
	Lecture-30	Antiviral agents and their mechanism of actions
	Practical-15	Plaque Assay (performance)
17 th	Lecture-31	Antiviral agents and their mechanism of actions (continued)
	Lecture-32	Presentation
	Practical-16	End-Point-Dilution Assay
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books/ Manuals:

1. Prescott Lansing M., Harley and Klein. (2002). Microbiology 5th Edition.

2. Zuckerman, A. J., Banatvala, J. E., Pattison, J. R., Griffiths, P., Schoub, B. (2004). Principles and Practice of Clinical Virology, 5th Edition. John Wiley and Sons Limited.
3. Cann, A. J. (2005). Principles of Molecular Virology. Elsevier Academic Press.
4. Dimmock N. J., Easton A.J. and Leppard K.N. (2007). Introduction to Modern virology. 6th edition. www.blackwellpublishing.com
5. Tortora G.J., Funke B.R. and Case C.L. (2010). Microbiology an introduction. 10th edition.

MIC-404 Immunology 3(2-1)

Course Title	Immunology
Course Code	MIC-404
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Hidayat Rasool
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course

1	Course is designed to introduce students to the subject of immunology, immune system and immunity.
2	Present a general perspective of different types of immunity.
3	To develop an understanding of antigen and antibody and to understand the mechanisms of different types of immune responses.
4	To impart basic knowledge about immunodiagnostics, cytokines and monoclonal antibodies with their applications
5	To discuss the process of immunization.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to immunology, immune system and immunity
	Lecture-2	Barriers of Innate/Non-specific immunity
	Practical-1	Laboratory Safety: Containment and decontamination
2 nd	Lecture-3	Acquired/Specific immunity: types and examples
	Lecture-4	Cells of immune system: Lymphocytes structure and function
	Practical-2	Collection of Blood sample from human
3 rd	Lecture-5	Cells of immune system: Monocytes, macrophages and granulocytes, dendritic cells
	Lecture-6	Organs of immune system: Primary organs- Thymus, Bursa, Bone marrow
	Practical-3	Collection of blood samples from animals
	Lecture-7	Organs of immune system: Secondary organs- Lymph nodes, spleen and MALTs

4 th	Lecture-8	Quiz
	Practical-4	Preservation and transportation of biological samples for immunological studies
5 th	Lecture-9	Antigens: Definitions-composition, properties, haptens, mitogens, adjuvants
	Lecture-10	Immunoglobulins: structure and functions
	Practical-5	Separation of cells, plasma and serum
6 th	Lecture-11	Antigen processing and presentations: endocytic pathway
	Lecture-12	Antigen processing and presentations: cytosolic pathway, assembly and presentation
	Practical-6	Separation and washing of RBCs
7 th	Lecture-13	Assignment
	Lecture-14	Introduction to immunodiagnostics: Principle, classification and reagents required
	Practical-7	Preparation of 0.5 and 1% RBCs suspension
8 th	Lecture-15	Primary binding tests: Radioimmunoassays
	Lecture-16	Revision and question answer session before Mid term
	Practical-8	Preparation and fixation of blood smears
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Primary binding tests: Immunofluorescence assays and Enzyme immunoassays
	Lecture-18	Secondary binding tests: Precipitation tests
	Practical-9	Preparation of serial dilutions (2-fold and 10-fold)
11 th	Lecture-19	Secondary binding tests: Agglutination tests, tertiary binding tests (neutralization and protection tests)
	Lecture-20	Micro haemagglutination tests: HA and HI
	Practical-10	Haemagglutination test
12 th	Lecture-21	Quiz
	Lecture-22	Cytokines: Definitions, nomenclature & classification, mode of action, discovery & purification, clinical applications
	Practical-11	Haemagglutination inhibition test
13 th	Lecture-23	Hybridoma and monoclonal antibodies: Introduction, production, screening and propagations
	Lecture-24	Uses of monoclonal antibodies
	Practical-12	Staining and microscopic examination of blood cells
14 th	Lecture-25	Major histocompatibility complex (MHC)
	Lecture-26	Assignment
	Practical-13	Blood grouping (ABO & Rh)
15 th	Lecture-27	Hypersensitivity reactions: Types and mechanisms with examples
	Lecture-28	Brief introduction to autoimmunity and autoimmune diseases

	Practical-14	Agar gel precipitation test
16 th	Lecture-29	Immunization: Introduction and types of vaccines-whole organism vaccines
	Lecture-30	Recombinant vaccines: Introduction with merits and demerits
	Practical-15	Raising of hyper immune sera and amboceptors in rabbit
17 th	Lecture-31	Presentation
	Lecture-32	Revision and question answer session
	Practical-16	Complement fixation test
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Judith, A.O., Punt, J. and Stranford, S.A. 2016. Kuby Immunology, 7th Ed., W.H. Freeman, New York, USA.
2. Male, D., Brostoff, J., Roth, B.D. and Roit, I., 2006. Immunology, 7th Ed., Mosby, Elsevier, UK.
3. Tizard, I., 2017. Veterinary Immunology, 10th Ed. Saunders Publishers, Elsevier, UK.
4. Lydyard, P., Whelan, A. and Fanger, M. 2011. BIOS Instant Notes in Immunology, 3rd Ed., Garland Science Product.

MIC-406 Parasitology 3(2-1)

Course Title	Parasitology
Course Code	MIC-406
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Usman Qamar
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course

1	Course is designed to introduce students to parasites.
2	☐ ☐ ☐ give the understanding of important properties, morphology, mode of transmission, lifecycle, diseases, diagnosis and treatment of different parasites.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Parasitology
	Lecture-2	Basic terminologies related to Parasitology
	Practical-1	Laboratory Safety: Containment and decontamination

2 nd	Lecture-3	History of Parasitology, ecology and host parasite relationship.
	Lecture-4	Classification of parasites
	Practical-2	Quality assurance of Parasitology tests.
3 rd	Lecture-5	Antiparasitic drugs: mode of action, drugs mechanisms and side effects.
	Lecture-6	Mechanisms of resistance of Antiparasitic drugs.
	Practical-3	Collection, transportation and storage of different parasitic blood and tissue samples.
4 th	Lecture-7	Entamoeba spp.
	Lecture-8	Naegleria, Acanthamoeba species.
	Practical-4	Collection, transportation and storage of different parasitic fecal samples.
5 th	Lecture-9	Giardia spp.
	Lecture-10	<i>Trichomonas vaginalis</i>
	Practical-5	Direct examination of fecal protozoa and cysts
6 th	Lecture-11	Introduction to blood parasites and Plasmodium spp.
	Lecture-12	Leishmania spp.
	Practical-6	Preparation of thick and thin blood smear
7 th	Lecture-13	Trypanosomes spp.
	Lecture-14	<i>Toxoplasma gondii</i>
	Practical-7	Microscopic examination of Plasmodium
8 th	Lecture-15	Pneumocystis spp.
	Lecture-16	Cryptosporidium spp.
	Practical-8	Microscopic examination of blood parasites other than plasmodium.
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Cestodes: <i>Taenia saginata</i> (beef tapeworm), <i>Taenia solium</i> (pork tapeworm).
	Lecture-18	<i>Echinococcus granulosus</i> (dog tapeworm).
	Practical-9	Direct examination of fecal eggs of Cestodes
11 th	Lecture-19	<i>Diphyllobothrium latum</i> (broad fish tapeworm)
	Lecture-20	<i>Hymenolepis nana</i> (dwarf tapeworm).
	Practical-10	Direct examination of fecal eggs of Cestodes
12 th	Lecture-21	Trematodes: Schistosoma species (blood flukes).
	Lecture-22	<i>Clonorchis sinensis</i> (liver fluke)
	Practical-11	Direct examination of fecal eggs of Schistosomes
13 th	Lecture-23	<i>Paragonimus westermani</i> (lung fluke).
	Lecture-24	Nematodes: Ascaris (giant roundworm).
	Practical-12	Direct examination of fecal eggs of nematodes
14 th	Lecture-25	<i>Enterobius vermicularis</i>
	Lecture-26	Trichuris (whipworm).
	Practical-13	Principle and procedure of fecal concentration techniques; Formol ether

		concentration technique and Zinc sulphate floatation technique
15 th	Lecture-27	Hook worms (Necator and Ancylostoma)
	Lecture-28	Strongyloides (small roundworm).
	Practical-14	Principle and procedure of fecal concentration techniques; Saturated sodium chloride floatation technique, Stoll's technique for counting helminths eggs
16 th	Lecture-29	<i>Wuchereria bancrofti</i>
	Lecture-30	<i>Loa loa</i>
	Practical-15	Microscopic examination of tissue nematodes
17 th	Lecture-31	Onchocerca spp.
	Lecture-32	Dracunculus and Toxocara larvae
	Practical-16	Serological identification of parasites
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Jawetz Melnick & Adelbergs Medical Microbiology 27 E (Lange) 27th Edition <https://www.amazon.com/Jawetz-Melnick-Adelbergs-Medical-Microbiology/dp/0071824987>.
2. Review of Medical Microbiology and Immunology, 14e. <https://accessmedicine.mhmedical.com/book.aspx?bookID=1792>.
3. Prescott's Microbiology, 10th Edition, By Joanne Willey and Linda Sherwood and Christopher J. Woolverton, 2017. <https://www.mheducation.com/highered/product/prescott-s-microbiology-willey-sherwood/M1259281590.html>.
4. District Laboratory Practice in Tropical Countries, Part 2. <https://www.medbox.org/district-laboratory-practice-in...part-2/download.pdf>.

MIC- 408 Epidemiology, Public Health and Bioethics 3(3-0)

Course Title	Epidemiology, Public Health and Bioethics
Course Code	MIC-408
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Zeeshan Nawaz
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course

1	To know what is Epidemiology & Public Health and their uses
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2	To learn Descriptive and Analytical Epidemiological studies
3	To be able to use different epidemiological tools for data analysis
4	To know about disease causation with the help of different models
5	To learn the diagnosis, prevention and control of different diseases

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Epidemiology and Public Health
	Lecture-2	Definitions (Epidemiology, Public Health, Health, Hygiene etc) and uses of Epidemiology
	Lecture -3	History of Epidemiology and Public Health
2 nd	Lecture-4	Frequency of Disease
	Lecture-5	Mortality of disease (Calculations and Formulas)
	Lecture -6	Morbidity of disease
3 rd	Lecture-7	Prevalence of disease (Calculation and Formula)
	Lecture-8	Factors affecting prevalence
	Lecture -9	Incidence of Disease (Calculation and Formula)
4 th	Lecture-10	Numericals for prevalence and incidence
	Lecture-11	Quiz
	Lecture -12	Cumulative Incidence (Calculation and Formula)
5 th	Lecture-13	Numericals for Cumulative Incidence
	Lecture-14	Incidence Rate (Calculation and Formula)
	Lecture -15	Numericals for Incidence Rate
6 th	Lecture-16	Relation between incidence and prevalence
	Lecture-17	Distribution of Disease (Pattern and Types)
	Lecture -18	Determinants of Disease and types of epidemiology
7 th	Lecture-19	Assignment
	Lecture-20	Epidemiological Triad
	Lecture -21	Disease Causation (Causal Pie Model)
8 th	Lecture-22	Koch's Postulates, Evan's Rules
	Lecture-23	Factors of component cause
	Lecture -24	Making a Hypothesis in disease causation
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Types of Epidemiological studies (Descriptive studies)
	Lecture-26	Analytical studies (Cohort study)
	Lecture -27	Case Control Study
11 th	Lecture-28	Cross sectional Study
	Lecture-29	2X2 Contingency Table
	Lecture -30	Odds Ratio and Relative Risk (Formulas)
12 th	Lecture-31	Quiz
	Lecture-32	Numerical for Odds ratio and Relative Risk
	Lecture -33	Experimental studies
13 th	Lecture-34	Sample, Sample size estimation (Formula)
	Lecture-35	Sampling methods (Types of sampling procedures)
	Lecture -36	Sero-epidemiology (Diagnostic tests)
14 th	Lecture-37	Agglutinations and Precipitations
	Lecture-38	ELISA, FAT, CFT and ICT
	Lecture -39	Sensitivity, Specificity, False Positive, False Negative, PPV, NPV and GMT etc

		(Formulas)
15 th	Lecture-40	Assignment
	Lecture-41	Concepts of Public Health
	Lecture -42	Dimensions of Wellness model
16 th	Lecture-43	Public Health Diseases (Polio, Measles)
	Lecture-44	Chicken pox, Hepatitis
	Lecture -45	Tuberculosis and Brucellosis
17 th	Lecture-46	Statistical Procedures (Mean, Median, Mode, Standard Deviation, Chi square test) etc.
	Lecture-47	Introduction to Bioethics (Principles)
	Lecture -48	Professional Patient Relationship and Bioethical Decision Making etc.
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (08 Objective) and (12 subjective)

Useful Weblinks and Additional Learning Resources	
1	http://sphweb.bumc.bu.edu/otlt/MPH-Modules/EP/EP713_DiseaseFrequency/EP713_DiseaseFrequency_print.html
2	http://sphweb.bumc.bu.edu/otlt/ MPH-modules/ep/ep713_causality/ep713_causality4.html
3	https://www.medcalc.org/calc/odds_ratio.php

Recommended Books:

1. Bonita, R., Beaglehole, R., Kjellstrom, T., 2006. Basic Epidemiology (2nd Edition). World Health Organization.
2. Leon Gordis, 2013. Epidemiology (5th Edition). Elsevier Saunders Publishers, PA, USA.
3. Karen L. R., 2015. Introduction to bioethics and ethical decision making. samples.jbpub.com/9781284059502/Chapter_2_Sample.pdf.

MIC- 410 Laboratory Animals and Model Organisms 2(0-2)

Course Title	Laboratory Animals and Model Organisms
Course Code	MIC-410
Credit Hours	2(0-2)
Total Marks	40
Contact Hours	4 Hours Per Week
Semester Duration	18 Weeks
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Asif Zahoor
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning Objectives of the Course

1	Introduction of the laboratory animals for <i>in vivo</i> studies.
2	Handling and care of lab animals considering the ethical standards

3	Introduction of plants used as model organisms
4	Legislation, ethics and views in society, design and statistics
5	Animal welfare, biology of research animals
6	The choice of animal model, genetic and environmental factors influencing animal experiments, health hazards
7	Principles of minimally invasive procedures on animals, anesthesia, analgesia and humane killing of laboratory animals
8	Microbiological quality, reporting, severity classification, the course of events in animal experiments
9	Introduction to microbial models

Week	Practical/ Practical	Course Contents
1 st	Practical-1	Introduction and significance of Lab animals
	Practical-2	Ethical standards of lab animal research
2 nd	Practical-3	Biology of laboratory animals
	Practical-4	Health monitoring
3 rd	Practical-5	Anesthesia
	Practical-6	Analgesia and euthanasia
4 th	Practical-7	Genetics
	Practical-8	Transgenic animal models
5 th	Practical-9	Handling techniques
	Practical-10	Rabbits: Housing and feeding
6 th	Practical-11	Rabbits: Sampling (Blood and fecal sampling)
	Practical-12	Mice: Housing and feeding
7 th	Practical-13	Mice: Sampling (Blood and fecal sampling)
	Practical-14	Rats handling and sampling
9 th	Practical-15	Guinea Pigs handling and sampling
	Practical-16	Birds (chicken) handling and sampling
9 th	Practical-17	Introduction and significance of Lab plants
	Practical-18	Arabidopsis and its life cycle
10 th	Practical-19	Maize and its life cycle
	Practical-20	Zebra Fish as model organism
11 th	Practical-21	Sampling from Fish
	Practical-22	<i>E. coli</i> – a model to study fundamental biological processes
12 th	Practical-23	<i>B. subtilis</i> - Studies on the regulation of gene expression
	Practical-24	Lambda phage, lytic and lysogenic cycle, gene expression control
13 th	Practical-25	Lytic bacteriophages T4
	Practical-26	Tobacco mosaic virus

14 th	Practical-27	Yeast (<i>Saccharomyces cerevisiae</i>) as a model for molecular biology, genomics and systems biology
	Practical-28	Filamentous (<i>Aspergillus nidulans</i>) fungi in biotechnology (production of antibiotics, enzymes and heterologous protein expression)
15 th	Practical-29	<i>Drosophila melanogaster</i> as a model organism in molecular biology
	Practical-30	Inoculation Routes
16 th	Practical-31	Biosafety and Biosecurity
	Practical-32	Design and Statistics
	Final Term Examination/ Result Submission/ Enrolment	Practical Exam of 40 Marks

Books and Manuals	
1	Sarah Wolfensohn (2013). Handbook of Laboratory Animal Management and Welfare 4 th Ed. Wiley-Blackwell.
2	Jonathan David Ward (2008). A Manual for Laboratory Animal Management. World Scientific.
3	National Research Council (2011). Guide for the Care and Use of Laboratory Animals: Eighth Edition.
4	P. Michael Conn (2008). Sourcebook of Models for Biomedical Research. Springer Science.

Visit to Other Facilities (If Required)	
1	Visit to Laboratory Animal Facilities (NIH Islamabad)

STA-507 Biostatistics 3(3-0)

Course Title	Biostatistics
Course Code	STA-507
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Statistics
Session	2018-22
Semester (Morning/ Evening)	4 th
Program	BS Microbiology

Learning objectives

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

Course Contents

Department of Microbiology, Government College University, Faisalabad

- Introduction to Biostatistics and its scope in Microbiology.
- Collection of Primary and Secondary data.
- Editing of data.
- Presentation of data: Tabulation, Classification, Visual Presentation (Diagrams and Graphs).
- Measures of Central Tendency: Arithmetic Mean by direct and short-cut method, Geometric Mean, Harmonic Mean, Mode, Median, ED_{50} (LD_{50} in detail), Quantile.
- Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation by direct and short-cut method, Variance, and their Coefficient.
- Correlation: Simple Correlation Table, Rank Correlation, Partial and Multiple Correlations.
- Regression and method of least square.
- Probability: Concept of Probability, Laws of Probability.
- Permutation and Combination.
- Probability distributions: Binomial distribution, Poisson distribution and their fitting to observed data, Normal distribution.
- Sampling and Basic Design
- Hypothesis Testing.
- Chi-square test, Student's t-test, Analysis of variance.
- Laboratory Experiments pertaining to the course.

Recommended Books

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

MIC- 501 Systemic Virology 3(2-1)

Course Title	Systemic Virology
Course Code	MIC-501
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Shafique
Session	2018-22
Semester (Morning/ Evening)	5 th
Program	BS Microbiology

Learning Objectives of the Course

1	To identify major families of viruses
2	To study System wise diseases of viruses
3	Describe how viruses infect host and cell interactions
4	Examine the ways that viruses persist in host cells
5	How viral diseases prevented and their control

Week	Lecture/ Practical	Course Contents
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1 st	Lecture-1	Introduction and scope of Virology
	Lecture-2	Branches of Virology and an overview of Viruses
	Practical-1	Laboratory Safety: Containment and decontamination
2 nd	Lecture-3	Historical Development in Systemic Virology
	Lecture-4	Historical Development (Continued)
	Practical-2	Introduction to Electron Microscopy: Parts and working of SEM
3 rd	Lecture-5	Nomenclature and Classification of Viruses
	Lecture-6	Introduction to viral families: dsDNA
	Practical-3	Introduction to Electron Microscopy: Parts and working of TEM
4 th	Lecture-7	Introduction to viral families: ssDNA
	Lecture-8	Quiz
	Practical-4	Preparation of specimen for SEM
5 th	Lecture-9	Introduction to viral families: dsRNA
	Lecture-10	Introduction to viral families: ssRNA
	Practical-5	Preparation of specimen for TEM
6 th	Lecture-11	Introduction to viral families: Retroviruses
	Lecture-12	Virus-host interaction
	Practical-6	Working of SEM & TEM (field trip)
7 th	Lecture-13	Assignment
	Lecture-14	Viral diseases: Introduction
	Practical-7	Lay out and construction of Virology Laboratory
8 th	Lecture-15	Viral Proteins, Virulence factors
	Lecture-16	Pathogenesis of viral diseases
	Practical-8	Facilities, equipment and precautionary measures
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Gastrointestinal infections
	Lecture-18	Gastrointestinal infections (Continued)
	Practical-9	Isolation and cultivation of viruses: Methods
11 th	Lecture-19	Respiratory infections
	Lecture-20	Respiratory infections (Continued)
	Practical-10	Isolation and cultivation of viruses: Laboratory animals
12 th	Lecture-21	Quiz
	Lecture-22	Infections of liver and systemic spread
	Practical-11	Isolation and cultivation of viruses: Embryo inoculation
13 th	Lecture-23	Infections of liver and systemic spread (Continued)
	Lecture-24	HIV and AIDS
	Practical-12	Isolation and cultivation of viruses: Embryo inoculation (Continued)

14 th	Lecture-25	HIV and AIDS (Continued)
	Lecture-26	Assignment
	Practical-13	Isolation and cultivation of viruses: Embryo inoculation (Continued)
15 th	Lecture-27	Carcinogenesis and tumor viruses
	Lecture-28	Carcinogenesis and tumor viruses (Continued)
	Practical-14	Isolation and cultivation of viruses: Cell culture
16 th	Lecture-29	Vaccines and Antiviral agents
	Lecture-30	Prion diseases
	Practical-15	Isolation and cultivation of viruses: Cell culture (Continued)
17 th	Lecture-31	Emerging viral infections
	Lecture-32	Revision and question answer session
	Practical-16	Cultivation and enumeration of Bacteriophages
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books

1. Nigel J. J., Dimmock, K. L. and Andrew E., 2001. Introduction to Modern Virology Blackwell Science, Inc.
2. Flint, S. J., Racaniello, V. R., Enquist, L. W. and Skalka, A. M. 2003. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. CMICROridge University Press.
3. Zuckerman, A. J., Banatvala, J. E., Pattison, J. R., Griffiths, P., Schoub, B., 2004. Principles and Practice of Clinical Virology, 5th Edition. John Wiley and Sons Limited.

MIC-503 Cell and Tissue Culture 3(2-1)

Course Title	Cell and Tissue Culture
Course Code	MIC-503
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Asif Zahoor
Session	2018-22
Semester (Morning/ Evening)	5 th
Program	BS Microbiology

Learning Objectives of the Course

1	To learn the basic principles of cell culture technology
2	To know about the different types of cell cultures
3	Basic knowledge of cell culture lab requirement and techniques

4	Application of cell culture in Microbiology
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Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to cell and cell culture
	Lecture-2	History and applications of cell culture
	Practical-1	Working guidelines in cell culture lab
2 nd	Lecture-3	Origin of cultured cells (Human and animal cells)
	Lecture-4	Biological properties of cultured cells
	Practical-2	Organization and Layout of cell culture lab
3 rd	Lecture-5	Culture Environment
	Lecture-6	Cell Adhesion (Cell adhesion molecules)
	Practical-3	Preparation of glassware, chemical and solutions
4 th	Lecture-7	Intercellular junctions
	Lecture-8	Intercellular junctions (Continued)
	Practical-4	Preparation of cell culture media
5 th	Lecture-9	Quiz
	Lecture-10	Extracellular matrix
	Practical-5	Cell and tissue disaggregation (Mechanical and Enzymatic)
6 th	Lecture-11	Cytoskeleton and cell motility
	Lecture-12	Cell proliferation
	Practical-6	Processing of primary explants (Chicken embryo)
7 th	Lecture-13	Differentiation
	Lecture-14	Maintenance of differentiation and de-differentiation
	Practical-7	Sub-culturing of primary cells
8 th	Lecture-15	Cell signaling
	Lecture-16	In vitro growth of cells
	Practical-8	Feeding of cultured cells
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Physical requirements of cells
	Lecture-18	Chemical requirements of cells
	Practical-9	Passaging of cultured cells
11 th	Lecture-19	Secondary cultures
	Lecture-20	Continuous cell lines
	Practical-10	pH maintenance
12 th	Lecture-21	Origin of mutant cell lines
	Lecture-22	Transformation

	Practical-11	Monitoring of contamination (Chemical, bacteria, fungi and viruses)
13 th	Lecture-23	Cell lines originated from tumor cells
	Lecture-24	Application of Continuous cell lines
	Practical-12	Control of cross contamination with other cell lines
14 th	Lecture-25	Morphology of cells in culture
	Lecture-26	Plant cell culture
	Practical-13	Counting of cells (Neubauer chamber)
15 th	Lecture-27	Insect cell culture
	Lecture-28	Lymphoid cell culture
	Practical-14	Cryopreservation of cell line
16 th	Lecture-29	Tissue culture and virology
	Lecture-30	Induced pluripotent stem cells
	Practical-15	Thawing of frozen cells
17 th	Lecture-31	Presentations
	Lecture-32	Revision and Question answer session
	Practical-16	Presentations
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books

1. Freshney, II., .2000. Culture of animal cells: A manual of basic techniques Wiley, John and Sons
2. Masters, J. R., 2000. Animal cell culture. Oxford University Press.
3. Lanza, R. P., Lanza, B., Atala, A., 2001. Methods of tissue engineering Academic Press Inc.
4. Barnum, S., 2004. Biotechnology: An Introduction (with Infotrac) Brooks /Cole.
5. Halford, N., 2006. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops .John Wiley and Sons Limited.

MIC- 505 Microbial Genetics 3(3-0)

Course Title	Microbial Genetics
Course Code	MIC-505
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Atif Nisar
Session	2018-22
Semester (Morning/ Evening)	5 th

Program	BS Microbiology
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Learning Objectives

The course deals with following goals

1. Organization and structure of microbial genomes
2. Concept of genome stability and plasticity
3. Methods of genetic recombination and gene transfer
4. To teach students various classical method of gene mapping in microbes.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Prokaryotic microbial genomes (archaea and bacteria)
	Lecture-2	Core genome versus pan genome
	Lecture-3	Chromosomal islands
2 nd	Lecture-4	Genome stability and horizontal gene transfer
	Lecture-5	Mobile elements and genome evolution
	Lecture-6	Plasmids and episomes: genetic structure and types
3 rd	Lecture-7	Replication of circular plasmids
	Lecture-8	Replication of linear plasmids
	Lecture-9	Plasmid copy number and partitioning system
4 th	Lecture-10	Plasmid incompatibility
	Lecture-11	Davis's U-tube experiment and bacterial conjugation
	Lecture-12	F ⁺ , F ⁻ and Hfr strains and conjugation
5 th	Lecture-13	Mapping bacterial genes with interrupted conjugation
	Lecture-14	Mathematical problems for bacteria gene mapping based on interrupted conjugation
	Lecture-15	Role of transfer (<i>tra</i>) operon in transfer of genetic material
6 th	Lecture-16	Molecular mechanism of conjugation in gram negative bacteria
	Lecture-17	Molecular mechanism of conjugation in gram positive bacteria
	Lecture-18	Transfer of genetic material from <i>Agrobacterium tumefaciens</i> to dicot plants
7 th	Lecture-19	Transposons: structure and function
	Lecture-20	Composite and complex transposons (Tn10 and Tn3 transposable elements)
	Lecture-21	Replicative and non-replicative transposition
8 th	Lecture-22	Conjugative transposons
	Lecture-23	Regulation of transposition
	Lecture-24	Integrations and insertion sequences
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Genetic recombination
	Lecture-26	Molecular mechanism of genetic recombination (Holliday junction formation)
	Lecture-27	Transformation and competence

11 th	Lecture-28	Transformation in gram positive bacteria (<i>Streptococcus</i> and <i>Bacillus</i>)
	Lecture-29	Transformation in gram negative bacteria (<i>Neisseria</i> and <i>Haemophilus</i>)
	Lecture-30	Transduction and phages
12 th	Lecture-31	Generalized and specialized transduction
	Lecture-32	Gene mapping in phages
	Lecture-33	Transduction: using phages to map bacterial genes
13 th	Lecture-34	Mathematical problems for bacterial gene mapping based on phage biology
	Lecture-35	λ phage: genome and life cycle
	Lecture-36	λ phage: genome insertion and excision
14 th	Lecture-37	λ phage: genetic control of lytic and lysogenic cycle
	Lecture-38	T4 phage: genome and life cycle
	Lecture-39	T4 phage: general pattern of gene expression
15 th	Lecture-40	μ phage: genome and life cycle
	Lecture-41	μ phage: transposition as a lifestyle
	Lecture-42	Single stranded DNA phages (M13)
16 th	Lecture-43	Molecular mechanisms of phase variation
	Lecture-44	Gene transfer mechanisms in archaea
	Lecture-45	Gene expression in archaea
17 th	Lecture-46	Eukaryotic microbial genomes (yeast, micro-algae and protozoa)
	Lecture-47	Budding yeast genetics: Mendelian inheritance and tetrad analysis
	Lecture-48	Numerical problems dealing with tetrad analysis in yeast
18 th	Final Term Examination/Result Submission/Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective)

Recommended Books:

1. Snyder, L., Champness, W., & Champness, W. (2013). Molecular genetics of bacteria. American Society for Microbiology.
2. Dale, J. W., & Park, S. F. (2013). Molecular genetics of bacteria. John Wiley & Sons.
3. Bainbridge, B. W. (2013). Genetics of microbes. Springer Science & Business Media.
4. Griffiths, A. J. (2005). An introduction to genetic analysis. Macmillan.
5. Streips, U. N., & Yasbin, R. E. (Eds.). (2002). Modern microbial genetics (Vol. 344). New York: Wiley-Liss.

MIC- 507 Molecular Biology and Biotechnology 3(2-1)

Course Title	Molecular Biology and Biotechnology
Course Code	MIC-507
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)

Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Bilal Aslam
Session	2018-22
Semester (Morning/ Evening)	5 th
Program	BS Microbiology

Learning Objectives of the Course	
1	Students shall understand the basic concepts and fundamentals of Molecular biology and Biotechnology.
2	Students would be trained with basic Molecular Biology Techniques
3	To learn the association of Molecular Biology and Microbiology in particular the Pathogenic Microbes
4	Scope of Biotechnology Particularly in the field of Microbiology

Week	Lecture/ Practical	Course Contents Covered
1 st	Lecture-1	Introduction to Molecular Biology, Definition and evolution of the subject
	Lecture-2	Brief History of Molecular Biology
	Practical-1	Safety measures for working in Molecular biology lab
2 nd	Lecture-3	Brief History of Molecular Biology continues; Transmission genetics,
	Lecture-4	Introduction to Molecular genetics and three domains of life
	Practical-2	Introduction to the Instruments of Molecular Biology lab
3 rd	Lecture-5	The Discovery of DNA
	Lecture-6	The Relationship between genes and Protein
	Practical-3	Introduction to various Molecular Biology Techniques
4 th	Lecture-7	Activities of genes
	Lecture-8	Quiz
	Practical-4	Hands on Practice with various delicate instruments (e.g. Micropipette, Microspin)
5 th	Lecture-9	Introduction to Molecular nature of gene
	Lecture-10	Transforming Principle by Griffith
	Practical-5	Detailed description of Polymerase Chain Reaction (PCR) Principle and Procedure
6 th	Lecture-11	Brief recall on DNA structure and experimental background
	Lecture-12	An introduction to gene function
	Practical-6	Characteristics of an ideal primer
7 th	Lecture-13	Assignment
	Lecture-14	Storing information (Genetic information)
	Practical-7	Detailed description and introduction of Instruments used in PCR
8 th	Lecture-15	Overview of gene expression
	Lecture-16	Brief introduction to protein structure and function
	Practical-8	DNA Extraction from bacterial cell

9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Discovery of mRNA
	Lecture-18	Introduction to various molecular methods and terms used in Molecular Biology
	Practical-9	Hands-on training (DNA extraction)
11 th	Lecture-19	Role of Biotechnology in the field of Microbiology
	Lecture-20	Introduction to genomics
	Practical-10	DNA quantification (Nanodrop)
12 th	Lecture-21	Quiz
	Lecture-22	Introduction to various tools used in genomics
	Practical-11	Preparation of various buffer solutions and dilutions used in PCR
13 th	Lecture-23	Introduction to Functional genomics
	Lecture-24	Introduction to transcriptomics
	Practical-12	Preparation of Master mix (Reaction mix) used in PCR, and hands-on training to use the thermal cycler
14 th	Lecture-25	Advancement in the field of Molecular Biology and Biotechnology
	Lecture-26	Advancement in the field of Biotechnology
	Practical-13	Preparation of agarose gel and perform agarose gel electrophoresis
15 th	Lecture-27	Assignment
	Lecture-28	Ethical issues of Molecular Biology and Biotechnology
	Practical-14	Gel Purification (purification of PCR product for sequencing)
16 th	Lecture-29	Role of Biotechnology in containment of human genetic disease
	Lecture-30	Introduction to various research groups and institutes working in the field of Biotechnology at national level
	Practical-15	Sequence analysis (BLAST etc.)
17 th	Lecture-31	Presentation
	Lecture-32	General discussion and Group discussion, Questions answers session for the preparation of Final exams
	Practical-16	Practical revision
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Useful Weblinks and Additional Learning Resources	
1	Molecular Biology by Robert F. Weaver
2	Gene cloning and DNA analysis by T. A. Brown
3	Genetics: Analysis and Principles- Brooker, R.J.
4	The Science of Genetics- Antherly A.G. Girton, J.R.
5	Microbial Genetics- Freifelder, D
Visit to Other Facilities (If Required)	

1	Study tour to National reference labs
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MIC- 509 Food Microbiology 3(2-1)

Course Title	Food Microbiology
Course Code	MIC-509
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Zeeshan Nawaz
Session	2018-22
Semester (Morning/ Evening)	5 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To know about food contamination by microorganisms
2	To learn about food spoilage by microorganisms
3	Preservation of food products & Control of microbial spoilage
4	Fermentation and fermented Food products
5	Food borne infections and intoxications

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Food and Dairy Microbiology
	Lecture-2	Contamination of Food and food products
	Practical-1	Safety Precautions and Laboratory rules
2 nd	Lecture-3	Spoilage of Food and food products
	Lecture-4	Spoilage of Canned Foods
	Practical-2	Equipments used in Food Microbiology Laboratory
3 rd	Lecture-5	Control of Microbial Contamination
	Lecture-6	Prevention of Food spoilage
	Practical-3	Isolation of Food borne microorganisms I
4 th	Lecture-7	Canning of Food Products
	Lecture-8	Quiz
	Practical-4	Isolation of Food borne microorganisms II
5 th	Lecture-9	Food Irradiation
	Lecture-10	Food Poisoning and intoxication
	Practical-5	Growth and enumeration of bacteria I
6 th	Lecture-11	Fungal Food poisoning (Myco intoxication)
	Lecture-12	Bacterial Food Poisoning

	Practical-6	Growth and enumeration of bacteria II
7 th	Lecture-13	Assignment
	Lecture-14	Staphylococcal Food poisoning
	Practical-7	Methylene Blue Reduction test for Milk quality
8 th	Lecture-15	Bacillus Food infections
	Lecture-16	Clostridium Food infections
	Practical-8	Resazurin Test for Milk quality
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	<i>E. coli</i> infections
	Lecture-18	Salmonella food infection
	Practical-9	Determination of coliform bacteria from milk I
11 th	Lecture-19	Shigella food infection
	Lecture-20	Campylobacter food infections
	Practical-10	Determination of coliform bacteria from milk II
12 th	Lecture-21	Quiz
	Lecture-22	Viral food borne infections
	Practical-11	Determination of <i>Staphylococcus aureus</i> from food
13 th	Lecture-23	Parasitic food borne infections
	Lecture-24	Fermentation and fermented food products
	Practical-12	Determination of <i>Salmonella</i> from food
14 th	Lecture-25	Fermentation of Dairy Products
	Lecture-26	Fermentation Cheese
	Practical-13	Microbial examination of meat and products
15 th	Lecture-27	Assignment
	Lecture-28	Fermentation of Beverages
	Practical-14	Examination of Canned food material
16 th	Lecture-29	Fermentation of bakery Products
	Lecture-30	Fermentation of Vinegar
	Practical-15	Laboratory Task
17 th	Lecture-31	Probiotics and Prebiotics
	Lecture-32	Storage and transportation of food products
	Practical-16	Laboratory Task
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books:

1. Jay, J.M., 2000. Modern Food Microbiology. A.N. Aspen Publications, USA
2. Singh, R.P., 2004. Microbiology. Kalyani Publishers, India
3. Bhunia, A.K., 2008. Food borne Microbial Pathogens. Springer Publishers, USA.
4. Awan, J.A. and S.U. Rahman, 2011. Microbiology Manual. Unitech Communications, Faisalabad, Pakistan

MIC- 511 Infectious Waste Management 3(2-1)

Course Title	Infectious Waste Management
Course Code	MIC-511
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Waseem
Session	2018-22
Semester (Morning/ Evening)	5 th
Program	BS Microbiology

Learning Objectives

1. Basic concept of infectious and non-infectious waste.
2. Type of infectious wastes and their management.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	An introduction to infectious material/waste.
	Lecture-2	An introduction to the management of infectious material/waste.
	Practical-1	Laboratory Safety: Containment and decontamination
2 nd	Lecture-3	Various types of infectious materials.
	Lecture-4	Handling and methods of their disposal.
	Practical-2	Difference between infectious & non-infectious wastes
3 rd	Lecture-5	Infectious diseases and methods of spread of agents involved.
	Lecture-6	Infectious diseases and methods of spread of agents involved (Continued)
	Practical-3	Categories/ types of infectious waste
4 th	Lecture-7	Laboratory and Hospital acquired infections
	Lecture-8	Quiz
	Practical-4	Management of sharps in labs.
5 th	Lecture-9	LAIs: possible sources and causes
	Lecture-10	Hazardous groups of microorganisms
	Practical-5	Cleaning and disinfection of working premises.
6 th	Lecture-11	Genetically modified organisms
	Lecture-12	Basic containment rules

	Practical-6	Working in Biosafety cabinet
7 th	Lecture-13	Assignment
	Lecture-14	Laboratory containment levels
	Practical-7	Needle stick injury
8 th	Lecture-15	Control measures and maintenance of control.
	Lecture-16	Guidelines for workers in pathological Labs. and post mortem rooms.
	Practical-8	Biosafety signage in the laboratory
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Rules for safe conduct of field work expeditions in outdoor activities.
	Lecture-18	Rules for safe conduct of field work expeditions in outdoor activities (Continued).
	Practical-9	Demonstration of infectious waste management
11 th	Lecture-19	Risk assessment: recognition of hazards
	Lecture-20	Competence, elimination of hazards, collection of data
	Practical-10	Demonstration of infectious waste management (Continued)
12 th	Lecture-21	Quiz
	Lecture-22	Risk group personnel
	Practical-11	Emergency response exercise
13 th	Lecture-23	Their education, training and monitoring
	Lecture-24	Radiation hazards and disposal of radioactive wastes.
	Practical-12	Spill management outside biosafety cabinet
14 th	Lecture-25	Radiation hazards and disposal of radioactive wastes (Continued)
	Lecture-26	Assignment
	Practical-13	Spill management inside biosafety cabinet
15 th	Lecture-27	Assignment
	Lecture-28	Tours to different hospitals for practical orientation of students
	Practical-14	Transportation of biological waste
16 th	Lecture-29	Presentation
	Lecture-30	Presentation
	Practical-15	Disposal of biological waste
17 th	Lecture-31	Quiz
	Lecture-32	Revision and Question answer session
	Practical-16	Laboratory Task
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books

1. World Health Organization. 2001. WHO biosafety manual, WHO, Geneva.
2. Gillespie, S., and Hawkey, P. 2006. Principles and Practice of Clinical Bacteriology, 2nd Edition. John Wiley & Sons, Inc U.S.A.
3. Frosch, M., Martin C. and Maiden, J., 2006. Handbook of Meningococcal Disease: Infection Biology, Vaccination, Clinical Management. John Wiley & Sons, Inc U.S.A.
5. Santoro, M.A., Gorrie, T.M., 2005. Ethics and the Pharmaceutical Industry, CMICROridge University Press
6. Fay, A., Rozovsky, J. D., Woods, Jr., J.M. and Bellamy, M., 2005. The Handbook of Patient Safety Compliance: A Practical Guide for Health Care Organizations. John Wiley and Sons limited.

MIC- 502 Vaccinology 3(2-1)

Course Title	Vaccinology
Course Code	MIC-502
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Shafique
Session	2018-22
Semester (Morning/ Evening)	6 th
Program	BS Microbiology

Learning Objectives of the Course

1	Get insights into manipulation of immune system for vaccine development.
2	Exploit natural disease resistance as a tool to find out vaccine targets.
3	Obtain detailed knowledge of different types of vaccines, characteristics of successful vaccines and their mode of protection.
4	Prepare vaccine at industry level and implement vaccination program.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	History of vaccine development
	Lecture-2	Introduction, immunity and its types
	Practical-1	Purification of antibody
2 nd	Lecture-3	Immunization: passive and active immunization
	Lecture-4	Vaccines: introduction & types of vaccines with their merits and demerits
	Practical-2	Preparation of different bacterial and viral antigens
3 rd	Lecture-5	Whole cell live attenuated and killed bacterial and viral vaccines
	Lecture-6	Toxoids and antitoxins
	Practical-3	Raising of hyper immune sera
4 th	Lecture-7	Vaccine production methods
	Lecture-8	Quiz

	Practical-4	Different methods of virus cultivation
5 th	Lecture-9	Different routes of vaccine administration
	Lecture-10	Current vaccination practices
	Practical-5	Purification & quantification of important bacteria for vaccine production
6 th	Lecture-11	EPI vaccines and Immunization Schedule
	Lecture-12	Production and testing of tetanus toxoid
	Practical-6	Purification and quantification of important viruses for vaccine production (continued)
7 th	Lecture-13	Assignment
	Lecture-14	Diphtheria Toxoids
	Practical-7	Hemagglutination assay
8 th	Lecture-15	Pertussis vaccine
	Lecture-16	BCG vaccine
	Practical-8	Hemagglutination assay (performance)
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Adjuvants: classification and properties
	Lecture-18	Mechanism of adjuvant action in vaccine
	Practical-9	Hemagglutination Inhibition assay
11 th	Lecture-19	Adjuvant types, functions with merits and demerits
	Lecture-20	Recombinant vaccines
	Practical-10	Hemagglutination Inhibition assay (performance)
12 th	Lecture-21	Quiz
	Lecture-22	Polynucleotide as vaccines
	Practical-11	Use of cell culture in attenuation of pathogenic microorganisms and vaccine production
13 th	Lecture-23	Vector vaccines
	Lecture-24	DNA vaccines
	Practical-12	Use of adjuvants in different vaccines
14 th	Lecture-25	Subunit vaccine; multivalent subunit vaccines
	Lecture-26	Anti-idiotypic vaccines
	Practical-13	ELISA, different types of ELISA
15 th	Lecture-27	Assignment
	Lecture-28	Human mucosal vaccines
	Practical-14	ELISA (performance)
16 th	Lecture-29	Edible vaccines produced in transgenic plants
	Lecture-30	Recent research and development of AIDS vaccines
	Practical-15	Study of immunogenicity of prepared vaccines in animal models

17 th	Lecture-31	Presentations
	Lecture-32	Presentations
	Practical-16	Safety evaluation of prepared vaccines in experimental animals
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books/ Manuals:

1. Janis Kuby, Immunology. 5th Edition. W H Freeman and company New York.
2. Ronald W. Ellis. (2001). New Vaccine Technologies. Eurekah.com / Landes Bioscience, 810 South Church Street Georgetown, Texas, USA.
3. Manmohan Singh. (2007). Vaccine Adjuvants and Delivery Systems. Novartis Vaccines Emeryville, California. Published by John Wiley & Sons, Inc., Hoboken, New Jersey. USA and simultaneously in Canada.
4. Derrek T. O Hagan. (2000). Vaccine Adjuvants, Preparation Methods and research protocols. Published by Humana Press Totowa, New Jersey, USA.
5. Robinson A., Hudson, M.J. and Cranage M.P. Methods in Molecular Medicine, Vol. 87: Vaccine Protocols, 2nd Edition. Humana Press Inc., Totowa, New Jersey, USA.
6. David male, Jonathan Brostoff, David B Roth, Ivan Roitt "Immunology" 7th edition 2006, Mosby, Europe Ltd, London.
7. Gregory G., C.A. Anthony and P. George; 1990. Vaccines: recent trends and progress. Series A: Life sciences: vol; 215 plenum press, New York

MIC-504 Environmental Microbiology 3(2-1)

Course Title	Environmental Microbiology
Course Code	MIC-504
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Saima Muzammil
Session	2018-22
Semester (Morning/ Evening)	6 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To give student an overview about Fundamental and Applied aspects of Environmental microbiology.
2	To understand the contemporary issues associated with environmental microbiology
3	To prepares the student to address pressing environmental challenges by developing a fundamental understanding of the microbial communities and processes in natural and built environments.
4	At the end student will be capable of applying fundamental principles of microbiology to the degradation of contaminants and principles of microbiology to wastewater treatment

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to environmental microbiology
	Lecture-2	Components/regions of environment: lithosphere, hydrosphere, stratosphere and biosphere
	Practical-1	Isolation of microorganisms from industrial effluent.
2 nd	Lecture-3	Greenhouse effect, ozone layer depletion and acid rain and its types
	Lecture-4	Greenhouse effect, ozone layer depletion and acid rain and its types (continued)
	Practical-2	Isolation of microorganisms from industrial effluent (cont)
3 rd	Lecture-5	The air as an environment of microorganisms/adaptation of microorganism to the air
	Lecture-6	Biological aerosols
	Practical-3	Isolation of Oil degrading bacteria from environment.
4 th	Lecture-7	Mechanisms protecting lungs against bioaerosol/survival of bioaerosol
	Lecture-8	Emission of bioaerosol and effect as human hazards
	Practical-4	Isolation of Oil degrading bacteria from environment. (cont)
5 th	Lecture-9	Biological and chemical pesticides: their advantages and disadvantages
	Lecture-10	Biological and chemical pesticides: their advantages and Disadvantages (continued)
	Practical-5	Determination of heavy metal in industrial effluent
6 th	Lecture-11	Microbial degradation of toxic and poorly degradable (recalcitrant) compounds.
	Lecture-12	Microbial degradation of organic compounds
	Practical-6	Determination of heavy metal in industrial effluent (cont)
7 th	Lecture-13	Assignment/quiz
	Lecture-14	Bioremediation of polymers (plastics)
	Practical-7	Effects of industrial effluents on germination and growth of seedlings.
8 th	Lecture-15	Bioremediation of Pesticides
	Lecture-16	Bioremediation of Petroleum products
	Practical-8	Effects of industrial effluents on germination and growth of seedlings. (continued)
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Oil degrading bacteria
	Lecture-18	Oil degrading bacteria (continued)
	Practical-9	Adaptation of soil bacteria to metal
11 th	Lecture-19	Biodegradation of wood and paper
	Lecture-20	Biodegradation of textiles and rubber and leather
	Practical-10	Adaptation of soil bacteria to metal (cont)
12 th	Lecture-21	Bioaccumulation of heavy metals and phyto remediation.
	Lecture-22	Phytoremediation and its types
	Practical-11	Study the effect of PGPR on plant seedling growth
13 th	Lecture-23	The degradation of synthetic chemicals in soil and water
	Lecture-24	Role of microbes in solid waste municipal treatment
	Practical-12	Study the effect of PGPR on plant seedling growth (cont)
14 th	Lecture-25	Role of microbes in solid waste municipal treatment Landfills, Leachate, Anaerobic degradation phases
	Lecture-26	Drinking water microbiome and treatment, Microbial instability
	Practical-13	Water purity test
15 th	Lecture-27	Sewage (waste water) treatment (microbial role)
	Lecture-28	Sewage (waste water) treatment (microbial role) (continued)

	Practical-14	Detoxification of metal ions through microbes
16 th	Lecture-29	Biofuels production
	Lecture-30	Applications of recombinant microorganisms in reducing environmental pollution.
	Practical-15	Isolation of bacteria from contaminated soil
17 th	Lecture-31	Microbes as a tool for the assessments of risks associated with the environment.
	Lecture-32	Revision and question answer session
	Practical-16	Isolation of bacteria from contaminated soil (cont)
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quiz, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Singh, R.P., (2004). Microbiology, Kalyani publisher, New Delhi, Chapter 11: Biological Nitrogen Fixation
2. D. Sylvia et al., Principles and Applications of Soil Microbiology, 2005, 2nd edition.
3. Laboratory manual (2015) Andrzej Bieganski, Stanislav Malý, Magdalena Frac, Ivan H. Tuf, Central Institute for Supervising and Testing in Agriculture, Hroznová 2, 656 06 Brno Czech Republic
4. Tortora, G.J., Christine, L. Case, C.L. Funke, B.R., Funke, B., Case, C., 2016. Microbiology: An Introduction, 9th Ed., Pearson Education, USA.
5. Bruce E. Rittmann, and Perry L. McCarty. Environmental Biotechnology: Principles and Applications. McGraw-Hill, 2001. ISBN: 0071181849. 2017.
6. Madigan, M., Bender K. S., Buckley D.H., Sattley W. M., and Stahl D.A. Brock Biology of Microorganisms. 15th ed. New York: Pearson, 2017. ISBN: 0134261925. 2001.

MIC-506 Medical Microbiology 3(2-1)

Course Title	Medical Microbiology
Course Code	MIC-506
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Usman Qamar
Session	2018-22
Semester (Morning/ Evening)	6 th
Program	BS Microbiology

Learning Objectives of the Course

1	To give knowledge of medically important microorganisms causing infections in human.
2	To understand the pathogenesis, clinical significance and pathogenicity of microbial infections.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Medical Microbiology
	Lecture-2	Staphylococci (<i>S. aureus</i> , <i>S. epidermidis</i> , <i>S. saprophyticus</i>)

	Practical-1	Laboratory Safety: Containment and decontamination
2 nd	Lecture-3	Streptococci (Lancefield Group A, B, D and <i>S. pneumoniae</i>)
	Lecture-4	Gram Positive Bacilli (<i>B. anthracis</i> , <i>B. cereus</i>)
	Practical-2	Quality assurance and quality control of medical microbiology tests.
3 rd	Lecture-5	Clostridium (<i>C. tetani</i> , <i>C. botulinum</i>).
	Lecture-6	<i>Neisseria meningitides</i> and <i>N. gonorrhoeae</i>
	Practical-3	Collection, transportation and storage of different samples from infectious diseases (blood, urine, pus).
4 th	Lecture-7	Gram negative rods: <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i>
	Lecture-8	Salmonella Typhi, Shigella spp.,
	Practical-4	Collection, transportation and storage of different samples from infectious diseases (feces, sputum, CSF, body fluid).
5 th	Lecture-9	Acinetobacter and <i>P. aeruginosa</i> , Haemophilus spp.,
	Lecture-10	<i>Vibrio cholerae</i>
	Practical-5	Bacterial staining (Gram, Z.N, Spore and Capsule)
6 th	Lecture-11	Mycobacterium tuberculosis and <i>M. laprae</i>
	Lecture-12	Introduction to medically important fungi
	Practical-6	Biochemical tests for Gram positive bacteria (catalase, coagulase, DNase, bile esculin test).
7 th	Lecture-13	Cutaneous and subcutaneous fungi (Dermatophytes)
	Lecture-14	Systemic fungi: Histoplasma spp., and Blastomyces spp.,)
	Practical-7	Biochemical tests for Gram negative bacteria (oxidase, indole, citrate, urease, methyl red and vogues Proskauer)
8 th	Lecture-15	Opportunistic fungi: Candia albicans
	Lecture-16	Aspergillus and Cryptococcus
	Practical-8	Culturing and microscopic examination of medically important fungi.
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Introduction to medically important parasites. Amoeba: <i>E. histolytica</i> .
	Lecture-18	<i>Giardia lamblia</i> , <i>Trichomonas vaginalis</i>
	Practical-9	Microscopic examination of fecal eggs and cysts
11 th	Lecture-19	Blood parasites: Plasmodium spp.,
	Lecture-20	Trypanosomes spp.,
	Practical-10	Microscopic examination of blood parasites.
12 th	Lecture-21	Leishmania spp.,
	Lecture-22	Helminths: <i>Tinea saginata</i> , <i>Echinococcus granulosus</i>
	Practical-11	Microscopic examination of fecal eggs of helminths
13 th	Lecture-23	Schistosomes spp.,
	Lecture-24	Nematodes: Ascaris (giant roundworm) and <i>Enterobius vermicularis</i> (Pin worm).

	Practical-12	Direct examination of fecal eggs of nematodes
14 th	Lecture-25	Hook worm
	Lecture-26	Trichuris (whipworm), <i>Wuchereria bancrofti</i> .
	Practical-13	Principle and procedure of different fecal concentration techniques
15 th	Lecture-27	Introduction to medically important viruses, Herpes viruses
	Lecture-28	Hepatitis viruses
	Practical-14	Microscopic examination of viruses
16 th	Lecture-29	Influenza viruses
	Lecture-30	HIV, Dengue virus.
	Practical-15	Identification of virus in cell cultures
17 th	Lecture-31	Polio virus, Rota virus, Rabies virus
	Lecture-32	Measles virus, Mumps virus, Rubella virus,
	Practical-16	Serological identification of viruses.
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

- Sherris Medical Microbiology, Sixth Edition 6th Edition. <https://www.amazon.com/Sherris-Medical-Microbiology-Sixth-Kenneth/dp/0071818219>.
- Jawetz Melnick & Adelbergs Medical Microbiology 27 E (Lange) 27th Edition <https://www.amazon.com/Jawetz-Melnick-Adelbergs-Medical-Microbiology/dp/0071824987>.
- Review of Medical Microbiology and Immunology, 14e. <https://accessmedicine.mhmedical.com/book.aspx?bookID=1792>.
- Prescott's Microbiology, 10th Edition, By Joanne Willey and Linda Sherwood and Christopher J. Woolverton, 2017. <https://www.mheducation.com/highered/product/prescott-s-microbiology-willey-sherwood/M1259281590.html>.
- District Laboratory Practice in Tropical Countries, Part 2. <https://www.medbox.org/district-laboratory-practice-in...part-2/download.pdf>.

MIC- 508 Veterinary Microbiology 3(2-1)

Course Title	Veterinary Microbiology
Course Code	MIC-508
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Zeeshan Nawaz
Session	2018-22
Semester (Morning/ Evening)	6 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To know about viral and bacterial diseases of animals and birds
2	To learn about the zoonotic potential of animal diseases
3	To know the prevention and control strategies of animals and poultry diseases
4	To have the knowledge of trans boundary diseases, disease diagnosis

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Veterinary Microbiology
	Lecture-2	Viral and bacterial threats to animals and poultry
	Practical-1	Types and sites of sample collection from animals
2 nd	Lecture-3	Viral Diseases of Livestock (FMD)
	Lecture-4	Viral Diseases of Livestock (PPR)
	Practical-2	Isolation of viral pathogens of animals I
3 rd	Lecture-5	Viral Diseases of Livestock (Blue Tongue)
	Lecture-6	Viral Diseases of animals (Rabies)
	Practical-3	Isolation of viral pathogens of animals II
4 th	Lecture-7	Bacterial Diseases of Livestock (Tuberculosis)
	Lecture-8	Quiz
	Practical-4	Isolation of bacterial Pathogens of animals I
5 th	Lecture-9	Bacterial Diseases of Livestock (HS)
	Lecture-10	Bacterial Diseases of Livestock (Brucellosis)
	Practical-5	Isolation of bacterial Pathogens of animals II
6 th	Lecture-11	Bacterial Diseases of Livestock (Anthrax)
	Lecture-12	Bacterial Diseases of Livestock (Mastitis)
	Practical-6	Types and routes of Livestock Vaccination
7 th	Lecture-13	Assignment
	Lecture-14	Viral Diseases of Poultry (Newcastle Disease)
	Practical-7	Types and routes of Poultry Vaccination
8 th	Lecture-15	Viral Diseases of Poultry (Avian Influenza)
	Lecture-16	Viral Diseases of Poultry (IBD)
	Practical-8	Field visit to a Veterinary Hospital
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Viral Diseases of Poultry (HPS)
	Lecture-18	Viral Diseases of Poultry (Marek's Disease)
	Practical-9	Diagnosis of Veterinary Diseases I
	Lecture-19	Bacterial diseases of Poultry (Salmonellosis)

11 th	Lecture-20	Bacterial diseases of Poultry (Fowl Cholera)
	Practical-10	Diagnosis of Veterinary Diseases II
12 th	Lecture-21	Quiz
	Lecture-22	Equine Diseases (Glanders)
	Practical-11	Diagnosis of Veterinary Diseases III
13 th	Lecture-23	Equine Diseases (Strangles)
	Lecture-24	Equine Diseases (Tetanus)
	Practical-12	Raising of hyper immune serum
14 th	Lecture-25	Zoonotic diseases and importance
	Lecture-26	Transboundary diseases and control
	Practical-13	Raising of amboceptors
15 th	Lecture-27	Assignment
	Lecture-28	Control strategies of livestock diseases
	Practical-14	Practical Performance I
16 th	Lecture-29	Control strategies of Poultry diseases
	Lecture-30	Quarantine strategies
	Practical-15	Practical Performance II
17 th	Lecture-31	International institutes working on animal diseases
	Lecture-32	National institute working on animal diseases
	Practical-16	Miscellaneous Task
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Recommended Books:

1. The Merck Veterinary Manual (8th Edition), Merck and Co, Whitehouse Station, NJ, USA.
2. Saif, Y.M. Diseases of Poultry (11th Edition). Blackwell Publishing Co., UK
3. Quinn, P.J., Markey, B.K., Leonard, F.C., Hartigan, P., Fanning, S., 2012. Veterinary Microbiology and Microbial Disease. Wiley, John and Sons Incorporated.

MIC- 510 Microbial Enzymology 3(3-0)

Course Title	Microbial Enzymology
Course Code	MIC-510
Credit Hours	3(3-0)
Total Marks	60
Contact Hours	3 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Muhammad Atif Nisar
Session	2018-22
Semester (Morning/ Evening)	6 th

Program	BS Microbiology
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Learning Objectives

The course is designed to achieve following goals

1. Basic knowledge of enzyme catalysis
2. Methods of enzyme purification
3. Application of microbial enzymology in industry

Week	Lecture/ Practical	Course Contents Covered
1 st	Lecture-1	Introduction to bioenergetics and thermodynamics
	Lecture-2	Concept of free energy
	Lecture-3	Introduction to reaction kinetics and order of reaction
2 nd	Lecture-4	Introduction to enzymes
	Lecture-5	Enzymes and activation energy
	Lecture-6	Enzymes and reaction equilibria
3 rd	Lecture-7	Enzyme substrate interaction
	Lecture-8	Role of amino acids in reaction catalysis
	Lecture-9	Effect of substrate concentration on enzyme catalysis
4 th	Lecture-10	Michaelis-Menten equation (mathematical derivation)
	Lecture-11	Line weaver-Burk equation
	Lecture-12	V_{max} , K_m , K_{cat} and binding energy
5 th	Lecture-13	Types of enzyme inhibitors
	Lecture-14	Michaelis-Menten equation for competitive inhibitors (mathematical derivation)
	Lecture-15	Michaelis-Menten equation for uncompetitive inhibitors (mathematical derivation)
6 th	Lecture-16	Michaelis-Menten equation for mixed inhibitors (mathematical derivation)
	Lecture-17	Effect of pH on reaction mechanism of serine proteases (chymotrypsin and related enzymes)
	Lecture-18	Catalytic triad of serine proteases (chymotrypsin and related enzymes)
7 th	Lecture-19	Reaction mechanism of HIV proteases and anti-HIV drugs
	Lecture-20	Penicillin binding protein (PBP) and β -lactam drugs
	Lecture-21	Reaction mechanism of lysozyme
8 th	Lecture-22	Allosteric enzymes
	Lecture-23	Homotropic and heterotropic allosteric regulator
	Lecture-24	Protein-Ligand Interactions (mathematical relationship)
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Antigen-antibody interaction (binding forces and binding energy)
	Lecture-26	Enzyme classification, naming and databases
	Lecture-27	Isozymes
11 th	Lecture-28	Crude/cell lysates preparation for enzyme extraction
	Lecture-29	Precipitation techniques and dialysis for enzyme extraction

	Lecture-30	Column chromatography
12 th	Lecture-31	Ion-exchange chromatography
	Lecture-32	Hydrophobic interaction chromatography
	Lecture-33	Gel filtration chromatography
13 th	Lecture-34	Affinity chromatography
	Lecture-35	High-performance liquid chromatography (HPLC) and fast protein liquid chromatography (FPLC)
	Lecture-36	Isoelectric focusing and electrophoresis
14 th	Lecture-37	Matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) and electrospray ionization mass spectrometry (ESI-MS)
	Lecture-38	Protein sequencing
	Lecture-39	Enzyme assay and measurement of enzyme activity and specific activity
15 th	Lecture-40	Industrially important microbial enzymes
	Lecture-41	Industrial production of microbial enzymes
	Lecture-42	Introduction to bioprocess design (batch and fed-batch fermentation)
16 th	Lecture-43	Introduction to bioprocess design (continuous fermentation)
	Lecture-44	Bacterial and fungal amylase (industrial application)
	Lecture-45	Bacterial and fungal lipases (industrial application)
17 th	Lecture-46	Diagnostic application of enzymes
	Lecture-47	Therapeutic application of enzymes
	Lecture-48	Ribozymes (RNA enzymes)
18 th	Final Term Examination/Result Submission/Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective)

Recommended Books:

1. Bisswanger, H. (2017). Enzyme kinetics: principles and methods. John Wiley & Sons.
2. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (Edition 7). Macmillan.
3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level. New York: Wiley.
4. Scopes, R. K. (2013). Protein purification: principles and practice. Springer Science & Business Media.
5. Price, N. C., & Frey, P. A. (2001). Fundamentals of enzymology. Oxford University Press.

Web Links:

1. Enzyme Database - BRENDA (<https://www.brenda-enzymes.org/>)
2. Worthington Enzyme Manual-Worthington Biochemical Corporation (<http://www.worthington-biochem.com/index/manual.html>)
3. ExPASy- ENZYME (<https://enzyme.expasy.org/>)

BIN-422 Introduction to Bioinformatics 3(2-1)

Course Title	Introduction to Bioinformatics
Course Code	BIN-422
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	From Department of Bioinformatics & Biotechnology
Session	2018-22
Semester (Morning/ Evening)	6 th
Program	BS Microbiology

Learning Objectives of the Course

1	To know the fundamentals of Bioinformatics
2	To give basic knowledge of various bioinformatics tools
3	Application of Bioinformatics tools in Microbiology

Course Contents

Introduction and Importance of Bioinformatics, Biological Databases, Introduction to NCBI, EBI and DDBJ, Protein Sequence Primary and Secondary Databases, Protein Pattern Databases, Structure Classification Databases, Analysis of Protein Sequences, Introduction and Applications of Pairwise Sequence Alignment, Sequence Homology, Similarity and Identity, Global VS Local Alignment, Database Similarity Searching using BLAST and FASTA, Introduction and Applications of Multiple Sequence Alignment, Multiple Sequence Alignment Scoring Matrices, Molecular Phylogenetics, Phylogenetic Tree Representations and Construction Methods/Programs, Phylogenetic Tree Evaluation and Visualization. Introduction to genome and Genome browsers, gene prediction in prokaryotes and eukaryotes, RNA structure prediction, siRNA and shRNAs, gene pathway analysis, computational secondary and tertiary protein structure prediction methods, structure prediction evaluation, protein fold identification and computer aided drug designing, Molecular docking, image analysis.

Practicals

Primary databases for literature, DNA and Protein sequences, Databases of online tools for DNA and Protein sequence analysis, Global Sequence Alignment, Local Sequence Alignment, Database Similarity Searching using BLAST and FASTA, On-line Tools for Multiple Sequence Alignment, Primer designing and calculation of primer parameters, Phylogenetic Tree Construction and evaluation. Online tools for gene prediction in prokaryotes and eukaryotes, protein secondary and tertiary structure prediction using online server, protein structure visualization, Auto-dock programme, siRNA and shRNA designing practice, image analysis software etc.

Recommended Books

1. Baxevanis, A. D. and Ouellette, B.F.F. (2004) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. A John Wiley and Sons, Inc. Publication, New York.
2. Baxevanis, A. D. et al., (2013) Current Protocols in Bioinformatics. Wiley Publishers (Online Library).
3. Claverie, J.M. and Notredame, C. (2007) Bioinformatics for Dummies. Wiley Publishing Inc., Indianapolis, Indiana.

4. Ye, S.Q. (2008) Bioinformatics: A practical Approach. Chapman and Hall/CRC Publishers, Taylor and Francis Group, London, UK.
5. Xiong, J. (2006) Essential Bioinformatics. Cambridge University Press, Cambridge, UK.
6. Orengo, C.A., Jones, D.T. and Thornton, J.M. (2007) Bioinformatics: Genes, Proteins, and Computers. BIOS Scientific Publishers Ltd, Oxford, UK.
7. Hall, B.G. (2004) Phylogenetic Trees Made Easy: A How to Manual. Sinauer Associates, Inc., Massachusetts, USA.
8. Felsenstein, J. (2004) Inferring Phylogenies. Sinauer Associates, Inc., Massachusetts, USA.

MIC-601 Diagnostic Microbiology 3(2-1)

Course Title	Diagnostic Microbiology
Course Code	MIC-601
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Usman Qamar
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course

1	Course is designed to introduce students to the subject of diagnostic microbiology.
2	To understand the role of microbiology laboratory in the diagnosis and interpretation of infectious diseases.
3	To know the collection, transportation, processing, analysis and schematic diagnosis of specific specimens source.

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to diagnostic microbiology
	Lecture-2	Introduction to triad of infectious disease: Infectious agent, environment, and infected host.
	Practical-1	Morphologic identification of the agent in stains of specimens or sections of tissues (light and electron microscopy).
2 nd	Lecture-3	Phases of diagnostic cycle: pre analytical phase, analytical phase, post analytical phase.
	Lecture-4	Administrative aspect of the microbiology laboratory: risk management and patient safety, lab safety, quality assurance, quality control.
	Practical-2	Culture isolation and identification of the agent.
3 rd	Lecture-5	Nosocomial infections and surveillance study.
	Lecture-6	Manual, semi-automatic system for the identification of microorganisms.
	Practical-3	Biochemical identification of microorganisms by API

4 th	Lecture-7	Laboratory aids in the selection of antimicrobial therapy of Gram positive bacteria
	Lecture-8	Laboratory aids in the selection of antimicrobial therapy of Gram negative bacteria.
	Practical-4	Biochemical identification of microorganisms by automatic system (Vitek 2 systemetc).
5 th	Lecture-9	Laboratory diagnosis of anaerobic infections
	Lecture-10	Laboratory diagnosis of upper respiratory tract
	Practical-5	Laboratory aids in the selection of antimicrobial therapy (Diffusion methods)
6 th	Lecture-11	Laboratory diagnosis of lower respiratory tract
	Lecture-12	Laboratory diagnosis of gastro intestinal tract infection (<i>E. coli</i> , <i>Salmonella</i> spp.,).
	Practical-6	Laboratory aids in the selection of antimicrobial therapy (Dilution methods).
7 th	Lecture-13	Laboratory diagnosis of gastro intestinal tract infection (<i>Shigella</i> , <i>Vibrio cholerae</i>)
	Lecture-14	Laboratory diagnosis of urinary tract infections.
	Practical-7	Detection of antigen from the agent by immunologic assay (latex agglutination, complement fixation assay),
8 th	Lecture-15	Laboratory diagnosis of catheter associated urinary tract infections
	Lecture-16	Quiz
	Practical-8	Detection of antigen from the agent by immunologic assay enzyme immunoassay [EIA], fluorescent-labelled (peroxidase-labelled) antibody stains.
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Laboratory diagnosis of blood borne pathogens
	Lecture-18	Laboratory diagnosis of genital infections
	Practical-9	Demonstration of meaningful antibody or cell-mediated immune responses to an infectious agent.
11 th	Lecture-19	Laboratory diagnosis of bone (osteomyelitis)
	Lecture-20	Laboratory diagnosis of joints (septic arthritis)
	Practical-10	Nucleic Acid Hybridization Probes
12 th	Lecture-21	Laboratory diagnosis of central nervous system
	Lecture-22	Laboratory diagnosis of skin
	Practical-11	Bacterial and fungal Identification Using 16S and 18S rRNA Probe Hybridization.
13 th	Lecture-23	Laboratory diagnosis of wound, abscess.
	Lecture-24	Laboratory diagnosis of eye infections
	Practical-12	Target Amplification Systems, Signal Amplification Techniques.
14 th	Lecture-25	Laboratory diagnosis of ear infections
	Lecture-26	Quiz
	Practical-13	Amplification Methods: Non-PCR-Based, Real-Time PCR.
15 th	Lecture-27	Laboratory diagnosis of viral infections
	Lecture-28	Diagnosis approaches or scheme of viral infections

	Practical-14	PCR-Sequencing, Microarray, High-Throughput Sequencing
16 th	Lecture-29	Laboratory diagnosis of fecal parasitic infections
	Lecture-30	Assignment
	Practical-15	Application of MALDI-TOF Mass Spectrometry for the detection of microorganisms.
17 th	Lecture-31	Laboratory diagnosis of blood parasitic infections
	Lecture-32	Laboratory diagnosis of fungal infections
	Practical-16	Virus Culture (Preparation of Inocula, Cultivation in cell culture, Shell Vial Cultures (centrifugation-enhanced culture, Immune Electron Microscopy).
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Koneman's Color Atlas and Textbook of Diagnostic Microbiology 7th edition, 2016. <https://smtebooks.com/book/4231/konemans-color-atlas-textbook-diagnostic-microbiology-7th-pdf>.
2. Jawetz Melnick & Adelbergs Medical Microbiology 27 E (Lange) 27th Edition, 2017. <https://www.amazon.com/Jawetz-Melnick-Adelbergs-Medical-Microbiology/dp/0071824987>.
3. Manual of Clinical Microbiology, Eleventh Edition, 2015. <http://www.asmscience.org/content/book/10.1128/9781555817381>.
4. Mackie & McCartney Practical Medical Microbiology, 14/e Hardcover – January 1, 2007. <https://www.amazon.com/Mackie-McCartney-Practical-Medical-Microbiology/dp/813120393X>.
5. District Laboratory Practice in Tropical Countries, Part 2. <https://www.medbox.org/district-laboratory-practice-in...part-2/download.pdf>.

MIC-603 Soil and Agricultural Microbiology 3(2-1)

Course Title	Soil and Agricultural Microbiology
Course Code	MIC-603
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Saima Muzammil
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course

1	To give student an overview about Fundamental and Applied aspects of Agricultural microbiology.
2	Comparative study of major groups of life found in soils
3	Over view of plant-microbes interactions in soils.
4	General understandings of microbially mediated transformations of different minerals in soil

5	Comparative study of major groups of life found in soils.
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Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction, history and scope of Agricultural Microbiology
	Lecture-2	Importance, nature and classification of plant diseases in Pakistan
	Practical-1	Isolation of fungal phyto-pathogens from diseased plants
2 nd	Lecture-3	Fungal diseases: Rusts disease
	Lecture-4	Smuts and Wilts
	Practical-2	Qualitative determination of soil microflora by the Buried Slide Method
3 rd	Lecture-5	Root rots and Introduction to bacterial diseases
	Lecture-6	Bacterial diseases: Blights, Cankers.
	Practical-3	Determination of soil microbial biomass. Fumigation-extraction method
4 th	Lecture-7	Bacterial diseases: Leaf spots and Rots.
	Lecture-8	Introduction to viral diseases: Mosaics, Dwarfs
	Practical-4	Isolation of bacterial phyto-pathogens from diseased plants
5 th	Lecture-9	Viral diseases: Stunts, Yellows Leaf curl
	Lecture-10	Viral diseases: Witches Broom, Ring spots and Wilts
	Practical-5	Examination of rhizosphere
6 th	Lecture-11	Cultural practices in disease control and chemical control
	Lecture-12	Introduction of soil microbiology. Soil as habitat, organisms found in soil
	Practical-6	Assay of β -glucosidase activity
7 th	Lecture-13	Soil description, soil physical and chemical properties, various soil abiotic factors
	Lecture-14	Soil Organisms: Bacteria, fungi, Actinomycetes etc. Nutrition and metabolism of soil bacteria
	Practical-7	Assay of the dehydrogenase activity
8 th	Lecture-15	Soil Protozoa and Nematodes Classification and feeding behavior
	Lecture-16	General Discussion and Revision
	Practical-8	Assay of CM cellulase activity
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Interaction among soil microorganisms, Diversity in soil microbial populations
	Lecture-18	Influence of plants on soil microbes, growth characteristics of soil organisms
	Practical-9	Plant disease diagnostic techniques: study of symptoms, signs
11 th	Lecture-19	Plant defenses mechanisms towards pathogenic microorganisms (emphasis on bacteria and fungi)
	Lecture-20	Soil organic matter, decomposition of soil organic matter by microbes
	Practical-10	How to prepare fungicide (Bordeaux mixture)
12 th	Lecture-21	Quiz
	Lecture-22	Biological nitrogen fixation, Modes of nitrogen fixation
	Practical-11	Preparation of bio-fertilizer
13 th	Lecture-23	Microbial role in root nodulation (emphasis at nitrogen fixing bacteria)
	Lecture-24	Genetic and biochemistry of root nodulation
	Practical-12	Isolation of plant growth promoting bacteria from rhizosphere
14 th	Lecture-25	Soil Nitrification, De-nitrification, fate of nitrate in soil
	Lecture-26	Sulfur cycle
	Practical-13	Isolation of plant growth promoting bacteria from rhizosphere

15 th	Lecture-27	Phosphorus cycle and role of microbes in it
	Lecture-28	Plant growth promoting bacteria (types and classification)
	Practical-14	Study the effect of PGPR on plant seedling growth
16 th	Lecture-29	Agrobacterium biology and plant transformation
	Lecture-30	Agrobacterium biology and plant transformation (continued)
	Practical-15	Study the effect of PGPR on plant seedling growth
17 th	Lecture-31	Importance of the subject in the agricultural development of Pakistan
	Lecture-32	Revision and question answer session
	Practical-16	In-vitro study of bio-control bacteria
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. Prell, H. H., Day, P. R., 2001. Plant-fungal pathogen interactions: A classical and molecular view. Springer Verlag. Alcamo, I. E., 2001. Fundamentals of Microbiology, Jones and Bartlett Publishers, USA.
2. Aneja K. R. 2009. Experiment in Microbiology: Plant Pathology & Biotechnology. New Age Int. Pvt. Ltd.
3. Advanced Techniques in Soil Microbiology by Ajit Varma & Ralf Oelmüller, 2007. Springer-Verlag Berlin Heidelberg. DOI 10.1007/978-3-540-70865-0
4. Bakker, P.A.H.M., Raaijmakers, J.M., Bloemberg, G., Höfte, M., Lemanceau, P., Cooke, B.M. (2007). New Perspectives and Approaches in Plant Growth-Promoting Rhizobacteria Research. Springer Press.
5. Soil Microbiology and Sustainable Crop Production by Geoffrey R. Dixon, Emma L. Tilston, 2010. Springer Science & Business Media, ISBN 9048194792, 9789048194797
6. Siddiqui, Z.A (2006). PGPR: Biocontrol and Biofertilization. Springer Verlag.
7. Jones, H (1996). Plant Gene Transfer and Expression protocols (Methods in Molecular Biology). Humana Press.
8. Yoshihiro N, Mari N, Satoshi Y and Masaki I (2012). Transgenic plants, Advances and Limitations, Chapter 9, Methods to Transfer Foreign Genes to Plants. CRSS Press
9. Singh, R.P., (2004). Microbiology, Kalyani publisher, New Dehli, Chapter 11: Biological Nitrogen Fixation
10. Laboratory manual (2015) Andrzej Bieganski, Stanislav Malý, Magdalena Frąc, Ivan H. Tuf, Central Institute for Supervising and Testing in Agriculture, Hroznová 2,656 06 Brno Czech Republic

MIC- 605 Marine and Fresh Water Microbiology 3(2-1)

Course Title	Marine and Fresh Water Microbiology
Course Code	MIC- 605
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Muhammad Waseem
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course	
1	Basics of Aquatic Microbiology (Microbial life in salted and fresh water)
2	Knowledge of Quorum sensing (History of quorum sensing)
3	Understanding the Global warming/ Biogeochemical cycling
4	To learn about Microbial loop/Food web
5	Aqua-culturing related microbiological problems

Week	Lecture/ Practical	Course Contents Covered
1 st	Lecture-1	Introduction and importance of marine microbiology
	Lecture-2	Zonation and stratification in marine environment
	Practical-1	Water sampling, transportation, processing, water quality control data interpretation
2 nd	Lecture-3	Ecology of microorganism in sea water
	Lecture-4	Difference in ecology of microbes due to water movements, microbes in estuaries and salt marshes
	Practical-2	Qualitative and quantitative analysis of water
3 rd	Lecture-5	Environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms.
	Lecture-6	Biogeochemical cycling of C, N, S & P
	Practical-3	Practical performance of water analysis
4 th	Lecture-7	Global warming
	Lecture-8	Quiz
	Practical-4	Practical performance of water analysis
5 th	Lecture-9	Global warming
	Lecture-10	Advantages and disadvantages of marine microorganisms including their importance in marine biotechnology.
	Practical-5	Practical performance of water analysis
6 th	Lecture-11	Some common diseases of marine fauna
	Lecture-12	Some common diseases of marine fauna
	Practical-6	Practical performance of water analysis
7 th	Lecture-13	Assignment
	Lecture-14	Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures in marine environment
	Practical-7	Biological oxygen demand of fresh water sample
8 th	Lecture-15	Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures in marine environment
	Lecture-16	Quorum sensing history
	Practical-8	Biological oxygen demand of fresh water sample (Continued)

9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Introduction to fresh-water environment and its microbiology
	Lecture-18	Stratifications in lakes and ponds. Lotic system and lentic system
	Practical-9	Quantitative study of aquatic microorganism
11 th	Lecture-19	Ecological habitats of microorganisms in aquatic environment
	Lecture-20	Laws of ecology with particular reference to fresh-water ecosystem: environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms.
	Practical-10	Laws of ecology with particular reference to fresh-water ecosystem: environmental factors (biotic and abiotic) and their influence on the distribution of microorganisms.
12 th	Lecture-21	Quiz
	Lecture-22	Fresh water microbial loop
	Practical-11	Practical 10 (Continued)
13 th	Lecture-23	Nuisance bacteria in drinking water and difference between fresh water and drinking water
	Lecture-24	Taxonomy of specific Fresh water microorganism
	Practical-12	Presentation
14 th	Lecture-25	Enumeration of bacteria: sampling and samplers, processing and actual enumeration procedures.
	Lecture-26	Presentation
	Practical-13	Visit to some aquaculture
15 th	Lecture-27	Assignment
	Lecture-28	Advantages and disadvantages of fresh-water microorganisms including their importance in fresh-water biotechnology.
	Practical-14	Effect of physical factors on microbial fresh water flora.
16 th	Lecture-29	Some common diseases of fresh-water fauna
	Lecture-30	Some common diseases of fresh-water fauna
	Practical-15	Effect of physical factors on microbial sea water flora.
17 th	Lecture-31	Presentation
	Lecture-32	Revision and Question answer session
	Practical-16	Effect of physical factors on microbial fresh water flora.
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Useful Weblinks and Additional Learning Resources		
1	Okafor, N., 2010. Environmental microbiology of aquatic and waste System. Springer Science + Business Media B.V. 2011	
2	Prescott, Harley and Klein's, Microbiology. fifth edition, The McGraw–Hill Companies, 2002	

3	Paul, J., 2001. Marine Microbiology (Methods in Microbiology Vol. 30). Academic Press, Inc.
4	Kirchman, D. L., Kirchman, D. L., 2000. Microbial ecology of the ocean. Wiley, Johns and Sons Inc.
5	Munn, C., 2003. Marine microbiology: Ecology & application. Lavoisier.
6	Paul F. and Andrew H. K., 2007. Evolution of Primary Producers in the Sea. Academic Press.
7	Horst, D. S. and Matthias Z., 2006. Marine Geochemistry. Springer

Visit to Other Facilities (If Required)	
1	Visit of aqua culturing farm
2	Visit to water treatment plant to see the processing of fresh water into drinking water

MIC- 607 Pharmaceutical and Industrial Microbiology 4(3-1)

Course Title	Industrial Microbiology
Course Code	MIC-607
Credit Hours	4(3-1)
Total Marks	80
Contact Hours	5 Hours Per Week (3 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Abu Baker Siddique
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course	
1	To know the Role of microorganisms in different industries
2	To understand the Fermentation Process of Microbiological industry
3	Source and control of microbial contamination
4	Design clean rooms and quality control labs

Week	Lecture/ Practical	Course Contents Covered
1 st	Lecture-1	Introduction to course
	Lecture-2	Introduction: Scope of Industrial Microbiology,
	Lecture-3	Introduction: Characteristics of Industrial Microbiology
	Practical-1	Methods of estimation of microbial cell mass
2 nd	Lecture-4	Fermentations and its types
	Lecture-5	Scope of fermentation biotechnology In Industry
	Lecture-6	Properties of commonly used Microorganisms in industry
	Practical-2	Chemical Methods of estimation of microbial cell mass
3 rd	Lecture-7	Nutritional requirement of Industrial organisms and commonly used media
	Lecture-8	Physical requirements of Industrial organisms
	Lecture-9	Fermentation and its uses in Industrial Microbiology. Fermenter and Fermenters operation (Principles and problems)
	Practical-3	Physical Methods of estimation of microbial cell mass

4 th	Lecture-10	Fermentation and its uses in Industrial Microbiology. Fermenter and Fermenters operation (Principles and problems)
	Lecture-11	Describe the potential sources of microbial contamination in the industry
	Lecture-12	Describe the method to control microbial contamination in industry
	Practical-4	Physical aspects of mutagenesis in industry
5 th	Lecture-13	Define GMP and its applications
	Lecture-14	Design clean rooms and microbiology quality control lab
	Lecture-15	Design clean rooms and microbiology quality assurance lab
	Practical-5	Chemical aspects of Mutagenesis in industry
6 th	Lecture-16	Quiz
	Lecture-17	Elaborate on the sources of anti-microbial compounds
	Lecture-18	Elaborate on the sources of anti-microbial compounds
	Practical-6	Pyrogen testing through LAL testing
7 th	Lecture-19	Elaborate on the mechanisms of anti-microbial compounds
	Lecture-20	Elaborate on the mechanisms of anti-microbial compounds
	Lecture-21	Introduction to sterilization, disinfection and antisepsis, methods of sterilization and sterility testing
	Practical-7	Sterility testing of pharmaceutical products
8 th	Lecture-22	Pyrogens and pyrogens testing, manufacture of sterile products
	Lecture-23	Fermentation methods to produce antibiotics (penicillins, cephalosporins, gentamicin)
	Lecture-24	Fermentation methods to produce antibiotics (erythromycin, tetracyclines, rifamycin, griseofulvin)
	Practical-8	Methods to extraction and purification of antibiotics
9 th	Mid Term Examination	Mid Term of 18 Marks (08 Marks objective) and (10 Marks subjective)
10 th	Lecture-25	Downstream Processing
	Lecture-26	Production of Fermented foods (Yoghurt)
	Lecture-27	Production of Fermented foods (Yoghurt)
	Practical-9	Microbiological assay of vitamins
11 th	Lecture-28	Production of Fermented foods (Cheese)
	Lecture-29	Production of Fermented foods (Cheese)
	Lecture-30	Production of Brewing (Beer) types
	Practical-10	Microbiological assay of drugs
12 th	Lecture-31	Production of Brewing (Beer) types
	Lecture-32	Production of Brewing (Wine) and its types
	Lecture-33	Production of Brewing (Wine) and its types
	Practical-11	Microbiological assay of drugs (Continued)
	Lecture-34	Production of Organic acids (Citric acid)

13 th	Lecture-35	Production of Organic acids (Citric acid)
	Lecture-36	Production of Organic acids (Lactic acid)
	Practical-12	Production of Citric acid
14 th	Lecture-37	Quiz
	Lecture-38	Production of biopolymers and biosurfactants
	Lecture-39	Production of biopolymers and biosurfactants
	Practical-13	Production of Methanol
15 th	Lecture-40	Production of biopolymers and biosurfactants
	Lecture-41	Production of biopolymers and biosurfactants
	Lecture-42	Production of Enzymes
	Practical-14	Production of Ethanol
16 th	Lecture-43	Production of Enzymes
	Lecture-44	Production of Single Cell Protein
	Lecture-45	Production of Single Cell Protein
	Practical-15	Production of organic acids (Lactic acid)
17 th	Lecture-46	Introduction to recombinant DNA technology, its role in pharmaceutical industry, pharmaceutical products made by genetic engineering e.g. cytokines (interferon), hormones
	Lecture-47	Introduction to recombinant DNA technology, its role in pharmaceutical industry, pharmaceutical products made by genetic engineering e.g. cytokines (interferon), hormones
	Lecture-48	Introduction to recombinant DNA technology, its role in molecular diagnosis
	Practical-16	Field Trip
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (12 Marks) Final Term of 30 Marks (12 Objective) and (18 subjective) Practical Exam of 20 Marks

Useful Weblinks and Additional Learning Resources / Books	
1	Nduka Okafor, 2007. Modern industrial microbiology and biotechnology, Published by Science Publishers, Enfield, NH, USA
2	David, B., Jewell, T.R. 2000. Biotechnology: demystifying the concept, Oxford University Press.
3	Hugo and Russell, Pharmaceutical microbiology. 7 th edition 2004. Blackwell Science Ltd London.

Visit to Other Facilities (If Required)	
1	Visit to Pharmaceutical Industry
2	Visit to Food Industry

MIC-609 Genetic Engineering 3(2-1)

Course Title	Genetic Engineering
Course Code	MIC-609
Credit Hours	3(2-1)
Total Marks	60
Contact Hours	4 Hours Per Week (2 Hours Theory + 2 Hours Practical)
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Bilal Aslam
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course

1	Introduction to the basic concept of genetic engineering, and its scope
2	Students would be trained with various tools used in Genetic Engineering
3	In the course, association of genetic engineering with industry would be mapped

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to genetic engineering
	Lecture-2	Laying the foundations of genetic Engineering
	Practical-1	Lab Safety Measures
2 nd	Lecture-3	Concept Map of genetic engineering
	Lecture-4	Brief recall on Molecular Biology
	Practical-2	Introduction to instruments
3 rd	Lecture-5	Working with Nucleic acid
	Lecture-6	Tools of the trade: Restriction Enzymes
	Practical-3	Laboratory requirements in genetic engineering
4 th	Lecture-7	DNA modifying enzymes
	Lecture-8	Quiz
	Practical-4	Isolation of nucleic acid (DNA & RNA)
5 th	Lecture-9	Methodology of gene manipulation
	Lecture-10	Host cells and Vectors
	Practical-5	DNA quantification
6 th	Lecture-11	Plasmid Vectors
	Lecture-12	Bacteriophage Vectors; Other Cloning Vectors
	Practical-6	DNA sequencing Techniques
7 th	Lecture-13	Assignment
	Lecture-14	Getting DNA into Cells: Transformation
	Practical-7	Polymerase Chain Reaction (PCR) and its types
	Lecture-15	Gene Cloning: Concept Map

8 th	Lecture-16	Cloning Strategies
	Practical-8	Introduction to Instruments used in PCR
9 th	Mid Term Examination	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)
10 th	Lecture-17	Cloning from mRNA
	Lecture-18	Cloning form genomic DNA
	Practical-9	Hands-on training on PCR instruments
11 th	Lecture-19	Advanced cloning strategies
	Lecture-20	Cloning of large DNA fragments in BAC & YAC
	Practical-10	Principles and Procedures of various techniques of Genetic engineering
12 th	Lecture-21	Quiz
	Lecture-22	Selection, Screening and analysis of recombinants
	Practical-11	Principles and Procedures of various techniques of Genetic engineering (Continued)
13 th	Lecture-23	Insertional inactivation
	Lecture-24	Analysis of cloned genes: Restriction mapping
	Practical-12	Principles and Procedures of various techniques of Genetic engineering (Continued)
14 th	Lecture-25	Analysis of cloned genes: Blotting Techniques
	Lecture-26	Assignment
	Practical-13	Brief recall on Bioinformatics
15 th	Lecture-27	Association of Genetic Engineering and Biotechnology
	Lecture-28	Making proteins& Enzymes
	Practical-14	Revisions, Group Discussions
16 th	Lecture-29	The rBST (recombinant bovine somatotropin) Story, Transgenic plants and animals
	Lecture-30	Therapeutic products for use in human health care systems
	Practical-15	Group discussions, Group activities
17 th	Lecture-31	Presentation
	Lecture-32	Medical and Forensic application of gene manipulation
	Practical-16	Group discussions, Group activities
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective) Practical of 20 Marks

Learning sources/ Recommended Books/Manuals

1. An introduction to genetic engineering by Desmond S. T. Nichol (Cambridge)
2. Gene Cloning and DNA analysis an introduction by T. A. Brown
3. Molecular Cloning a Laboratory Manual by Michael R. Green and Joseph Sambrook
4. Genetic Engineering by Setlow, Jane K. (Springer)

MIC-611 Research Methodology 2(2-0)

Course Title	Research Methodology
Course Code	MIC-611
Credit Hours	2(2-0)
Total Marks	40
Contact Hours	2 Hours Per Week
Semester Duration	18 Weeks
Mid Term Examination	9 th Week
Final Term Examination	18 th Week
Instructor Name	Dr. Bilal Aslam
Session	2018-22
Semester (Morning/ Evening)	7 th
Program	BS Microbiology

Learning Objectives of the Course

1	Understand research terminology
2	Be aware of the ethical principles of research, ethical challenges and approval processes
3	Describe quantitative, qualitative and mixed methods approaches to research
4	Identify the components of a literature review process
5	Critically analyze published research
6	Provide a comprehensive introduction to research proposal writing, research methodologies, and foundational research theories and protocols

Week	Lecture/ Practical	Course Contents
1 st	Lecture-1	Introduction to Research
	Lecture-2	Types of Research
2 nd	Lecture-3	Characteristics of Research
	Lecture-4	Identification and Prioritization of research Problems/Areas
3 rd	Lecture-5	Novelty
	Lecture-6	Research Objectives
4 th	Lecture-7	Research Plans
	Lecture-8	Search and Search Engines
5 th	Lecture-9	Scientific Database
	Lecture-10	Literature Search
6 th	Lecture-11	Designing of Research Proposal
	Lecture-12	Problem Statement/ Significance of Study
7 th	Lecture-13	Specific Objectives
	Lecture-14	Introduction
8 th	Lecture-15	Review of literature
	Lecture-16	Materials and Methods
9 th	Mid Term	Mid Term of 12 Marks (05 Marks objective) and (07 Marks subjective)

	Examination	
10 th	Lecture-17	References
	Lecture-18	Formatting, Citation Format & References
11 th	Lecture-19	Software for Research
	Lecture-20	Types of Research Publications
12 th	Lecture-21	Working with MS Word
	Lecture-22	Working with MS EXCEL
13 th	Lecture-23	Working with MS POWER POINT
	Lecture-24	DATA Presentation
14 th	Lecture-25	Presentation (By Students)
	Lecture-26	Presentation (By Students)
15 th	Lecture-27	Presentation (By Students)
	Lecture-28	Presentation (By Students)
16 th	Lecture-29	Written Proposals (By Students)
	Lecture-30	Written Proposals (By Students)
17 th	Lecture-31	Group Discussion
	Lecture-32	Group Discussion
18 th	Final Term Examination/ Result Submission/ Enrolment	Sessional including Quizzes, assignments, presentations etc. (08 Marks) Final Term of 20 Marks (08 Objective) and (12 subjective)

Learning sources/ Recommended Books/Manuals

1. Robert Burns (2000). Introduction to Research Methods. SAGE Publications Ltd.
2. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
3. Catherine Dawson (2009). Introduction To Research Methods 4th Edition. Constable & Robinson.
4. Goyal, R. C. (2010). Research methodology for health professionals. Jaypee Brothers Publishers. Klatt, E. C. (2015).

MIC-631
MIC-632

Project **3(0-3)**
Internship **3(0-3)**

Findings:

The following facts are drawn in the light of this report

Strengths:

- Program meets almost all the objectives
- Highly qualified, experienced and professionally competent faculty
- Students are being prepared for quality academic and research skills
- Internship of students in reputable organizations

Weaknesses:

Acute shortage of Laboratory support staff / Lab attendant

- Lack of experimental animal house facility
- Lack of Computing facility for faculty members
- Lack of proper furniture for class rooms
- Lack of gas facility in laboratories

Opportunities:

- Students are being provided the opportunity to learn and work on basic as well as advanced scientific equipment.
- Mentoring of students for getting national and international research scholarships as well as job opportunities.

Recommendations:

In the light of this report, following are the recommendations

1. At least three lab attendants are immediately required for proper practical and research work of students in under-graduate and post-graduate labs.
2. Strengthening of computing facilities for faculty.
3. Provision of separate experimental animal house at new campus