University of Dhaka

Faculty of Biological Sciences

Curriculum for Bachelor of Science (Honours) Degree in Microbiology

Sessions: 2018-2019 and onward

Department of Microbiology

University of Dhaka
Dhaka-1000
Bangladesh

UNIVERSITY OF DHAKA
DEPARTMENT OF MICROBIOLOGY

Curriculum for Bachelor of Science (Honours) Degree in Microbiology

Department of Microbiology

The Department of Microbiology was established in 1979 under the Faculty of Biological Sciences, University of Dhaka and presently located in the Science Complex Building. It started the journey offering Master of Science (MSc) degree programme in Microbiology to a few competent students having a BSc (Honours) degree in Biochemistry/Botany/Pharmacy/Soil Science with Microbiology as core course. The Department steadily gained well reputation in education and research at home and abroad, and the demand for trained Microbiologists gained a ground. It necessitated opening the Undergraduate (Honours) programme in the academic session of 1988-1989. From the academic session of 1994-1995, the traditional three-year BSc (Honours) programme has been upgraded to four-year BS (Honours) as terminal degree. Presently the Department not only offers the undergraduate BS (Honours) course but also offers specialized courses and research facilities in Post-Graduate levels such as MS, MPhil and PhD.

The Department provides modern systems for lectures and practical works with high quality teaching and research facilities. Teaching in the classrooms is facilitated with digital multimedia and other necessary supports. The Department has a rich seminar library with a large collection of reference books and journals. It possesses a number of practical and research laboratories with modern equipment, facilities and service systems. In addition, the Department trains new scientists and produces excellent research publications. The Department of Microbiology has been recognized as a centre of excellence in the field of Microbiology, Molecular Biology and Biotechnology researches in Bangladesh. Various research groups are working in collaboration with the top research organizations at home and abroad.

Introduction to the Programme

Title of the Programme: Bachelor of Science or BS (Honours)

Duration of the Programme: Four Years (4 Academic Sessions)

Level: Graduation

Type: Degree

Medium of Instruction: English

Eligibility for Admission: To be eligible for admission into the 4-year BS (Honours) Course in Microbiology, the candidates must have Biology, Chemistry, Physics and Mathematics in their HSC or equivalent examinations in Science group or recognized equivalent examinations. The educational qualification and selection of the candidates for admission in the Department shall be decided as per the University admission rules and regulations.

BS (Honours) Microbiology programme is designed to provide the students with a multidisciplinary approach to study the microbial world and to prepare cope up with the issues for wide spectrum of areas including Healthcare, Food, Agriculture, Environment and Industry. The student will study the key concepts associated with microbes in both theoretical and practical contexts. The Graduate will qualify to recognize a specialist high level knowledge of an area of work or study to enable the use of

an individual's own ideas and research in response to complex problems and situations in microbiological fields. The graduate also involves the achievement of a high level of professional knowledge and is appropriate for people working as knowledge-based professionals or in professional management positions.

General Objectives of the Programme

Emphasis is given on developing knowledge and understanding such that the undergraduate students acquire the skills, qualities and attributes expected by employers or for postgraduate studies and research in applied microbiology. The trained graduates will play a vital role in the sustainable development in economic growth and would bring qualitative changes in the above mentioned areas in the country. The practical training and fieldwork in the curriculum will provide hands-on experience in different fields of microbiological and biotechnological sciences. It will also create awareness about public health and safety, and facilitate the establishment of liaison between Microbiologist with society and industry. The individual learning outcomes of Microbiology study are:

- students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiological sciences;
- students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research methods, including accurately reporting observations and analysis;
- students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing; and
- students will demonstrate engagement in the Microbiology discipline through involvement in research or internship activities, the Microbiology Student Association (MSA), club and outreach or mentoring activities specific to microbiology.

General Regulations and Guidelines

The student admission, programme duration, credit assignment, evaluation of student performance, grading system and requirements for the degree of Bachelor of Science with honors (BS Honours) in Microbiology shall be conducted as per the Rules and Guidelines of the Faculty of Biological Sciences, University of Dhaka (Approved 23 August 2015).

Duration of the Programme

The BS (Honours) degree shall extend over four academic years (sessions) with the final examination after the end of each academic year. The duration of each session will be 44 working weeks which includes-

(a) Contact in the Class and In-course Assessment	30 weeks
(b) Preparation for the Final Examination (1st, 2nd and 3rd Year)	4 weeks
(c) Preparation for the Final Examination (4th Year)	6 weeks
(d) Course Final Examination	8 weeks
(e) Tabulation of Results	4 weeks

Requirements for Graduation

A student must fulfill the requirements for a Bachelor's degree within a maximum period of 6 (six) academic years, starting from the year of registration. To graduate with a Bachelor degree (BS

Honours) a minimum total of 128 credits or more if approved by the University authorities, with no 'F" grade in any course must be earned by the student during the programme. He/she must also have earned the minimum required CGPA 2.5 on a 4.00 scale. After successful completion of the requirements the degree will be awarded and conferred by the University authorities.

Assignment of Credits

The entire undergraduate programme is covered by a set of theoretical, practical (laboratory/field works/short project), seminar/workshop, and other relevant courses/activities. A minimum of 15-class per session will constitute 1 (one) Credit hour for the Theoretical courses. Credits for Practical and other courses will be determined by the Department. A student must have to earn a minimum of 128 credits for successful completion of his/her graduation programme. The distribution of marks and credits in four years will be as follows:

Academic Year	Major Course (marks)		Supporting Course (marks)		Viva-voce (marks)	Credits	[1]Sessionals (marks)	Credits	Total Marks	Total Credits
	Theoretical course	Laboratory works	Theoretical course	Laboratory works						
First	300	100	200	----	50	26	50	2	700	28
Second	400	100	150	50	50	30	50	2	800	32
Third	600	200	----	----	50	34	100	4	950	38
Fourth	700	200	----	-----	50	38	100	4	1050	42
Total	2000	600	350	50	200	128	300	12	3500	140

[1]**Sessionals**: It includes specimen collection, assignment, orientation, participation in departmental seminars/workshops, field works, excursion, visit to industry/research organizations, internship, etc.

Evaluation of Student's Performance

The total performance of a student in a given course will be evaluated on the basis of a scheme of Continuous assessment, In-course examinations and Course Final examinations.

(a) Marks Distribution for Courses: The distribution of marks for theoretical and practical courses will be as follows:

Class attendance/participation	5%
In-course assessment	35%
Course Final Examination	60%

(b) Continuous Assessment: The continuous assessment for theory courses will be made through a set of in-course examinations and class attendance/participation and for practical course (laboratory/field works/short project) will be made through class attendance/participation, assignments, evaluation of interactive skills and laboratory reports/project reports and other sessional activities. The scheme of continuous assessment will be announced by the course teacher(s) at the beginning of the course.

(c) Class Attendance/Participation: A student must attend at least 75% of the total classes held in an academic year to be eligible for appearing in the Course Final examinations. A student

attending at least 60% classes but less than 70% classes will be allowed to appear for the examination after paying non-collegiate fees fixed by the University and student attending less than 60% classes will not be allowed to appear for the Final examination for that year/session. Basis on the awarding marks for class attendance will be as follows:

Attendance (% of the total class held)	Marks (%)
95 and above	5
90 to less than 95	4
85 to less than 90	3
80 to less than 85	2
75 to less than 80	1
Less than 75	0

(d) In-course Assessment: In-course tests of minimum one hour duration shall be conducted and evaluated by the course teacher(s). There will be at least 2 (two) written tests for 3/4-credit courses and at least 1 (one) test for 2-credit courses. Additional assessment may be made by the course teacher(s) prior approval by the Academic Committee of the Department. The question patterns for in-course tests should preferably be of objective type. The Course teacher will show the assessed in-course scripts to the students and shall announce the results within two weeks of the date of holding the test.

Make-up test will be arranged for a student who fails to appear in in-course test/tests due to unavoidable circumstances like accident, medical surgery, parent has expired or such situations prior approval of the Academic Committee of the Department and the test must be held during the course period. Absence in any in-course test will be counted as zero for calculating the average marks for that in-course test.

(e) Course Final Examination: The Course Final examination for theoretical course will be conducted centrally by the Controller of Examinations as per University Rules. The examination will be of 3 hours duration for 4-credit course and 2 hours for 2-credit course. The question patterns for Course Final tests should be defined by the Department.

For evaluation of the Course Final examination for theoretical courses there will be two examiners: one internal (will be course teacher or teachers) and the other external (will preferably be within the Department/University provided that he/she is not a course teacher for the course paper to be examined). Under the double examiner system and in case of difference more than 20% of marks, there will be a 3rd examiner for evaluation and marks of the nearest two examiners will be calculated for average out as final marks.

(f) Assessment of Seminar/Project/Internship: The mode of assessment of Seminar/ Project/Internship will be determined by the respective Departmental Examination Committee approved by the University.

(g) Viva-Voce: A regular student must appear at the Viva-voce/Oral examination at the end of the Course Final examinations and it will be conducted by the respective Departmental Examination Committee approved by the University.

Sessionals

A regular student must complete his/her Sessionals of the 1st, 2nd, 3rd, and 4th year as determined by the Department. The sessional marks shall not be taken into consideration for the determination of yearly GPA. All marks of the 4 Sessionals shall be included to determine letter grade (LG), grade points (GP), points earned (PE) and to mention in the Grade sheet. These courses will be identified by prefixing the letter grade earned with the letter 'N' in the transcript.

Grading System

A basic four-point (4.00) grading scale will be followed and marks obtained for each course will be converted to grades. The following letter grades and corresponding grade-points will be used to determine the student's grade point average (GPA).

Marks Obtained	Corresponding Letter Grade	Grade point	Grade Description
80% or above	A+	4.00	*Grade A*: Exceptional performance; all course objectives achieved; objectives met in a consistently outstanding manner.
75% to less than 80%	A	3.75	
70% to less than 75%	A-	3.50	
65% to less than 70%	B+	3.25	*Grade B*: Very good performance; significantly more than the majority (at least two-thirds) of the course objectives achieved; objectives met in a consistently thorough manner.
60% to less than 65%	B	3.00	
55% to less than 60%	B-	2.75	
50% to less than 55%	C+	2.50	*Grade C*: Satisfactory performance; al least majority of the course objectives achieved; objectives met satisfactorily
45% to less than 50%	C	2.25	
40% to less than 45%	D	2.00	*Grade D*: Minimally acceptable performance; less than majority but more than the minimum required course objectives achieved; objectives achieved at a minimally acceptable level.
Less than 40%	F	0.00	*Grade F*: Failed in the course

A course in which a student has obtained "D" or higher grade will be counted as credits earned by him/her and obtained "F" grade will not be counted towards his/her earned credits.

Calculation of GPA and CGPA

Grade Point Average (GPA) is the weighted average of the grade points obtained in all courses passed/completed by a student in an academic year. The GPA is computed in the following manner:

$$\mathbf{GPA} = \sum \mathbf{PE} / \sum \mathbf{Cr}$$

Where, PE means Points Earned (i.e. Grade Points x Credits) and Cr means Credits attempted in the year.

The Cumulative Grade Point Average (CGPA) for the 2nd year, 3rd year and 4th year results is computed by dividing the total accumulated grade points earned up to date by the total credit points attempted.

Promotion to Higher Class

(a) Promotion from 1st year to 2nd year: A student must earn a minimum GPA of 2.00 and must have passed (minimum 'D' grade) all the courses taken for promotion. Students who failed in courses (maximum 8 credit hours) but have earned the required GPA 2.00 will be promoted on probation, and those on probation shall appear in the retake examination and must pass the failed course(s) to be allowed to continue studies in the 2nd year.

(b) Promotion from 2nd year to 3rd year: A student must have earned a minimum CGPA of 2.25 and must have passed (minimum 'D' grade) all the courses for promotion. Students who failed in courses (maximum 8 credit hours) but have earned the required CGPA 2.25 and students who earned CGPA less than 2.25 but equal to or more than 2.00 without 'F' grade will be promoted on probation. Those on probation shall appear in the retake examination and must pass the failed course(s) to be allowed to continue studies in the 3rdyear.

(c) Promotion from 3rdyear to 4th year: A student must have earned a minimum CGPA of 2.50 and must have passed (minimum 'D' grade) all the courses for promotion. Students who failed in courses (maximum 8 credit hours) but have earned the required CGPA 2.50 and students who earned CGPA less than 2.50 but equal to or more than 2.25 without 'F' grade

will be promoted on probation. Those on probation shall appear in the retake examination and must pass the failed course(s) to be allowed to continue studies in the 4th year.

Retake Examination

(a) Student on probation for failing in the final examination course(s) must sit for Retake examination of the failed course(s) within 6 weeks after publication of results, conducted by the respective original Examination Committee of the year and expenses of the Retake examinations, as determined by the University authority, must be borne by the student(s). If a student achieves the required credits in the retake examination, he/she will be considered as promoted and his/her letter grade for that course will be preceded by the letter 'P' in the transcript. If any student fails to earn the required credits, his/her promotion on probation will be deemed cancelled.

(b) Student on probation for failing to earn requisite CGPA without any 'F' will be allowed to Retake examination for maximum 8 credits (including practical and viva-voce) under the same conditions mentioned above as determined by the University. If a student succeeded to earn the required CGPA, he/she will be considered as promoted and his/her letter grade for that course will be preceded by the letter 'P' in the transcript. If any student fails to achieve the required CGPA, his/her promotion on probation will be deemed cancelled.

(c) Students who failed in maximum of 8 credits of the 4th year, he/she must sit for Retake examination of the failed courses under the same conditions mentioned above as determined by the University. After the Retake examination, if a student achieves required credits, he/she will be considered for graduation and his/her letter grade for that course will be preceded by the letter 'P' in the transcript.

Improvement of Grade points

(a) To improve GPA or CGPA, a student may appear in the final examination (theory course, practical course or viva-voce), only once, with the following next batch in a maximum 8 credits in each year and the student shall apply to the Chairman of the department for improving the grade at least 8 weeks before the start of the final examination. Improved grade point will be used for GPA and CGPA. The transcript will have a symbol "I' identifying the improved course.

(b) If a student desire to improve the grade point earned in a course of 4th year, he/she must apply for such improvement examination before the award of the degree (i.e. before issuance of certificate). Improvement shall not be allowed once the degree is awarded.

Drop out

A student failing to earn the required minimum GPA/CGPA and/or to earn requisite credits after retake examination, he/she may take readmission with the approval of the Academic Committee of the department to appear in the course final examination with the next batch. If he/she fails again to earn the required minimum GPA/CGPA and/or to earn requisite credits, he/she will be dropped out from the programme.

Readmission

(a) A student failing to earn the requisite credits and/or GPA/CGPA for promotion or graduation may seek readmission with the next batch. For readmission, a student will have to apply within one month after announcement of the results of the concerned year. Readmission will be allowed only after the approval of the departmental Academic Committee.

(b) On readmission a student may choose, subject to approval of the departmental Academic Committee, to keep grades and credits earned earlier or choose to take all or any course again. Student must clearly indicate his/her choice on the allocation for readmission.

(c) If a student succeeded after taking readmission his/her letter grade for the course will be preceded by letter 'R' in the transcript.

Other regulations

Respective statuary authorities of the University shall design the curriculum, allocate courses for teaching, constitution of examination committee and panel of examiners as per rules of the University. For any other matters including not covered in this general rules and guidelines, the existing rules and guidelines of the faculty and University of Dhaka will be applicable.

Dean's Award

As a recognition of excellent performance, the names of the students obtaining CGPA 3.75 or above after successful completion of the 4-year graduation courses, will be eligible for the Dean's Award with a maximum of 5candidates from each department. Candidates who have received 'F' grade or taken retakes/improvement in any course or taken readmission or failed to attend a minimum of 80% of the classes offered during the graduation programme will not be eligible for the Dean's Award.

Structure of the Curriculum

The Four-Year (Honours) programme is covered by a set of theoretical, practical (laboratory/short research projects), viva-voce, and sessional activities (seminars, field works, assignment, visiting to industry/research organizations), etc. The programme will span over a minimum of 128 credits of which year-wise course distribution has been detailed below. Of these 128 credits, 16 credits shall have to be taken as supporting/allied courses and will be distributed in the 1st Year and 2nd Year courses. Total credit points of the supporting courses will be added to the major Honours subjects/courses for deciding yearly GPA. All the courses and Sessionals offered by the Department/other department for the 1st Year, 2nd Year, 3rd Year and 4th Year are mandatory. The optional theoretical courses with relevant parts in the laboratory works are offered to the students during the 3rdYear and the 4th Year as their choice of interests.

First Year BS (Honours)

Course:	**6 Major courses**	**Marks: 400**	**Credits: 16**
	3 Supporting courses	**Marks: 200**	**Credits: 8**
	1 Viva-voce	**Marks: 50**	**Credits: 2**
	1 Sessionals	**Marks: 50**	**Credits: 2**
Total:	**11 courses**	**Marks: 700**	**Credits: 28**

Course Code	Course Name	Marks	Credit	Mandatory/Optional
Major Courses				
MBG 101	Introductory Microbiology	50	2	Mandatory
MBG 102	Microbial Diversity and Ecology	50	2	Mandatory
MBG 103	Human Physiology	50	2	Mandatory
MBG 104	Basic Techniques in Microbiology	50	2	Mandatory
MBG 105	Basic Biochemistry	100	4	Mandatory
MBG 106	Laboratory Works	100	4	Mandatory
Supporting Courses				
MBG 107	Computer Applications for Life Sciences	50	2	Mandatory
MBG 108	Communicative English	50	2	Mandatory
CM 100F	Fundamentals of Chemistry	100	4	Mandatory
MBG 109	**Viva-Voce**	50	2	Mandatory
MBG 110	**Sessionals**	50	2	Mandatory

Second Year BS (Honours)

Course:	**9 Major courses**	**Marks: 500**	**Credits: 20**
	3 Supporting courses	**Marks: 200**	**Credits: 8**
	1 Viva-voce	**Marks: 50**	**Credits: 2**
	1 Sessionals	**Marks: 50**	**Credits: 2**
Total:	**14 courses**	**Marks: 800**	**Credits: 32**

Course Code	Course Name	Marks	Credit	Mandatory/optional
Major Courses				
MBG 201	General Microbiology	50	2	Mandatory
MBG 202	Fundamental Cell Biology	50	2	Mandatory
MBG 203	Environmental Microbiology	50	2	Mandatory
MBG 204	Bacterial Metabolism	50	2	Mandatory
MBG 205	Basic Microbial Genetics	50	2	Mandatory
MBG 206	Medical Microbiology-1	50	2	Mandatory
MBG 207	Basic Food Microbiology	50	2	Mandatory
MBG 208	Fundamentals of Enzymology	50	2	mandatory
MBG 209	Laboratory Works	100	4	Mandatory
Supporting Courses				
MBG 210	Biostatistics and Calculus	100	4	Mandatory
CM 222H	Biologically Important Organic Compounds	50	2	Mandatory
CMGL101H	General Chemistry Laboratory	50	2	Mandatory
MBG 211	**Viva-Voce**	50	2	Mandatory
MBG 212	**Sessionals**	50	2	Mandatory

Third Year BS (Honours)

Course:	**9 Major courses (mandatory)**	**Marks: 650**	**Credits: 26**
	3 Major courses (optional)	**Marks: 150**	**Credits: 6**
	1 Viva-voce	**Marks: 50**	**Credits: 2**
	1 Sessionals	**Marks: 100**	**Credits: 4**
Total:	**14 courses**	**Marks: 950**	**Credits: 38**

Course Code	Course Name	Marks	Credit	Core/Optional
Major Courses				
MBG 301	Biosynthetic Metabolism	50	2	Mandatory
MBG 302	Microbial Molecular Genetics	50	2	Mandatory
MBG 303	Medical Microbiology-II	50	2	Mandatory
MBG 304	Virology-1	50	2	Mandatory
MBG 305	Immunology-I	100	4	Mandatory
MBG 306	Molecular Cell Biology	50	2	Mandatory
MBG 307	Agricultural Microbiology	50	2	Mandatory
MBG 308	Fermentation Technology	50	2	Mandatory
MBG 309	Applied Mycology	50	2	Optional
MBG 310	Pharmaceutical Microbiology	50	2	Optional
MBG 311	Microbiological Hazards and Food Safety	50	2	Optional
MBG 312	Marine Microbiology	50	2	Optional
MBG 313	Laboratory Works	200	8	Mandatory
MBG314	**Viva-Voce**	50	2	Mandatory
MBG 315	**Sessionals**	100	4	Mandatory

Fourth Year BS (Honours)

Course:	**9 Major courses (mandatory)**	**Marks: 750**	**Credits: 30**
	3 Major courses (optional)	**Marks: 150**	**Credits: 6**
	1 Viva-voce	**Marks: 50**	**Credits: 2**
	1 Sessionals	**Marks: 100**	**Credits: 4**
Total:	**14 courses**	**Marks: 1050**	**Credits: 42**

Course Code	Course Name	Marks	Credit	Mandatory/Optional
MBG 401	Virology-II	100	4	Mandatory
MBG 402	Immunology-II	50	2	Mandatory
MBG 403	Genomics and Bioinformatics	50	2	Mandatory
MBG 404	Genetic Engineering	50	2	Mandatory
MBG 405	Microbial Biotechnology	100	4	Mandatory
MBG 406	Analytical Techniques in Life Sciences	100	4	Mandatory
MBG 407	Quality Control of Food and Agricultural Products	50	2	Mandatory
MBG 408	Environmental Pollution and Bioremediation	50	2	Mandatory
MBG 409	Industrial Microbiology	50	2	Optional
MBG 410	Epidemiology, Public Health and Bioethics	50	2	Optional
MBG 411	Microbial Diagnosis in Health Clinics	50	2	Optional
MBG 412	Advances in Food Fermentation Techniques	50	2	Optional
MBG413	Lab works &Research Project	200	8	Mandatory
MBG414	Viva-Voce	50	2	Mandatory
MBG 415	Sessionals	100	4	Mandatory

Sessionals

The Sessionals include specimen collection, orientation, assignment, participation in departmental seminars/workshops, field works, excursion, visit to industry/research organizations, internship, etc. A regular student must complete his/her Sessionals in 1st, 2nd, 3rd and 4th year. The Sessionals and its marks for each year will be distributed as per direction of the Department.

Structure of Courses

Courses for the First Year BS (Honours)

The First Year foundation courses provide a broad introduction to biological sciences with supporting courses, covering key concepts and introduction to the essential data handling, strengthen skills in communication and laboratory works required for all the microbiological scientists. The course unit details given below are subjected to change, and are the latest example of the curriculum available on this course of study.

MBG 101 Introductory Microbiology Credits: 2 Class: 30 hours

The course is designed for undergraduate beginners in microbiology, and is intended to cover all the basic concepts and principles that a student should know the different aspects of microbiology including recent development in the area. It provides a comprehensive account of the microbial world including both general and applied aspects. The course lies in its clearly defined targets and concise its frequent references to microbiological concepts, characteristics of different groups of microorganisms and their applications to various fields for human welfare.

Course Objectives

1. To recognize and apply concepts and theories of basic microbiological sciences.
2. To demonstrate the science of microbiology contributing various fields for human welfare.
3. To apply the knowledge on functions of various microorganisms in everyday interactions.

Learning Outcomes

After completion the course the students are able to:

1. Understand the aspects of microbiological sciences and its impacts on human society, environment and health.
2. Demonstrate the historical development with concepts and theories of science of microbiology.
3. Familiar with the morphological, molecular and functional characteristic features of prokaryotic cells.
4. Explain basic structures and characteristics of bacteria including morphology, growth and growth requirements, and cultural properties.
5. Understand the nature, habitats, classification and economic importance of archeae, algae, fungi, protozoa and virus.

Unit	Course Content	Class hours
1	**Introduction to Science of Microbiology:** Basic science of microbiology; Development of microscopes; Branches microbiology; Application of microbiology in human welfare, environment and health; Classification of microorganisms; Study of phylogenetic relationships.	**6**
2	**Historical Development of Microbiology:** Discovery of microorganisms; Origin of life; Spontaneous generation vs biogenesis; Germ theory of disease; Development of laboratory techniques, fermentation, vaccination, antisepsis and chemotherapy; The golden age of and contributions in historical development of microbiology.	**6**
3	**Prokaryotic Cells:** Introduction to cells; Morphological characterization, ultra structure and chemical composition of prokaryotic cells; Functions of different sub cellular elements; Endosymbiotic concept.	**5**
4	**Introduction to Bacteria:** Structure, size, shape and arrangements; Characteristics of Gram-negative and Gram positive bacteria; Morphological, nutritional and cultural characteristics.	**5**
5	**Introduction to Microbes other than Bacteria:** General characteristics, morphological and physiological properties, classification, distribution in nature and economic importance of archaea, viruses, fungi, algae and protozoa.	**8**

Recommended Books

1. Microbiology - M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg; McGraw-Hill Inc. New York
2. Microbiology: An Introduction - G.J. Tortora, B.R. Funke and C.L. Case; Pearson, Boston
3. Introductory Microbiology - T. Gross, J. Faul, S. Kettendge and D. Spnngham; Springer, USA
4. Brock Biology of Microorganisms - M.T. Madigan, K.S. Bender, D.H. Buckley, D.A Stahl and W.A. Satttley; Pearson Prentice Hall
5. Microbiology: Concepts and Applications - M.J. Pelczer Jr, E.C.S. Chan and N.R. Krieg; McGraw Hill Inc. New York
6. Fundamental Principles of Bacteriology - A.J. Salle; McGraw Hill Book Inc., New York
7. Introduction to Microbiology - A.S. Rao; PHI Learning Pvt. Ltd.

MBG 102 Microbial Diversity and Ecology Credits: 2 Class: 30 hours

This course provides an overview of microbial ecology including the interactions between microorganisms and environment, the functions and stability of the complex microbial communities of natural systems. A parallel goal of this course is to explore ways of new findings in microbial ecology to enable environmental and public health protection. It will also cover microbial diversity and their functions, effect of factors on growth and survival of microorganism in various natural ecosystems, microbial community assembly and patterns, succession, adaptation, and population dynamics and other modes of microbial life in ecosystems.

Course Objectives

1. To obtain an overview of the diversity of microbial world and place it into an ecological context.
2. To learn the food dependency of organisms in an ecosystem and the essential roles microorganisms in various natural ecosystems of the Earth.
3. To understand the physical and chemical characteristics of natural environments that interact with microbial life and influence its activities

Learning Outcomes

After completion the course the students will be able to:

1. Understand the basic concepts and historical development of ecology.
2. Explain the meaning of developing microbial communities in contextual parts of ecosystem.
3. Familiar with scope and levels of organization on characteristics of different natural habitats.
4. Define the key concepts of ecology including abiotic and biotic factors with their impacts on microbial communities of ecosystem.
5. Understand the nature and interactions of extremophiles in extreme environments.

Unit	Course Content	Class hours
1	**Basic Concept of Microbial Ecology:** Scope of microbial ecology; Relation of microbial ecology to general ecology; Historical overview of microbial ecology; Basic concepts, characteristics and components of ecosystems.	3
2	**Microbial Communities and Ecosystems:** Development of microbial communities; Structure of microbial communities; Ecosystems; Microbial communities in nature	3
3	**Microorganisms in Natural Habitats:** Atmoecosphere - characteristics and stratification, atmosphere as habitat and medium for microbial dispersal, microorganisms in atmo-ecosphere; Hydrosphere- ecology, composition and activity of fresh water microbial communities, physical and chemical factors, estuaries and marine environment, characteristics and stratification of ocean; Composition and activity of marine microbial communities, role of microbes in the aquatic environment; Lithosphere - introduction to soil, rocks and mineral, soil horizon, texture, matter, chemical properties and microbial communities.	12
4	**Effect of Abiotic Factors on Microorganisms:** Abiotic limitations to microbial growth; Leibig's law of minimum and Shelford's law of tolerance; Effect of temperature, radiation, pressure, salinity, water activity, movement, hydrogen ion concentration, redox potential, organic and inorganic compounds on microorganisms.	10
5	**Adaptation and Interactions of Microbes in Extreme Environments:** Hot springs, acid springs and lakes, salt lakes, deep sea, extraterrestrial systems.	2

Recommended Books

1. Microbial Ecology: Fundamentals and Applications - R.M. Atlas and R. Bartha; Addison Wesley Longman, New York
2. Current Perspectives in Microbial Ecology - M.J. Klug and C.A. Reddy; ASM, Washington
3. Ecological Systems and the Environment - T.C. Foin; Houghton Mifflin, London
4. Microbial Ecology: A Conceptual Approach - J.M. Lynch and N.J. Poole; John Wiley & Sons, New York
5. Microbial Ecology: Organisms Habitats Activities - H. Stolp; Cambridge University Press, England.
6. Microbial Ecology - L.L. Barton and D.E. Northup; Wiley Blackwell, USA
7. Microbiology: An Introduction - G.J. Tortora, B.R. Funke and C.L. Case; Pearson, Boston

MBG 103 Human Physiology Credits: 2 Class: 30 hours

This course particularly imparts the concepts and mechanisms of integration in the different functional systems of humans. It covers the physiology of humans, with emphasis on the major organs and the processes they govern, including heart function and circulation, muscle function and movement and the kidney and osmoregulation. It also includes the energetic and temperature regulation, respiration and digestion systems of humans. This helps a student of microbiology to correlate any disease process with specific parts and systems of the affected human body.

Course Objectives

1. To provide a foundation of physiological principles and their application in real-life situations
2. To Familiarize with the different physiological systems of the human body and their functions with emphasis on clinical relevance
3. To acquaint students with different biosynthetic, secretory, and regulatory aspects of coordination.

Learning Outcomes

After completion of the course, students will have the knowledge to:

1. Demonstrate different physiological systems of the human body.
2. Demonstrate the ability to integrate physiology from the cellular and molecular level to the organ system and level of organization.
3. Explain the role of each system for the proper functioning of human body.
4. Describe the significance of a system in maintaining a balanced environment in the body.
5. Understand the effect of microbiological infection on each system.

Unit	Course Content	Class hours
1	**Digestion and Digestive System:** Mechanisms and control of secretion; Composition of digestive juices; Digestion and absorption of foodstuffs in human.	4
2	**Blood and Circulatory System:** Composition, formation, destruction and function of blood; Blood coagulation; Blood groups; Tissue fluid; Cardiovascular system.	7
3	**Respiratory System and Respiratory Stimulants:** Structures and functions of lungs, liver, kidney, pancreas, spleen and nervous system.	9
4	**Water and electrolytic balance:** Regulate water and electrolyte levels by hormonal action.	3
5	**Lymphoid and lymphatic system:** Structures and functions of lymphoid and lymphatic systems; Lymphatic diseases.	2
6	**Endocrinology:** Functions, mechanisms and properties of different hormones.	2
7	**Reproductive System:** Structure and function of testis, ovary, uterus and placenta.	3

Recommended Books

1. Martini Fundamentals of Physiology and Anatomy - F.H. Martini, J.L. Nath and E.F. Bartholomew; Pearson Publications.
2. Introduction to Human Physiology - M. Griffiths; MacMillan, New York
3. Human Physiology - R.F. Schmidt and G. Thews, Springer Verlag
4. Human Anatomy, Physiology and Pathophysiology - G. Thews,E.Mutschler and P. Vaupel; Elsevier, New York
5. Human Physiology - S.R. Fox; McGraw-Hill
6. Principles of Anatomy and Physiology - G.J. Tortora and B. Derrickson, Wiley
7. Essentials of Medical Physiology - K. Sembulingam and P. Sembulingam; Jaypee Brothers

MBG 104 Basic Techniques in Microbiology Credits: 2 Class: 30 hours

This course provides an overview on the basic techniques for microscopy for morphological characteristics of microbes and operates microorganisms from culturing, enumerating, identification and preservation. It helps to meet the requirements of students for basic concepts and theoretical background for their beginning of laboratory works in microbiology. The course includes the recipes and formulations for a number of typical media and reagents, and consists of an extension of these basic methods into microbiology as applied to the classical or conventional techniques.

Course Objectives

1. To introduce students to types of microscopes and microscopy for microbes.
2. To expose students to understand the basic techniques of culturing and preservation of microbes.
3. To determine the growth characteristics of the microorganisms for identification.

Learning Outcomes

Upon completion of this course, the student will be able to:

1. Understand principles different microscopic techniques and explains how it work.
2. Learn different microbiological staining techniques for morphological characterization of microbes.
3. Classify culture media based on their consistency, nutritional component and application.
4. Understand and explain the principles preservation of microbes.
5. Learn the fundamentals of direct and indirect methods for measuring microbial growth.

Unit	Course Content	Class hours
1	**Microscopes and Microscopy:** Light spectrum, resolving power and magnification power; Microscopes- light and electron microscopes; Microscopy- bright-field, dark-field, fluorescence, phase-contrast, differential interference contrast, transmission electron, scanning, scanning tunnelling and atomic force microscopy.	8
2	**Observation of Microorganisms under Microscope:** Wet-mount and hanging-drop techniques; Preparation of microorganisms for staining, chemical properties of stains, staining mechanisms, positive and negative staining, simple, differential and special staining techniques.	6
3	**Cultivation of Microorganisms:** Criteria for an ideal culture medium; Media used for cultivation microbes- chemically defined media, complex media, anaerobic growth media, selective and differential media; Culture techniques- enriched culture, anaerobic culture, and pure culture techniques; Special purpose media for eukaryotic microorganisms; Batch, fed-batch and continuous culture.	7

4	**Culture Preservation:** Long-term and short-term techniques for preservation of microbial culture; Type culture collections.	**3**
5	**Growth Measurement:** Direct methods- counting chamber, electronic count, membrane filtration and standard plate count (spread-plate and pour-plate); Indirect methods- turbidity, metabolic activity, dry weight and genetic probing.	**6**

Recommended Books

1. Brock Biology of Microorganisms – M.T. Madigan, K.S. Bender, D.H. Buckley, D.A Stahl and W.A. Satttley; Pearson Prentice Hall
2. Microbiology- M.J. Pelczer Jr, E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
3. Microbiology: Concepts and Applications - M.J. Pelczer Jr, E.C.S. Chan and N.R. Krieg; McGraw Hill Inc., New York
4. Microbiology: An Introduction- G.J. Tortora, B.R. Funke and C.L. Case; Pearson, Boston
5. General Microbiology- H.G. Schlegel, C. Zaborosch and M. Kogut; Cambridge University Press
6. Basic Techniques in Microbiology - S. Paniker, S.S. Patil and S. Agnihotri; Success Publications, Mumbai.
7. Prescott's Microbiology - J.M. Willey, L. Sherwood, C.J. Woolverton and L. M. Prescott; McGraw-Hill, New York.

MBG 105 Basic Biochemistry Credits: 4 Class: 60 hours

The course is designed to provide the elementary knowledge on the structure and function of biological molecules, including carbohydrates, lipids, nucleic acids, proteins and vitamins. It also includes the dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. In this course the concepts of the chemical basis of life and the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Objectives

1. To learn about the molecular structures of cells, biopolymers, building blocks and other biomolecules
2. To explain the biological functional properties of the important biomolecules
3. To explain the methods for isolation and detection of the bioactive metabolites of living body

Learning Outcomes

After completing the course the will able to:

1. Familiar with the biological functions of bioelements, acids, base and buffers.
2. Characterize and Identify the five classes of bioplymers and their monomeric building blocks.
3. Explain the metabolism of glucose for the generation of ATP.
4. Understand the basic nature of carbohydrates and their biological functions.
5. Describe the metabolism of fats and their utilization for fuel.
6. Describe the structure and replication of DNA with the genetic information in its base sequence.
7. Describe basic mechanism of RNA and protein synthesis.
8. Explain how protein synthesis can be controlled at the level of transcription and translation.
9. Summarize the role of vitamins in biological systems.

Unit	Course Content	Class hours
1	**Acid, Base and Buffer:** Ion product of water; acid; base; pH; pH indicator, buffer solution and buffer capacity	**7**
2	**Essential Bioelements and Biomolecules:** Major and minor bioelements; Available and nonavailable forms, sources and biological functions of bioelements; Cellular composition	**5**

	of biomolecules.	
3	**Bioenergetics:** Membrane bioenergetics- the Chemiosmotic Theory; electrochemical energy, use of the Δp, exergonic reactions that generate a Δp. Bioenergetics in the Cytosol: high-energy molecules and group transfer potential, the central role of group transfer reactions in biosynthesis, ATP generation by different processes; free energy; energy coupling.	**8**
4	**Carbohydrates:** Nomenclature, classification and functions; Optical properties; General reactions; Method of estimation; Selection from natural sources and representative examples of each class with characteristics.	**6**
5	**Lipids:** Nomenclature, classification and reactions of fatty acids; Sterols and methods of estimation; Structure and biological functions of different classes of lipids.	**5**
6	**Amino Acids and Peptides:** Structural features, optical activity and classification of amino acids ionization of solution; Behaviour; Isolation of amino acids from protein hydrolysates; Peptide bonds and biologically important peptides.	**8**
7	**Proteins:** General introduction; classification based on shape, structure and biological properties; isolation from natural sources; different levels of structural organization; properties and classification of enzymes; enzyme inhibition; digestive enzymes.	**10**
8	**Nucleic Acids:** Basic chemistry of nucleosides and nucleotides; polynucleotide and their biological functions; the chemical nature of gene.	**5**
9	**Vitamins:** classification; occurrence; deficiency symptoms; biological functions; vitamins as coenzymes	**6**

Recommended Books

1. Lehninger Principles of Biochemistry - D.L. Nelson and M.M. Cox, W.H. Freeman and Company
2. Biochemistry - M.K. Campbell; Cengage Learning
3. Biochemistry Illustrated - P.N. Campbell and A.D. Smith, Published by Churchill Livingstone
4. Biochemistry: A short course - J.L. Tymoczko, J.M. Berg & L. Stryer, W.H. Freeman and Company
5. Biochemistry - J.M. Berg, J.L. Tymoczkoand L. Stryer, W.H.Freeman and Company
6. Biochemistry - D. Voetand and J.G. Voet; John Wiley and Sons

MBG 106 Laboratory Works Credits: 4 Class: 75 hours

The first year laboratory course is designed to focus on the students and the tangible world around them and to observe and render in different ways using a rage of techniques for the beginners in microbiology. This Laboratory core curriculum described below represents topics and themes considered essential to teach in every microbiology laboratory, regardless of its emphasis. These core themes and topics are meant to frame objectives to be met somewhere within the introductory microbiology laboratory. Laboratory works typically supplement and integrate closely with the lecture content in a way that is unique to each instructor. Development of laboratory techniques and exercises designed to reinforce concepts covered in this course.

Course Objectives

The main objective of the course is to achieve the basic laboratory skills in microbiological sciences for the beginners. The other specific objectives include introduction of the basic techniques used for morphological and cultural characterization different microbes/cells, determination of biomolecules, and to develop analytical and communicating skills along with data processing for laboratory reports.

Learning Outcomes

After successful completion, a student will demonstrate ability in: viewing and interpreting slides of microbiological specimens stained with appropriate dyes for morphological characterization using

bright field microscope; estimating the number of cells and other properties of clinical samples; using appropriate aseptic techniques for the transfer and handling of microorganisms and instruments; using appropriate microbiological media and test systems; employing proper equipment and methods for isolation and preservation of microbes in culture media; using appropriate methods for determination of different biomolecules relevant to microbiology; and exercising computation for database analysis and interpretation made during lab works.

Unit	Course Content	Class hours
1	**Microscopy** 1. Use and function of microscopes 2. Observation of stained cell preparations 3. Observation of living bacterial cells 4. Observation of living yeasts and molds 5. Micrometry: measurement of microbial cell	**15**
2	**Staining of Bacterial Cells** 1. Simple staining and Negative staining 2. Gram staining 3. Acid-fast staining 4. Capsule staining 5. Spore staining 6. Flagella staining	**15**
3	**Human Physiology** 1. Blood sampling, choice of anticoagulants, and preservation 2. Determination of total leukocytes count (TLC) & differential leukocytes count (DLC) 3. Determination of serum bilirubin, cholesterol and non-esterified fatty acid, uric acid, glucose, etc. in clinical samples. 4. Observation of respiratory movement and respiratory rate by kymography. 5. Measurement of human blood pressure by using Palpatory/Auscultatory method. 6. Determination of specific gravity and viscosity of blood plasma.	**15**
4	**Cultivation Techniques** 1. Media preparation and sterilization techniques. 2. Culture transfer techniques 3. Techniques for isolation of pure cultures 4. Observation of cultural characteristics of bacteria on various media 5. Observation of cultural characteristics of yeast/mold on various media 6. Techniques for preservation and maintenance of pure cultures	**15**
5	**Determination of Biomolecules** 1. Preparation of solutions- molar, molal, normal and buffer solutions 2. Determination of HCl/citric acid by titrimetric method 3. Quantitative test for soluble protein 4. Quantitative test for reducing sugar 5. Determination of ascorbic acid component of biological sample 6. Qualitative test for different biomolecules **7.** Determination of lactose contents of milk	**15**

RecommendedBooks

1. Microbiology: A Laboratory Manual- J. Cappucino & N. Sherman; Pearson Education Limited
2. Principles of Microbiology - R.M. Atlas, WM.T. Brown Publishers.
3. Practical Workbook of Human Physiology - K.S. Nageswari & R. Sharma, Jaypee Brothers Ltd.
4. Laboratory Protocols in Applied Life Sciences - P.S. Bisen, CRC Press
5. Laboratory Safety: Principles and Practices- D.O. Flaming, J.H. Richardson & J.I. Tulis, ASM Washington D.C.

MBG 107 Computer Applications for Life Sciences Credits: 2 Class: 30 hours

This course is designed as supporting/allied course to cover the basic knowledge and skills required in the field of life sciences to solve biological problems with the computation technology and for individual student to use computer hardware and software as tools to create documents, file managements, gather information and solve problems. Students learn basic programming skills in different avenues of biology and apply these skills in building projects for life sciences.

Course Objectives

1. To present a basic understanding of computer operating systems useful for life sciences.
2. To provide students the exposure of modern computation to study life sciences in a smarter way.
3. To create an environment of basic programming and other applications to deal with life science problems.

Learning Outcomes

Upon completion of the course, the student will be able to:

1. Familiar with the basic systems, data storage, input-output devices of a microcomputer.
2. Identify and categorize of operating systems and applications of system software.
3. Demonstrate the basic skill level in applications of computer to create documents, file managements, gather information and solve problems.
4. Familiar with the data management systems with their number systems and codes.
5. Learn the basic applications of computer to deal with the avenue of life sciences in an efficient way.
6. Learn basic programming language necessary for life sciences.

Unit	Course Content	Class hours
1	**Microcomputer System:** Basic microcomputer system, microprocessor organization, machine cycle; Computer memory- memory types, primary and secondary memory, latches, flipflops, registers, flash memories; BUS organization; Input and output devices.	4
2	**Computer Software:** Software, classification of software, commercial software, Freeware; Advantages of package programmes, popular package programmes; Programming language.	4
3	**System Software and Operating System:** System software, role of BIOS language translators, text editor, the tasks of an OS, OS characteristics, types of OS, Linux, UNIX, MS DOS, and WINDOWS.	4
4	**Database Concepts and Basic applications:** Basic concepts, database software, database structure, GenBank, ENA, DDBJ, PDB, database management system and its merits and demerits. Applications of MS word, MS excel, MS access, SPSS, bioinformatics tools and databases; Swissprot, Bioedit, MEGA, Chromas, clustal W.	8
5	**IT Applications for Life Sciences (Hands on)** 1. Simple exercises on WINDOWS and UNIX operating system to learn commands 2. Practical experience/application of Word-processing, Power-point presentation, and	10

	analysis of spread-sheet 3. Application of graphics programme- Photoshop, Illustrator 4. Applications of database 5. Development of programmes in Python or Bypython	

Recommended Books

1. Computer Fundamentals - M.L. Rahman and M.A. Hossain; Systech, Dhaka
2. Introduction to Computer Science - P.W. Murrill and C.L. Smith; Harper and Row, New York
3. Computer Fundamentals: Concepts, Systems and Applications - P.K. Sinha&P. Sinha; BPB Publications, New Delhi
4. Computer fundamentals - A. Goel; Pearson New Delhi
5. Fundamentals of computer - A. Saxena, S. Chauhan & K. Gupta; Laxmi Publications
6. Python for Biologists – M.O. Jones; Greatespace Ind Pub Platform

MBG 108 Communicative English **Credits: 2 Class: 30 hours**

The course is designed as supporting/allied course to provide introduction to technical writing and communication skills in reading, writing, speaking and listening in English that enables the students to meet their real life communication needs and its role in the world. It also gives scope to develop proficiency in the language and will help increase the usage of better vocabulary.

Course Objectives

1. To interact with academic content: reading, writing, listening, speaking
2. To demonstrate ability to think critically utilizing information and digital literacy skills
3. To demonstrate behavior and attitudes appropriate to a university environment

Learning Outcomes

After successful completion of this course the students would be able to:

1. Develop proficiency in the language and will help increase the usage of better vocabulary
2. Understand and apply the conventions of academic writing in English with confidence
3. Enhance reading abilities and apply the skills with better understanding
4. Apply the skills and strategies of a successful speak
5. Apply the skills and strategies of a successful listener

Unit	Course Content	Class hours
1	**Fundamentals**: Parts of speech and its exercise; sentence structure- active & passive voice; use of adjectives & verbs; gerund- forms & uses; vocabulary building; comprehension.	**5**
2	**Reading:** Strategies of reading - predicting, skimming, scanning, intensive & extensive; speed reading; inferencing and analyzing selected texts- texts reflecting common interests, special texts related to major courses of Microbiology.	**4**
3	**Writing:** Writing process- brainstorming, outlining, drafting, editing and proofreading; Paragraph development- structure& types of paragraphs; Letter writing- apology, request for leave, acknowledgement, permission, information & friendly letters; Essay writing- structure and types, thesis statement, introduction and conclusion; Technical report writing- academic and lab reports, summary/paraphrase writing; Writing research papers- planning, method, organizing extracted information, drafting, and revising, ethical issue of writing.	**8**
4	**Speaking:** Introducing self and others; Expressing like and dislikes, personal experiences, apologies and excuses, comparison and contrast; Describing people/place/events, saying times; Giving and following instruction, reporting, complaining; Seminar presentation and interviews.	**8**

5	**Listening:** Listening comprehensions focusing on varying elements of vocabulary and structures will be practiced. Student will be taught how to be an active listener to obtain information and key ideas.	**5**

Recommended Books

1. Guide to Writing- J.D. Ramage, J.C. Bean, J.J. Allyn and B. Longman
2. The Heinmann ELT English Grammar- D. Beaumont and C. Granger; Macmillan
3. Advanced English Comprehensive Texts for Science Students - M. Smithies; Collier- Macmillan
4. Reading and Study Skill - J. Longman

CM 100F Fundamentals of Chemistry Credits: 4 Class: 60 hours

This course is designed as supporting/allied course for the graduate students of Microbiology. A development of fundamental principles of chemistry and their applications, chemical nomenclature, bonding theories, thermo-chemistry, periodic properties, solution calculations, gas laws and the properties of solids and liquids are among the topics discussed. It will also provide the student with the opportunity to establish and develop the generic skills including ability to use conceptual models and gather and rationalize data, problem-solving and critical thinking.

Course Objectives

The aim of the subject is to provide students with an understanding of the nature of matter, solutions and gases, the chemical change related to equilibrium, energy and kinetics, and the nature of redox processes; and structures and functional groups in organic molecules.

Learning Outcomes

Upon completion, the student should have a firm foundation in the fundamentals and applications of current chemical and scientific theories including physical, inorganic, organic and analytical chemistries. The students should also have an understanding of the nature of matter, solutions and gases, the chemical change related to equilibrium, energy and kinetics, and the nature of redox processes; and structures and functional groups in organic molecules.

Unit	Course Content	Class hours
1	**The Structure of Atoms:** the discovery of electron proton and neutron; cathode rays; radioactivity; α-particles; scattering Rutherford model; fraction of atomic masses; isotopes; mass spectroscopy spectrum of atomic hydrogen; Bohre models; dual nature of matter; wave nature of electrons; atomic orbital; electron configuration of atom.	**3**
2	**Radioactivity and Nuclear Reactions:** nuclear binding energy: fission and fusion reactions	**3**
3	**Periodic Classification of Elements:** ionization potential; electro negativity; electron affinity; atomic radius; variation of properties along a period and a group; diagonal relationship; representative elements; transition elements; chemical properties of s-, p- and d-block elements.	**4**
4	**Chemical Bonds:** electronic theory; valence bonds theory; molecular orbital theory; sigma (δ)- and pi (π) bonds; C-C bonds; catenation; polar molecules electro negativity and electron affinity; hydrogen bond; shapes of molecules; VSEPR theory; hybridization.	**3**
5	**Oxidation and Reduction:** oxidation number; analytical reagents.	**3**
6	**States of Aggregation of Matter:** kinetic theory of matter; nature of heat; changes of states.	**3**
7	**The Gaseous State:** the gas laws; the perfect gas equation; the kinetic theory of gases; the distribution of molecular velocities; inter molecular attraction; liquefaction of gases; the critical state; the critical constants	**3**
8	**Vapour Pressure of Liquids:** temperature dependent mixtures of liquids; Raoult's law; fractional distillation; solutions of non-volatile solids; colligate properties of solutions;	**3**

	Henry's law; Nernst distribution law	
9	**Energy Changes in Chemical Reactions:** the first law of thermodynamics F; the concept of internal energy and enthalpy; measurement of enthalpy changes; enthalpy of formation; Hess's law; lattice enthalpy; Born-Haber cycle; spontaneous process; concept of entropy	**3**
10	**Chemical Equilibrium:** the equilibrium law; the equilibrium constant; homogeneous and heterogeneous equilibrium; the principal of Le Chatelier and Brown; the dependence of K on temperature.	**3**
11	**Acids and Bases:** the Lewis concept; the Bronsted concepts in strong and weak acids; acid-base equilibrium in aqueous solutions; Ostwald dilution law; pH; buffer solutions; neutralisation curves; indicators for acid-base titration.	**3**
12	**Electrolysis:** galvanic cells; electrodes and electrode reactions reduction potential; the electrochemical series the standard hydrogen electrode; measurement of pH	**3**
13	**Rates of Chemical Reactions:** order and molecularity; zero and first order reactions; half life; carbon dating; temperature dependence of rates of reaction.	**3**
14	**The Organic Compounds and Organic Chemistry:** hydrocarbons; aliphatic hydrocarbons; standard and unsaturated hydrocarbon; alkanes, alkenes and alkynes; the aromatic hydrocarbons; delocalisation in the benzene ring; nomenclature of organic compounds; the IUPAC system; petroleum; natural gas; refining of petroleum; petrochemicals.	**4**
15	**The Concept of:** Acid Bases, Nueleophiles, Electrophiles, Carbocations and Carboanions and Free Radicals.	**3**
16	**Reactions of Alkanes, Alkenes and Alkynes:** substitution and hydrogen abstraction reactions in alkanes; hydrogenation; hydrohalogenation; ozonolysis of alkenes and alkynes; homolytic addition of hydrogen halides; geometrical isomers	**3**
17	**Functional groups:** alcohols, aldehydes, ketones, ethers, epoxides, amines, amides; typical reactions of the functional groups	**4**
18	**Some Important Reactions of the Aromatic Compounds:** substitution at the benzene ring; Friedel-Craft's reaction; diazotization and coupling; sulphonation and nitration	**3**
19	**Organic Macro Molecules:** polythene; teflon; plastic; resin; nylon; peptides; proteins; cellulose and starch	**3**

Recommended Books

1. General Chemistry - D.D. Ebbing and M.S. Wrighton, A.I.T.B.S publishers, Delhi
2. General Chemistry – L. Pauling; Dover Publications
3. Chemistry - J.M. Coxon, J.E. Gergusson and I.F. Philips
4. A-Level Chemistry – E.N. Ramsden

MBG 109 Viva-Voce **Credits: 2**

A comprehensive viva-voce is mandatory and will be held at the end of the academic session as per regulation of the faculty.

MBG 110 Sessionals **Credits: 2**

The Department will determine the tasks and marks for the Sessionals as capstone course. It includes: (i) orientation to Microbiology: faculty, facilities, services, curricula and career opportunity in Microbiology, (ii) safety regulations and good microbiological laboratory practice (GMLP) in laboratory works, (iii) code of conduct and academic integrity, and (iv) assignments.

Courses for the Second Year BS (Honours)

The students will continue their studies on other basic courses in greater depth. The students have the opportunity to carry out basic knowledge and techniques that are widely used in current microbiological sciences. The course unit details given below are subjected to change, and are the latest example of the curriculum available on this course of study.

MBG 201 General Microbiology **Credits: 2 Class: 30 hours**

This course is designed to introduce students to the basic aspects of microorganisms especially reproduction and growth patterns. It also describes how growth can be controlled by use of antimicrobial agents and the enzymatic activities of microorganisms for the breakdown of different substrates. The course also includes the characteristics and economic importance of atypical forms of bacteria.

Course objectives

1. To familiarize the microbial growth and reproduction with metabolic assessment
2. To acquaint the basic methods for controlling bacterial growth
3. To introduce characteristics of atypical forms of bacteria

Learning Outcomes

Upon completion of the course students should be able to:

1. Demonstrate the ability to accurately analyze and apply information relating to microbial growth and reproduction.
2. Acquire an understanding of fundamental concepts of the impacts of nutritional and environmental factors on microbial growth.
3. Describe how different chemical agents/antibiotics can be used to control of bacterial growth.
4. Explain the principle and mechanism of actions of antimicrobial agents on microbes.
5. Identify atypical bacteria with their characteristic features and economic importance.

Unit	Course Content	Class hours
1	**Microbial Growth and Reproduction:** growth and types of reproduction; growth measurements; growth phases; generation time; mathematical expression of growth; synchronous growth	7
2	**Growth Requirements:** growth requirements - physical, nutritional and environmental growth requirements; classification based on growth requirements; classification of microbes based on growth requirements; assessment of growth requirements of microbes by conventional methods.	5
3	**Control of Microbial Growth:** Principles of microbial control; the rate of microbial death; the action of microbial control agents; conditions (factors) influencing microbial control; physical and chemical methods of control.	5
4	**Antimicrobial Agents:** Type, chemistry, mode of action and efficiency. study of penicillin, tetracycline, chloramphenicol, nystatin, gentamicin and griseofulvin.	5
5	**Atypical Bacteria:** General characteristics and importance of actinomyces, cyanobacteria, mycoplasmas, rickettsias, chlamydias and spirochetes; gliding, sheathed, budding and appendaged bacteria	8

Recommended Books

1. Principles of Microbiology- R.M. Atlas; William C Brown Pub
2. Microbiology- M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
3. Microbiology: Concepts and Applications- M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg: McGraw Hill Inc., New York

4. Microbiology: An Introduction- G. J. Tortora, B.R. Funke and C.L. Case; Pearson, Boston
5. A Text Book of Microbiology – R.C. Dubey and D.K. Mahrsshwari; S. Chand, India

MBG 202 Fundamental Cell Biology **Credits: 2 Class: 30 hours**

Cell biology is the study of the properties and functions of cells. The cell is the basic unit of life for all living things. Therefore, the study of cell biology is fundamental to learning about how all living organisms develop, survive and evolve. Learning about the composition of the cell as well as the way they replicate and interact with their environment helps scientist better understand the tissues, organs and organisms that they come together to create.

Course Objectives

1. To familiar with the basic concept of cells of living organisms and its development
2. To learn about the functions of cell components in coordination and regulation of life
3. To explore the mechanisms of controlling adaptation and cell cycling in nature

Learning Outcomes

Upon completion of the course, students should be able to:

1. Develop a broad understanding of the cells and its molecular architecture with the unified role it plays for the ultimate sustainability of the organisms.
2. Understand how these cellular components are used to generate and utilize energy in cell.
3. Identify the range of cellular activities that are especially relevant to multicellular organization.
4. Learn how do cells conduct, coordinate and regulate nuclear and cell division, and
5. Learn the components of interacting molecules of cells and extracellular matrix and roles in cell and organ function and development.
6. Understand how external signals can lead to changes in gene expression and protein synthesis in cells.

Unit	Course Content	Class hours
1	**Molecular Architecture of Cells:** Cellular and chemical foundations of life; historical development of cell theory; Distinguishing traits of prokaryotic cells and eukaryotic cells; Cell size, shape and arrangements. **Prokaryotic Cell Structure:** Glycocalyx, flagella, axial filaments, fimbriae and pili; Cell walls of bacteria and archaea; Cytoplasmic membrane, cytoplasm, ribosomes, inclusions and endospore. **Eukaryotic Cell Structure:** Structure and sub-cellular organelles; Rough and smooth endoplasmic reticulum (ER); Role of the vacuole in plant cells; Tonoplast; Cytoskeleton, nucleoid, nuclear envelope, nuclear pore complex and nuclear lamina; Chromatin, nucleolus.	**10**
2	**Transporting of Molecules Across Cell Membrane of Eukaryotes:** Functions of cell membrane- role of phospholipids, cholesterol, proteins and protein complexes; Nutrient transport process- active and passive transport; Simple diffusion, osmosis, and facilitated diffusion; Active transport by ATP-powered pump; Bulk transport by exocytosis and endocytosis- pinocytosis, phagocytosis, and receptor mediated endocytosis.	**3**
3	**Intra-cellular Processing:** Delivery of ribosome-synthesized proteins to the correct location- signal hypothesis; Transportation of proteins into/through endoplasmic reticulum (ER); Processing of proteins in ER; Transport of proteins in mitochondria, Golgi Apparatus and nucleus.	**2**
4	**Cell division and Cell Cycle:** Bacterial cell division by binary fission; Mitosis in eukaryotes, stages of mitosis and meiosis; Phases of eukaryotic cell cycle- G1, S, G2 and M phase, cell cycle control systems. .	**6**

5	**Interactions between Cell and its Environment:** Extracellular matrix (ECM)-components and their functions. Interactions of cells with ECM, Intergrins, focal adhesion and hemidesmosome; Anchoring cells to their substratum; Cell-cell adhesion and cell junctions.	**9**

Recommended Books

1. Cell and Molecular Biology: concepts and experiments- G. Karp and Marshall; Wiley & Sons
2. Karp's Cell and Molecular biology: Concepts and Experiments – G. Karp, J. Iwasa and W. Marshal; Wiley and Sons Pub.
3. Molecular Biology of the Cell: Alberts, Johnson, Lewis, Raff, Roberts and Walter. Garland Science.
4. Microbiology: An Introduction – G.J Tortora, B.R. Funke and C.L. Case. Pearson Education Inc.
5. Principles of Cell Biology – J. Plopper; Lewin's CELL
6. Cell Biology – T.D. Pollard and W.C. Earnshaw; Elsivier, Philadelphia

MBG 203 Environmental Microbiology Credits: 2 Class: 30 hours

The course introduces the basic and applied concepts of microbial environment and the factors steering the assembly and functioning of complex environmental microbial communities. It provides an overview of biological interaction of microbes, techniques to study environmental microbes, pollution problem, water-borne indicator organisms, sewage treatment and sanitation, and stimulate students' interest in performing the research necessary for this course. The students will learn the principles for using complex microbial communities for environmental applications in the light of the Microbial Resource Management.

Course Objectives

1. To acquire knowledge on the wide microbial diversity in different complex ecosystems
2. To learning the beneficial roles of microbes in improvement of environmental health and harmful effects in deteriorated environments;
3. To learn the principles and methods for the detection of microbial interaction with environment

Learning Outcomes

Upon completion of this course, students will be able to-

1. Familiarize with interaction among diverse microbial population as well as with other life form.
2. Use techniques to detect environmental microbes, sample collection and processing.
3. Get acquainted with indicator organism related to potable water.
4. Learn about pollution problem and potential role of microbes to remediate the problems.
5. Learn about different sewage treatment systems, sanitation and public health in Bangladesh perspectives.

Unit	Course Content	Class hours
1	**Biological Interactions:** Microbial interaction - interaction within a single microbial population, positive and negative interactions, interaction between diverse microbial populations; neutralism, commensalism, synergism, mutualism, competition, ammensalism, parasitism, predation; microbe plant interaction, and microbe-animal interaction.	**9**
2	**Techniques for Studying Environmental Microbes:** Sample collection and processing; detection of microbial populations; determination of microbial numbers; determination of microbial biomass; measurement of microbial metabolism	**6**
3	**Microbiology of Potable Water:** Introduction to indicator organisms; water-borne pathogens; isolation and identification of indicator bacteria; water-borne pathogens	**4**

4	**Sanitation and Public Health Microbiology:** Water supply systems in rural and urban areas; preservation and use of safe water; public tube well coverage.	**2**
5	**Microorganisms and Pollution Problems:** Persistence and biomagnification of xenobiotic molecules; recalcitrant halocarbons, polychlorinated biphenyls, alkyl benzyl sulfonates and synthetic polymer	**5**
6	**Sewage Treatment:** Primary treatment; secondary treatment; aerobic and anaerobic treatment; tertiary treatment	**4**

Recommended Books

1. Microbial Ecology: Fundamentals and Applications- by R.M. Atlas & R. Bartha; Addison Wesley Longman, New York
2. Microbial Ecology: A Conceptual Approach- by J.M. Lynch & N. J. Poole; John Wiley & Sons, New York
3. Microbiology- by M.J. Pelczer Jr., E.C.S. Chan &N.R. Krieg; McGraw-Hill Book Company
4. Environmental Microbiology of Aquatic & Waste systems – by N. Okafor, Springer, New York
5. Environmental Microbiology – by R.M. Maier, I.L. Pepper & C.P. Gerba, Academic Press
6. Microbial Ecology: Organism, Habitats, Activities- by H. Stolp; Cambridge UniversityPress
7. An Introduction to Soil Microbiology – by A. Martin, John Wiley & Sons Inc. New York & London.

MBG 204 Bacterial Metabolism Credits: 2 Class: 30 hours

This course is designed to introduce students about the bacterial physiology and metabolism particularly focusing on the catabolic pathways. The course will summarize different metabolic pathways centering on central metabolic pathway as well as fermentation pathways. The supporting streams linked with the central metabolic pathways like brief introduction to metabolic pathway, electron transport chain and metabolic dynamics of aerobic heterotrophs will also be covered.

Course Objectives

1. To understand the basic concept of metabolism and metabolic network in a bacterial cell
2. To learn the central metabolic pathway and electron transport chain of bacterial cell
3. To familiar with the basic catabolic pathway of interest other than central metabolic pathway

Learning Outcomes

Upon completion of the course, students should be able to:

1. Familiar with the basic facts, principles, theories related to microbial physiology and metabolism.
2. Acquire, retain, and communicate complex conceptual ideas related to bacterial physiology and metabolism.
3. Describe the network involved in metabolic pathways including solute transport.
4. Understand the detail of central metabolic pathway
5. Explain the mechanism of electron transport chain
6. Understand the catabolic pathway of interest other than central metabolic pathway focusing on fermentation pathways

Unit	Course Content	Class hours
1	**Introduction to Metabolism:** Important differences and relationships between anabolic and catabolic mechanisms in living organisms.	**3**
2	**Electron Transport:** Aerobic and anaerobic respirations, electron carriers, organization of the electron carriers in mitochondria, organization of the electron carriers in bacteria; coupling sites, proton pumps, electron flow patterns in bacteria.	**5**

3	**Solute Transport:** Kinetics of solute uptake, energy-dependent transport, source of energy for transport.	**5**
4	**Central Metabolic Pathways:** Glycolysis, the fate of NADH, the pentose phosphate pathway, the Entner–Doudoroff pathway, TCA cycle; carboxylations to replenish oxaloacetate. the pyruvate and phosphoenolpyruvate carboxylases glyoxylate cycle, glyoxal bypass; inter linkages of pathways; anapleuretic reactions, pathways for utilisation of sugars other than glucose	**9**
5	**Fermentations:** Oxygen Toxicity, Energy Conservation by Anaerobic Bacteria, Propionate Fermentation: Acrylate Pathway, Succinate–Propionate Pathway, Acetate Fermentation, Lactate Fermentation, Mixed-Acid and Butanediol Fermentation, Butyrate Fermentation	**3**
6	**Catabolic Activities of Aerobic Heterotrophs:** Degradation of biopolymers; growth with amino acids, organic acids, aromatic compounds, aliphatic hydrocarbons and C_1 compounds.	**5**

Recommended Books

1. The Physiology and Biochemistry of Prokaryotes - D. White, J. Drummond and C. Fuqu; Oxford University Press
2. Microbial Physiology - A.G. Moat and J.W. Foster; John Wiley, New York
3. Bacterial Metabolism - G. Gottschalk; Springer-Verlag, New York
4. Microbiology - M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
5. Microbiology: Concepts and Applications - M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg; McGraw Hill Inc., New York
6. Lehninger Principles of Biochemistry - D.L. Nelson and M.M. Cox; W.H. Freeman and Companyk

MBG 205 Basic Microbial Genetics Credits: 2 Class: 30 hours

The course presents the basic facts and concepts with basic knowledge to stimulate students to move on to more advanced aspects of the subject. The course includes the fundamental concepts structural and functional properties of genetic materials, the function of the gene as a unit of biological information. role of the gene as a unit of inheritance and exploration of the areas of research that are responsible for the high profile that genetics has in our modern world, from agriculture and industry to medicine and forensics, and the ethical challenges that genetic knowledge imparts.

Course Objectives

1. To familiar with the concepts and the genetic mechanisms of heredity of eukaryotes.
2. To learn about the mechanisms of the replication and transcription in prokaryotes and eukaryotes.
3. To understand the translation of genetic code for protein synthesis in living body.

Learning Outcomes

The intention of the course is for students to demonstrate your ability to:

1. Describe the historical developments and concepts of genetics to acquire specialized language relevant to microbial molecular genetics.
2. Explain the chromosome basis of inheritance and integrate information on concepts relevant to sex determination.
3. Familiar with the key concepts and mechanisms of DNA replication including microbial molecular genetics.
4. Describes how genes are transcribe and the structural and functional features of the transcripts.
5. Understand the nature genetic code and the translation of the genetic message.

Unit	Course Content	Class hours
1	**Basic Principles of Heredity**: Importance and fundamental concepts of genetics; Discovery of basic principle of heredity- monohybrid, dihybrid and trihybrid crosses; Mendel's experiments and his interpretation - the basic principles of dominance, segregation and independent assortment; misinterpretations of Mendelian principles; Extension of Mendelism and modification of basic principles.	6
2	**Chromosomal Basis of Inheritance:** Chromosome theory of heredity; sex chromosomes and sex determination; sex-linked genes in human beings; variation in chromosome number and structure; Chromosome variation- mutations including Rearrangements, Aneuploids and Polyploids.	9
3	**Replication of DNA:** Semi-conservative replication; Mode, requirement and direction of replications; DNA polymerases; Mechanisms of replication of bacterial DNA, eukaryotic DNA and replication in archaea; Circular DNA replication	5
4	**Transcription in Prokaryotes and Eukaryotes:** different types of RNA molecules; prokaryotic and eukaryotic RNA polymerases; mechanism of transcription in prokaryotes and eukaryotes; post-transcription modification of RNA; interrupted genes in eukaryotes; mechanism of removal of intron sequences.	5
5	**Translation and Genetic Code:** polypeptides and proteins; synthesis of polypeptide chain; nonsense mutation and suppressor mutation; the genetic code; Wobble hypothesis; post-translation modification of protein.	5

Recommended Books

1. Genetics - M.W. Strickberger; Prentice Hall College Div
2. Genetics - D.P. Snustad and M.J. Simmons; John Wiley and Sons, Inc.
3. Genetics: Analysis of Genes and Genomes - D.L. Hartl and M. Ruvolo; Jones & Bartlett, New Delhi
4. Molecular Biology of the Gene - J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick; Pearson, San Francisco
5. Molecular Biology - D. Freifelder; Jones and Bartlett, Boston
6. Essential Genetics - P.J Russell; Blackwell Science Inc
7. Principles of Genetics - E.J. Gardner, M. J. Simmons& D.P.Snustad; John Wiley and Sons

MBG 206 Medical Microbiology-I Credits: 2 Class: 30 hours

This course is designed to provide learning opportunities in the basic principles of medical microbiology and infectious disease. It covers the role of the human body's normal microflora and mechanisms of infectious disease transmission. The course provides the conceptual basis for understanding pathogenic microorganisms including clinical examples and the mechanisms by which they cause disease in the human body. It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory diagnosis of infectious diseases.

Course Objectives

1. To develop knowledge based on principles of microbial pathogenesis.
2. To learn basic interactions microorganisms with human host and the diseases they produce.
3. To familiar with the major types of pathogenic microorganisms and their related diseases.

Learning Outcomes

At the end of this course students will be able to:

1. Explain the basic concept of infection and infectious diseases.
2. Describe the role of microbes in diseases including the nature of disease causing microbes and their route of transmission.
3. Acquire basic knowledge about the virulence factors for identifying specific pathogens.
4. Summarize the role of the host in infectious disease, including natural barriers to infection

5. Compare and contrast different microbial diseases, including the properties of different types of pathogens, and the mechanisms of pathogenesis.
6. Specify the role of ecology and evolution in the spread of infectious diseases, comparing the role of transmission, population size and susceptibility, and virulence.

Unit	Course Content	Class hours
1	**Infection and Infectious Diseases:** Concept of infection and infectious diseases; pathogenesis of infectious diseases; virulence (ID_{50}, and LD_{50})	3
2	**Major Reservoirs of Microbial Pathogens and transmission of disease:** acquisition of and mode of transmission of diseases. Introduction to nosocomial infection.	3
3	**Introduction to Virulence factors:** adherence factors; invasion of host cells and tissues; toxins; enzymes; intracellular pathogenesis; antigenic heterogeneity; iron acquisition	5
4	**Host-Microbe Interaction:** normal resident microflora of human body and their role; initial colonization of a new born; introduction to resident flora of skin, mouth, upper respiratory tract, intestinal tract, uro-genital tract, eye	4
5	**Non-Specific Host Defences against Microbial Pathogens:** primary defences conferred by tissues and blood	3
6	**Progress of an Infection:** true and opportunistic pathogens; portal of entry; size of inoculum; stages in the course of infections and diseases; mechanism of invasion and establishment of the pathogens; signs and symptoms of a disease; portal of exit	3
7	**Introduction to the Microbiology of Major Infectious Diseases:** Skins, respiratory system; nervous system; genito-urinary tract; gastrointestinal tract; circulatory system	9

Recommended Books

1. Jawetz, Melnick and Adelberg's Medical Microbiology- K.C. Carroll, S.A. Morse, T. Mietzner, andS. Miller; McGraw Hill Education
2. Essential Clinical Microbiology: an introductory text- E. MCookeand G.L.Gibson; Wiley and Sons, New York
3. Bacterial Pathogenesis: A Molecular Approach- A.A. Salyersand D.D. Whitt; ASM Press
4. Medical Microbiology- J.P. Duguld, B.P. Marinianand R.H.A. Swain
5. Medical Microbiology - C.Mims, J. Playfair and I. Roitt; Wakelin D and Williams R.

MBG 207 Basic Food Microbiology Credits: 2 Class: 30 hours

This course is designed to give students an understanding of the principles of food microbiology, role of microorganisms in food processing and preservation; the relation of microorganisms to food spoilage, food-borne illness, and intoxication; general food processing and quality control. Students will be able to familiarize themselves with the techniques used to research, regulate, prevent and control the microorganisms in food and understand the function of beneficial microorganism during food manufacturing process.

Course Objectives

1. To learn about the relevance of microorganisms with food processing industries
2. To learn about food related microorganism with their growth and spoilage
3. To learn about control of food spoilage and preservation of foods

Learning Outcomes

After completion the course student will able to:

1. Acquire knowledge about food categories & their common microbial association.
2. Demonstrate detailed understanding about the factors influencing microbial growth in food.

3. Make predications, assess and articulate for a specific food the microorganisms important in quality, spoilage and disease.
4. Acquire basic skills needed to learn procedures for preservation of foods.
5. Demonstrate the ability to perform basic regulatory guidelines for manufacturing safe and quality foods for consumers.

Unit	Course Content	Class hours
1	**Food and Food-Associated Microbes:** General aspects of food- needs, composition, types of commodities, categorization and major sources; Microbes associated with food- bacteria, yeasts and viruses; Applications of genetically modified microbe; Sources of microbial contaminants in food; Introduction to food-borne diseases.	5
2	**Factors Affecting Microbial Growth in Food:** Intrinsic factors- pH, water activity, redox potential, nutrient content, antimicrobial constituents, biological structures; Extrinsic factors- temperature, relative humidity, gases; Implicit factors- specific growth rate, mutualism, antagonism, commensalism; Process factors- slicing, washing, packing, irradiation, Pasteurization.	5
3	**Microbial Food spoilages:** Causes and types of spoilages; Microbial contamination and spoilages of food- cereal and cereal products, sugar and sugar products, vegetables and fruits, meat and meat products, fish and sea-foods, poultry, milk and milk products, and heated canned food.	7
4	**Food Preservation:** General principles; Physical methods- high temperature, low temperature, drying and radiation; Chemical preservatives and natural antimicrobial compounds; Biological control of food-borne microorganisms.	7
5	**Food Sanitation, Control and Inspection:** Microbiology in food sanitation- water supply, waste treatment & disposal, good hygienic practice, good manufacturing practice, HACCP; Food control- role of national and international agencies; Inspection- food, transport and food premises.	6

Recommended Books

1. Fundamental Food Microbiology - B. Ray; CRC Press, New York
2. Food Microbiology: an introduction - T.J. Montville & K.R. Matthews; ASM Press, USA.
3. Microbiology - W.C. Frazier & D.C. Westhoff; McGraw-Hill
4. Basic Food Microbiology -G.J. Banwart; Chapman and Hall, inc.
5. Modern Food Microbiology - J.M. Jay; Springer
6. Food Microbiology - M.R. Adams & M.O. Moss; Thomas Graham House Cambridge
7. Microbiology of Frozen Foods - R.K. Robinson; Elsevier Applied Science Publishers

MBG 208 Fundamentals of Enzymology **Credits: 2 Class: 30 hours**

This fundamental course is designed to give students an understanding of the physical, chemical and kinetic properties of enzymes. It includes the influence of parameters such as concentrations of substrate and enzyme, pH, temperature, and inhibitors on activity of enzymes. Specificity and mechanism of action of enzymes are described by considering examples selected from among enzymes of importance to food science, nutrition, and the biological sciences. Moreover the kinetics of the enzymatic reaction will be one of the major concentrations of this course contact. Regulation of enzyme as well as their relation to each other will be under the umbrella of the scope of this course.

Course Objectives

1. To introduce students to various theoretical and practical aspects of enzymology
2. To give comprehensive knowledge in the field of structure, function and kinetics of enzyme and their role as catalyst and regulator of cell metabolism.
3. To integrate the practical aspects of enzymology with the kinetic theories to provide a mechanistic overview of enzyme activity and regulation in cells.

Learning Outcome

Upon successful completion of this course, the student will learn:

1. The major classes of enzyme and their functions in the cell.
2. Structural feature of enzyme and mechanism of folding of enzyme in the *in-vivo* system.
3. Properties of enzymes and regulation of biochemical pathways (inhibition, allosterism).
4. Study of enzyme kinetic as well as the estimation of important parameter (Km. Vmax, Kcat)
5. Analyze kinetic inhibition data and to determine the mechanism of inhibition.

Unit	Course Content	Class hours
1	**Introduction to Enzymes:** Composition and classification of enzymes; Isoenzymes; Multi-enzymes; Enzymes in organized systems; Applications of enzymes- industrial enzymes, diagnostic enzymes and therapeutic enzymes.	4
2	**Properties and Functions of Enzymes:** Remarkable properties; catalytic power; specificity; different forms; cofactors, coenzymes and vitamins	4
3	**Structure of Enzymes:** Primary, secondary, tertiary and quarternary structure; folding and domains; molecular chaperones	4
4	**Enzyme Regulation:** Allosteric enzymes; structure, properties and regulations.	3
5	**Mechanism of Enzyme Action:** Active site; substrate binding; general acid-base catalysis; covalent catalysis; non-protein catalytic groups and metal ions; Enzyme turnover.	5
6	**Kinetics of Enzyme-Catalyzed Reactions:** Factors influencing catalytic activity; simple enzyme kinetics with single and multi-substrate; Michaelis-Menten kinetics; turnover number, K_m and V_{max}; other influences on enzyme activity; pH, temperature, fluid forces, chemical agents and irradiation.	5
7	**Enzyme Inhibition and deactivation:** Competitive, non-competitive and un-competitive inhibition; deactivation models; strategies for enzyme stabilization.	5

Books Recommended

1. Lehninger Principles of Biochemistry – D.L. Nelson and M.M. Cox, W.H. Freeman and Company, New York
2. Biochemical Engineering Fundamental – J.E. Bailey and D.F. Ollis, McGraw-Hill, New York
3. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins - N.C. Price and L. Stevens; Oxford Science Publications
4. Advances in Enzymology and Related Areas of Molecular Biology – F.F. Nord; John Wiley & Sons.

MBG 209 Laboratory Works **Credits: 4** **Class: 80 hours**

The second year laboratory course is designed to focus on the senses and basic techniques more of an insight into range of processes related to the theoretical courses. This basic Laboratory curriculum described below represents topics and themes considered essential to the development of cognitive, analytical, communicating and interpersonal skills in microbiology laboratory. These themes and topics are meant to frame objectives to be met somewhere within the microbiology laboratory. Laboratory works typically supplement and integrate closely with the lecture contents of the theoretical courses in a way that is unique to each instructor. Development of laboratory techniques; exercises designed to reinforce concepts covered in this course.

Course Objectives

The main objective of the course is to achieve the basic laboratory skills in microbiological sciences. The specific objectives include developing laboratory skills in demonstration of cell structures and

division, growth measurement, the factors influencing microbial growth and their metabolic activities in foods, microbiological health hazards, microbial enzymes, etc. and to develop analytical and communicating skills along with data processing for laboratory reports.

Learning Outcomes

After successful completion of the laboratory works, students will be able to learn the basic and applied techniques for demonstration of molecular architecture and functions of the basic unit of life, determine microbial growth and the influence of different factors on microbial growth in food. The students can determine the microbiological status of environmental and clinical samples with their physical, chemical and microbiological status. The students should earn the capability to demonstrate the structure and functions of genetic materials of microorganisms along with their transformations. Identify pathogens from clinical samples and their sensitivity to different antimicrobial agents. They will also develop skills to determine spoilages of different foods with their causative agents, employ proper methods for preservation of foods and assess the activity of microbial biocatalysts with their functional properties for applications.

Unit	Course Content	Class hours
1	**Growth Measurement** 1. Serial dilution technique for viable cell counts (spread plate and pour plate) 2. Techniques of enumeration of microorganisms: Improved Neubauer counting chamber; Miles and Misra technique 3. Study and plot the growth curve of *E. coli* by tubidiometric and standard plate count. 4. Effect of oxygen and pH on growth of *E. coli*. Antimicrobial sensitivity test of microorganisms (qualitative) 5. Actions of antiseptics, disinfectants, and photo-reactivation and anti-metabolites 6. Demonstration of the thermal death time and decimal reduction time of *E. coli*	10
2	**Cell Biology** 1. Study a representative plant and animal cell by microscopy 2. Study of different stages of Meiosis and Mitosis by permanent slides. 3. Study of the structure of cell organelles through electron micrographs. 4. Identification and study of cancer cells by photomicrographs. 5. Cytochemical staining of DNA – Feulgen;	10
3	**Environmental Microbiology** 1. Determination of environmental influence on microbial growth 2. Analysis of soil- pH, moisture content, water holding capacity 3. Assessment of microbiological quality of natural water. 4. Determination of BOD/COD of waste water sample. 5. Demonstration of sewage treatment	10
4	**Metabolic Activities of Microorganisms** 1. Hydrolysis of biopolymers such as starch, lipid, casein and gelatine 2. Carbohydrate fermentation 3. MIU, KIA and IMViC tests 4. Nitrate reduction, oxidise, catalase and litmus milk reaction tests 5. Antimicrobial sensitivity test (qualitative) 6. Demonstration of anaerobic culture techniques	10
5	**Basic Microbial Genetics** 1. Demonstration of different types of DNA & RNA using micrograph and model 2. Demonstration of semi-conservative replication of DNA using micrograph 3. Detection of genetic material by staining 4. Isolation of genomic and plasmid DNA from *E. coli*	10

	5. Resolution and visualization of DNA by Agarose Gel Electrophoresis 6. Protoplast fusion test 7. Test for enzyme induction	
6	**Medical Microbiology** 1. Collection, transportation and microscopic examination of clinical samples. 2. Identification of infections of ear, nose, throat, skin and urogenital tract by swab test 3. Culture sensitivity test for isolated pathogenic microbes by disc diffusion method 4. Identification of human staphylococcal and streptococcal pathogens 5. Urine analysis (physical, chemical and microbiological) 6. Microscopic study of parasites	**10**
7	**Microbiology of Food** 1. Isolation of spoilage microorganisms from fresh foods 2. Isolation and determination of microbes from fruit juices 3. Isolation of spoilage microorganisms from processed food 4. MBRT and APT of milk samples and their standard plate count 5. Test for the efficacy of food preservatives 6. Visits to food industries	**10**
8	**Microbial Enzymes** 1. Isolation of cellulolytic, proteolytic, lipolytic and amylolytic microbes from different sources. 2. Determination of enzyme activity (cellulase, lipase, amylase, proteases and nucleases) 3. Determination of kinetic properties of an enzyme 4. Determination of activators and inhibitors of enzymes 5. Determination of molecule weight and substrate specificity of enzyme	**10**

RecommendedBooks

1. Microbiology: A Laboratory Manual- J. Cappucino & N. Sherman; Pearson Education Limited
2. Cell and Molecular Biology – P.V. Chaitanya; Prentice-Hall of India Pvt. Ltd.
3. Environmental Microbiology – I. Pepper, C. Gebra and J. Brandecke; Academic Press
4. Principles of Microbiology - R.M. Atlas, WM.T. Brown Publishers.
5. Food Microbiology: A Laboratory Manual – A.E. Yousef and C. Carlstrom; Wiley and Sons Inc.
6. Laboratory Protocols in Applied Life Sciences - P.S. Bisen, CRC Press

MBG 210 Biostatistics and Calculus **Credits: 4 Class: 60 hours**

This course designed to introduce the basic sequence, calculus, serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts and skills needed for mathematical manipulation. The calculus focuses on the study of functions of a single variable. Without statistical analysis research articles are not accepted for publication by the scientific journals.

Course Objectives

1. To help the students to analyze data pertaining to their research work
2. To assess the significance of their experimental designs.
3. To earn sound knowledge of the statistical programmes.

Learning Outcomes

Upon completing the course, the students will be able to:

1. Develop skills to demonstrate communicating quantitative information.
2. Demonstrate competence in the statistical, mathematical, computational, and nonmathematical skills in statistical science.

3. Demonstrate the ability to analyze data by appropriately fitting, assessing, and interpreting a variety of statistical models
4. Write technical reports and make technical presentations containing statistical results, and work in teams to demonstrate the consulting skills of a professional statistician
5. Manipulate data, implement statistical methods, document, and debug code in one or more profession statistical software programs
6. Solve problems in basic probability theory, statistical inference, and calculus.

Unit	Course Content	Class hours
1	**Organizing and Summarizing Data:** some basic concepts; statistics, biostatistics, variables, population and sample, random samples, distribution; tabulation, processing and summarizing of numerical data; the frequency – distribution, graphical representation of frequency table measures of central tendency; measures of dispersion, skewness of kurtoses; measures or exploratory data analysis by plotting	6
2	**Probability: i**ntroduction; some elementary probability; the binomial distribution; the normal distribution; the Chi-square distribution; the distribution of Student's	4
3	**Hypothesis Testing/Statistical Inference:** statistical hypothesis: simple and composite hypothesis; significance test; type-1 and type-II errors; power of a test; p-value; testing hypothesis of a single population mean, proportion, variance; comparison between two population means and between two population variance	6
4	**Analysis of Frequency using λ^2Distributions:** the λ^2 criterion; tests of goodness-of-fit; homogeneity of two-cell samples; tests of independence	4
5	**Correlation, Simple Regression and Multiple Regression:** correlation: linear regression model, evaluating the regression equation, the multiple regression model; evaluating multiple regression model; choosing independent variables for multiple regression model	6
6	**Analysis of Variance:** experiment; experimental unit; treatment; replication analysis of variance for the completely randomized design; the randomized complete block design; the Latin square design	5
7	**Statistical Methods in Epidemiology:** basic incidence measures; risk and rate; prevalence measures; measures of association; risk ratio or relative risk; exposure odds ratio; risk odds ratio; measures of potential impact; attributable risk	6
8	**Survival Analysis:** introduction; basic designs follow-up studies, cross-sectional studies and case control studies; survival function; hazard function; the product limit estimate of survival function; the life table analysis; the log rank test for comparing survival distributions	5
9	**Calculus for biology:**Fundamental theorem of calculus, simple limit ideas, functions and continuity, differentiation and applications, simple integration and applications, matrices and vectors, linear equation systems, sample models: predator prey model, disease model, cancer model	8
10	**Practical (Hands on)**	10

Recommended Books

1. Introduction to Biostatistics: a text book of biometry – P.K. Baneree; S. Chand and Com. Ltd.
2. Fundamentals of Biostatistics – B. Rosner;
3. Fundamentals of Calculus – C.C. Morris and R.M. Stark; Wiley

CM 222H Biologically Important Organic Compounds Credits: 2 Class: 30 hours

This course is designed by the Department of Chemistry as supporting/allied course for the graduate students of Microbiology. A large class of organic compounds of biological and chemical origin, have attracted scientific interest since historical times because of their applications in various purposes. The synthesis of organic compounds and their derivatives occupy an important place in the

realm of natural and synthetic organic chemistry due to their therapeutic and pharmacological properties. This course offers unique applications of biologically important natural compounds, which forms the crucial foundation to understand this contemporary subject.

Course Objectives

1. To familiar with the different classes of biologically important organic compounds with their sources and properties
2. To acquire knowledge about the basic concept of synthetic organic compounds and their applications in drug development.
3. To understand the unique applications of natural organic compound in human welfare.

Learning Outcomes

Upon completion of the course the students are able to:

1. Have an overview over biomolecules such as carbohydrates, polysaccharides, amino acids, proteins, nucleic acids, DNA/RNA and lipids with their structure and chemical properties.
2. Have an overview over the properties, composition and biosynthesis of the natural compound.
3. Have an overview over and understand reaction mechanisms with relevance to pharmacy and biology.
4. Have an overview over the structure and chemical properties of radicals, metals, enolates, heterocyclic compounds and their relevance to pharmacy and biology.
5. Understand the fundamental chemical properties that are of importance to drug effects in general.
6. Understand how fundamental chemical properties can affect drug receptor interaction, drug uptake, transport, metabolism and excretion from the body.

Unit	Course Content	Class Hours
1	**Fats and Oils:** occurrence, composition of fats and oils; hydrolysis of fats and oils; various use of fats and oils; saponification of fats and oils; Todine value and saponification value of fats and oils; saturated and unsaturated fatty acids	**3**
2	**Amino Acids, Peptides and Proteins:** structure and configuration of amino acids; isoelectric point preparations; reactions of amino acids and peptides; C-terminal and N-terminal residue of peptides; proteins, their classifications and functions; basic structure of proteins	**3**
3	**Carbohydrates:** definition, classification and composition of monosaccharides; ring structure of monosaccharides and their conformations; action of acids and bases on sugars: epimers, anomers and anomeric configurations; reactions of monosaccharides, disaccharides and trisaccharides, their structure and compositions; polysaccharides: cellulose, starch and their constituents	**3**
4	**Vitamins:** occurrence, symptoms due to deficiency of vitamins; chemistry of vitamin: A, B1, B2, B6, B12 and E their structures	**3**
5	**Synthesis of Following Drugs and Their Actions in Biological Systems:** sulpha drugs, sulphonamide sulphaptyridine, sulphaguanidine, sulphamethazine and sulphathaizole	**4**
6	**Antimaterials:** plasmaquine, mepacrine, proguanil and quinine	**3**
7	**Antibiotics:** penicillin, amoxycillin, streptomycin, chloromycetin, etc.	**3**
8	**Insectidides, Fungicides and Herbicides:** organic compounds: DDT, gammexane, methoxychlor and heptachlor; organophosphorous compounds; malathion, parathon, dimecron and diazinon; carbamates; 24-D (2,4-dichloroacetic acid)	**3**
9	**Organic Pollutants**	**2**
10	**Purines and Nucleic Acids:** structure of uric acid, nucleosides and nucleotides: DNA and RNA	**3**

Recommended Books

1. Chemistry of Organic Natural Products, Vol. I & II –Agarwal OP
2. Organic Chemistry – Morriona RT & Boyd RN
3. Organic Chemistry, Vol. I & II – Finer LL
4. Organic Chemistry – Handrickson JB & Pine SH
5. Applications of Biologically Important Natural Compounds – K. Cornwell

CMGL 101H General Chemistry Laboratory Credits: 2 Class: 36 hours

This course is designed by the Department of Chemistry as supporting/allied course for the graduate students of Microbiology. The course covers the determination of molecular mass of an unknown compound, velocity constant of a base catalyzed hydrolysis of ethyl acetate. Determination of viscosity of chemicals/solutions. Identification of unknown inorganic sample by semi micro qualitative analysis

Course Objectives

In the practical component, students should develop basic laboratory skills (observation, analytical techniques, report writing) and an appreciation of the health and safety issues associated with the safe handling and disposal of laboratory chemicals.

Learning outcomes

After completion the laboratory works, the students are able to recognize the basic practical skills for the both physical chemistry and organic chemistry. The student will have hands on experience with the scientific methods and prepare students for advanced work in chemistry and related fields. They will be able to perform experiments related to the above learning objectives, record observation, gather and analyze data and present the data in the written form.

Unit	Course Content	Class hours
1	**Physical Chemistry** 1. Determination of the molar mass of carbon tetrachloride by Duma's method 2. Determination of enthalpy of neutralization of acid calorimetrically 3. Determination of partition coefficient between water and carbon tetrachloride 4. Investigation of the variation of conductance of a weak electrolyte with concentration **5.** Investigation of the effect of reactant concentration on the rate of the reaction between thiosulphate ion and H^+ ion and determination of the reaction	**18**
2	**Organic Chemistry** 1. Determination of the melting point of the organic compounds **2.** Determination of presence of nitrogen, sulphur and halogens in organic sample Identification of functional groups in organic compounds	**18**

Recommended Books

1. Green Chemistry Laboratory Manual – S. Henrie; CRC Press
2. Handbook of Green Chemistry and Technology – J.H. Clark and D.Macquarrie; Wiley Balckwell

MBG211 Viva-Voce Credits: 2

A comprehensive viva-voce is mandatory and will be held at the end of the academic session as per regulation of the faculty.

MBG 212 Sessionals Credits: 2

The Department will determine the tasks and marks for the Sessionals as capstone course. It includes (i) Orientation: Laboratory equipment and reagents and their storage and disposal, (ii) specimen collection, (iii) field works and excursion, and (iv) assignments.

Courses for the Third Year BS (Honours)

The student will undertake an independent in-depth of interesting courses and begin to specialize. It may involve supervised practical work in a laboratory, or the students may choose to work on e-learning, educational, data analysis, bioinformatics or enterprise topics. The course unit details given below are subject to change, and are the latest example of the curriculum available on this course of study.

MBG 301 Biosynthetic Metabolism Credits: 2 Class: 30 hours

This course is designed to introduce students about the bacterial metabolism particularly focusing on the anabolic or synthetic pathways. The course will summarize different metabolic pathways and their regulation such as microbial inorganic metabolism, phototrophic prokaryotes and their significant light harvesting metabolic reactions, the nitrogen fixation system of nitrogen fixing bacteria.etc.

Course Objectives

1. To learn basic concept of biosynthetic pathways, their regulatory enzymes and kinetics.
2. To understand the mechanism of photosynthesis in different photosynthetic bacteria.
3. To learn the metabolism of different inorganic compounds and biosynthesis of carbohydrate, lipid, amino acid and nucleic acid

Learning Outcomes

Upon completion of the course, students should be able to:

1. Acquire, retain, and communicate complex conceptual ideas related to bacterial physiology and metabolism.
2. Know about the regulatory enzymes and their kinetics during metabolic reactions.
3. Explain the biosynthetic pathways of carbohydrate, lipid, amino acid and nucleic acid and their maintenance.
4. Understand the mechanism of autotrophic and phototrophic microbial cycles and nitrogen fixation.

Unit	Course Content	Class hours
1	**Regulation of Metabolic Pathways**: regulatory patterns of metabolic pathways; kinetics of regulatory and non-regulatory enzymes; conformational changes in regulatory enzymes; regulation by covalent modification.	5
2	**Carbohydrate synthesis:** gluconeogenesis pathway and regulation.	4
3	**Metabolism of Lipids and Nucleotides,** biosynthesis of fatty acids; role of cofactors in fatty acid biosynthesis; pathway to biosynthesis of mevalonate, squalene and sterols, biosynthesis of purines and pyrimidines; regulation of purine and pyrimidine biosynthesis	5
4	**Biosynthesis of Amino Acids**: the glutamate and ketoglutarate family; the aspartate and pyruvate families**; the se**rine-glycine family; aromatic amino acids.	6
5	**Photosynthesis:** The Phototrophic Prokaryotes, The Purple Photosynthetic Bacteria, The Green Sulfur Bacteria (Chlorobiaceae), Cyanobacteria and their Chloroplasts, Efficiency of Photosynthesis, Photosynthetic Pigments, The Transfer of Energy from the Light Harvesting Pigments to the Reaction Center, The Structure of Photosynthetic Membranes in Bacteria.	6
6	**Inorganic Metabolism:** Assimilation of Nitrate and Sulfate, Dissimilation of Nitrate and Sulfate, Nitrogen Fixation, Lithotrophy (aerobic chemolithotroph; hydrogen and CO oxidizers; ammonia, sulphur and ferrous ion oxidizers; facultative obligate chemolithotrophs)	5

Recommended Books

1. The Physiology and Biochemistry of Prokaryotes- D. White, J. Drummond and C. Fuqu, Oxford University Press
2. Microbial Physiology- A.G. Moat and J.W. Foster; John Wiley, New York
3. Bacterial Metabolism- G. Gottschalk; Springer-Verlag, New York
4. Microbiology- M.J. Pelczer Jr., E.C.S. Chan & N.R. Krieg, McGraw-Hill Book Company
5. Microbiology: Concepts and Applications- M.J. Pelczer Jr., E.C.S. Chan and N.R. Krieg; McGraw Hill Inc., New York
6. Lehninger Principles of Biochemistry- D.L. Nelson & M.M. Cox; W.H. Freeman and Company, New York

MBG 302 Microbial Molecular Genetics **Credits: 2 Class: 30 hours**

This course is designed to introduce students to microbial genetics. It describes how DNA in a bacteria can be changed in terms of its sequence. It describes the agents that are capable of bringing out these changes. It brings into account how changes in DNA can be repaired. The different ways by which DNA can be transferred from one bacterium to another is described. Mobile genetic elements such as transposons and their mechanism of action is explained. The fact that not all bacterial genes are expressed all the time and that this can be regulated is explained.

Course Objectives

1. To understand bacterial DNA sequences, ways of sequence changes and different repair systems.
2. To acquaint students with different ways of gene transfer system between bacteria and familiarize with function of transposons to bring about changes in bacterial DNA.
3. To explain the gene regulation in response to environmental signals and how genetic recombination takes place.

Learning Outcomes

The intention of the course is for students to demonstrate their ability to:

1. Analyze and integrate information on concepts relevant to microbial molecular genetics.
2. Define mutation and categorize it.
3. Explain how repair systems can fix changes in DNA.
4. Describe the different ways by which DNA can be exchanged among bacteria.
5. Explain how gene expression can be regulated.
6. Describe the processes of recombination.
7. Define transposons and explain their role in bacterial genetics.

Unit	Course Content	Class hours
1	**Mutation:** Mutation rate; types of mutations, Detection of mutations; mutagenic agents, Screening chemicals for mutagenicity Molecular basis of mutagenesis, Mutation induced by chemical and physical agents, Effects of mutation on multicellular organisms and microorganisms	8
2	**DNA Repair Mechanisms:** Nature of DNA damage, Light- dependent repair; excision repair, Mismatch repair; post- replication repair, Error-prone repair system; SOS repair	4
3	**Gene Transmission in Bacteria:** Mutant phenotypes in bacteria; basic test for transformation, conjugation and transduction, Transformation and gene mapping, Conjugation and gene mapping, Transduction and gene mapping, the evolutionary significance of sexuality in bacteria	5
4	**Regulation of Bacterial Gene Expression:** Constitutive, inducible and repressive gene expression; positive and negative control; lactose and histidine operon in *E. coli,*	6

	induction and catabolite repression; tryptophan operon in *E. coli* repression and attenuation, arabinose operon in *E. coli*; transcriptional, translational and post-translational regulatory mechanisms.	
5	**Genetic Recombination:** Types of recombination, Models of general recombination, Molecular basis of homologous recombination, Molecular basis of non-homologous recombination	**3**
6	**Transposable Genetic Elements:** Transposable elements in prokaryotes; IS elements, Composite transposons, Tn3 element, Mutagenic effects of bacterial transposable elements, the medical significance of bacterial transposons. Transposable elements in eukaryotes: Ac, Ds and Dt elements in maize, P elements and hybrid dysgenesis in *Drosophila*	**4**

Recommended Books

1. Principles of Genetics –E.J. Gardner, M.J. Simmons and D.P. Snustad, John Wiley and Sons
2. Molecular Biology of the Gene – J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick, Pearson, San Francisco
3. Lewin's Genes XI – J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick. Jones and Bartlett Learning
4. Genetics - D.P. Snustad and M.J. Simmons, John Wiley and Sons, Inc.
5. Genetics: A conceptual approach – B.A. Pierce, W.H. Freeman and Company
6. Cell and Molecular Biology - Gerald Karp, John Wiley and Sons Inc.

MBG 303 Medical Microbiology-II **Credits: 2 Class: 30 hours**

This course will introduce students to the microbial species that cause human disease and the basic principles of bacterial pathogenesis before conducting a survey of the pathogens and their specific virulence factors. It also covers current topics including antibiotic resistance, public health threats, and global health. The course also provides cutting-edge information on selected topics in Medical Microbiology, including molecular mechanisms by which bacterial pathogens cause disease and emergent technologies. Bacterial infections will be considered as molecular interactions between hosts and their infecting microbes. The course will also include some aspects of bacterial genetics and physiology, immune response to infection, and the cell biology of host-parasite interactions.

Course Objectives

1. To explore the general nature of relationship between human and microbial diseases
2. To identify the major factors determining virulence and their genetic basis
3. To Explain how humans try to prevent or treat these diseases.

Learning Outcomes

Upon completion of this course students will be able to:

1. Describe the most common diseases caused by pathogenic bacteria including their mechanisms for transmission, virulence and pathogenicity and resistant patterns.
2. Understand the tests used by microbiologists to identify and characterize organisms and their virulence factors
3. Explain the bacterial strategies for evading or surviving host defense systems.
4. Describe toxins and other toxic virulence factors.
5. Explain the genome plasticity, mobile genetic elements, intracellular signaling, membrane biogenesis.

Unit	Course Content	Class hours
1	**Clinical Manifestation, Pathogenesis, Virulence Factors, and Control of the following Pathogenic Microbes:** *Streptococcus* spp. *Staphylococcus* spp*; Corynebacterium diphtheriae; Mycobacterium tuberculosis; Vibrio cholerae; Escherichia coli; Salmonella enteric* typhi*; Neisseria* spp.; *Treponema pallidum*	6
2	**Introduction to Clinically Important Parasites:** *Giardia; Entamoeba, Leishmenia, Taenia,, Plasmodium spp*	5
3	**Bacterial strategies for Evading or Surviving Host Defense Systems:** Overview of Bacterial Defense Strategies; Preinfection; Colonization of Host Surfaces; Evading the Host Immune Response	7
4	**Toxins and Other Toxic Virulence Factors:** Transparent mechanisms, mysterious purposes; Characteristics and nomenclature of bacterial toxins; Nonprotein toxins; Protein exotoxins; Protein exoenzymes/effectors; Diseases mediated by toxins; Immunotoxins-toxin-based therapeutics and research tools.	5
5	**Mechanisms of Genetic Modification and Exchange: Role in Pathogen Evolution-** Adapt or Perish- Horizontal gene transfer (HGT) and acquiring new virulence traits by HGT; Mutational change and diversification; Phase variation; Antigenic variation; Horizontal gene transfer (HGT)- mobile genetic elements; Pathogenicity islands and pathogen evolution.	7

Recommended Books

1. Bacterial Pathogenesis: A Molecular Approach- A.A. Salyers and D.D. Whitt–ASM Press,
2. Jawetz, Melnick and Adelberg's Medical Microbiology – K.C. Carroll, S.A. Morse, T. Mietzner, S. Miller; McGraw Hill Education
3. Medical Microbiology - R.F. Boyd and J.J. Marr; Little Brown and Company, Boston
4. Manual of Clinical Microbiology – P.R. Murray, E.J. Baron, M.A. Pfaller, F.C. Tenover and R.H. Yolken – ASM Press, Washington D.C.
5. Medical Microbiology - C. Mims, J. Playfair, I. Roitt, D. Wakelin and R. Williams.

MBG 304 Virology-I **Credits: 2** **Class: 30 hours**

This course introduces the students with basic concept of viruses, covers the fundamental principles related to the interaction of animal and bacterial viruses with their host cells and events during viral replication. General topics include chemical and physical properties of viruses, virus classification, cultivation of viruses, prevention and control of infection.

Course Objectives

1. The students will be provided with a broad and general knowledge of modern Virology.
2. They will learn how viruses enter target cells, amplify their genomes and exit from these target cells
3. Will give a general view on the relationship of viruses and host, and will highlight the importance of host factors for virus survival.

Learning Outcomes

1. Student will learn the essential concepts of virology which include the structure of different viruses, properties, replication, types of infection.
2. How viruses cause disease, common bacteriophages, their mode of replication.
3. Treatment and the inhibitory action of the antiviral chemotherapy and laboratory diagnosis.

Unit	Course Content	Class hours
1	**Introduction to Virology:** brief history and development of virology; Nomenclature and Classification of Animal and Plant Viruses.	2
2	**Virus Cultivation:** cultivation and quantification of animal and bacterial viruses, purification and identification of virus; one step growth curve; inclusion bodies	3
3	**Virus Replication:** steps in virus replication; multiplication and gene expression of DNA and RNA viruses	4
4	**Pathogenesis of Viral Diseases:** infection initiation, entry, spread, organ invasion and tropism. Pattern of infection.	3
5	**Bacteriophages:** overview of bacteriophages; genome organization and multiplication of RNA and DNA bacteriophages; temperate bacteriophages; lytic and lysogenic cycle; transposable phages.	9
6	**Prevention and Treatment of Viral Infections:** viral vaccines; interferon: induction and action of interferons; antiviral chemotheraphy.	4
7	**Virion, Viroids and Prions:** Morphology, physical properties and chemical composition of virions; general properties and diseases caused by viroids and prions.	5

Recommended Books

1. Brock Biology of Microorganisms – M.T. Madigan, J.M. Martinko, P.V. Dunlap, D.P. Clark, Pearson Prentice Hall
2. Principles of Molecular Virology – A.J. Can, Elsevier Academic Press., New York
3. Fields Virology (Vol. I and II) - Edited by D.M. Knipe, P.M. Howley, D.E. Griffin,Lippincott Williams, New York
4. Fundamental Virology – B.N. Fields and D.M. Knipe, Raven Press, New York
5. Jawetz, Melnick and Adelberg's Medical Microbiology – K.C. Carroll, S.A. Morse, T.Mietzner and S. Miller, McGraw Hill Education

MBG 305 Immunology-1 **Credits: 4 Class: 60 hours**

The course will cover major concepts of immunology, general properties of antigen and antibody, immune cells involving antigen recognition, humeral and cell medicated immunity, immunity to infections, various immunological techniques for laboratory and research methodology.

Course Objectives

1. To introduce the concepts, basis of immunity and cells and organs involved in acquired immunity.
2. To understand the properties of antigen & antibody, role of antibodies and induction of antibody response to antigens.
3. To know the response of immunity to infection and immunological techniques for assessment and research.

Learning outcomes

1. The students will be trained about major concepts of immunology, general properties of antigen & antibody their knowledge reinforce and build upon important concepts in immunology studied in higher education will be reinforced.
2. Learn how the immune cells recognize antigen
3. Gain knowledge on concepts of induction of humeral and cell medicated immunity
4. Have a grasp on knowledge on immunity to infections have a hand on training on methods of immunological techniques for laboratory and research methodology

Unit	Course Content	Class hours
1	**Introduction to Immunology:** history and development of immunology; introduction to immune system; basic concept of innate and adaptive immunity; cellular and humoral immunity.	5
2	**Cells Involved in Immune Response:** general features and functions of lymphoid cells; mononuclear phagocytes; antigen presenting cells; polymorphs; mast cells; platelets	3
3	**Lymphoid Systems:** primary and secondary lymphoid tissue; primary lymphoid organs; secondary lymphoid organs and tissues	4
4	**Innate Immunity:** phagocytosis: process and evasion strategies, complement systems: activation, function and regulation of complements.	4
5	**Inflammation:** patterns of cell migration and inflammation and their control.	4
6	**Antigens:** general properties of antigen; antigenic determinants; haptens.	5
7	**Immunoglobulins:** basic structure and function of immunoglobulin; immunoglobulin classes and subclasses; physiochemical properties, distribution and functions of different classes and subclasses of immunoglobulin; memory B cell; genetic basis of antibody heterogeneity; antibody class switching.	6
8	**Membrane Receptors for Antigens:** Bcell surface receptors for antigens; T cell receptors (TCR major histocompatibility complex (MHC); antigens structure; functions of MHC class I and class II molecules; gene map of MHC antigens; processing and presentation of peptides by MHC molecule, antigen recognition; antigen-antibody interaction ; forces of antigen-antibody binding; haplotype restriction of T cell reactivity	5
9	**Lymphocyte activation:** interaction of T lymphocytes and APC; signals for T cell activation; B cell response to thymus dependent and -independent antigens; B cell activation by surface Ig and T cell	3
10	**Cytokines and chemokines**: General properties, Families of cytokines and associated receptor molecules, cytokine action and network interaction	2
11	**Immune regulations:** regulation of immune response by antigens, antibody, antigen presenting cells and lymphocytes; idiotypic regulation of immune response.	2
12	**Immunity to Infections:** immunity to extracellular and intracellular bacteria; bacterial survival strategies; immunity to viral infection; innate and specific immune response to viruses; strategies for evading immune defences by viruses; immunity to parasitic infection	5
13	**Immunological Techniques:** precipitation reactions; immunodiffusion;immuno-electrophoresis; agglutination; co-agglutination; haemagglutination; complement fixation; direct and indirect immunofluorescence; immunoassay; immunoblotting; immuno-precipitation; fluorescence-activated cell sorter (FACS), experimental animal models.	7
14	**Monoclonal antibodies:** production of hybridoma; screening, cloning and large-scale production of monoclonal antibodies.	5

Recommended Books

1. Immunology- P.J. Delves, S.J. Martin, D.R. Burton and I.M. Roitt, Mosby Elsevier
2. Roitt's Essential Immunology- P.J. Delves, S.J. Martin, D.R. Burton and I.M. Roitt, Wiley Blackwell
3. Kuby's Immunology- J.A. Owen, J. Punt, and S.A. Stranford, W.H. Freeman and Company, New York
4. Advanced Immunology- D. Male et al – Gower Medical pub., New York
5. Text Book of Immunology: an Introduction to Immunochemistry and Immunobiology- J.T. Barrett, Mosby, New York

MBG 306 Molecular Cell Biology Credits: 2 Class: 30 hours

The course focuses on eukaryotic cell biology that cover topics such as membrane structure and composition, transport, and trafficking; the cytoskeleton and cell movement, and the integration of

cells into tissues. The course will also cover important cellular processes such as cell cycle regulation, signal transduction, apoptosis and cancer cell biology. Throughout the semester we will attempt to relate defects in these various cellular processes to human diseases to help gain a better understanding for what happens when cells don't work as they should.

Course Objectives

1. To describe basic mechanisms for interactions between cells, cell growth, cell death, cell motility
2. To explain how these together facilitate the development of a multicellular organism,
3. To describe structures of biomolecules, with an emphasis on proteins and their processing.

Learning outcomes

After completing the course, the student should be able to:

1. Account for how cells can communicate and understand cell signaling and how it regulates cellular functions
2. Account for intracellular protein transport
3. Describe the cell cycle and the cell division, how cells die and how these important processes are regulated.
4. How its disregulation leads to cancer and other disease
5. Know the procedures of growing, maintain and preserving human embryonic stem cells; potential applications of stem cells;
6. Understand the ethical views surrounding embryonic stem cell research.

Unit	Course Content	Class Hours
1	**Chemical signaling between cells**: Three different strategies of chemical signalling, local chemical mediators, hormones and neurotransmitters, signaling mediated by intracellular receptors, mechanism of steroid hormone action, signaling mediated by cell surfaces, cyclic AMP and calcium ions as second messengers, involvement of G-proteins in signal transduction, target cell adaptation.	**8**
2	**Cell cycle regulation**: Regulation of cell cycle by CDK and associated proteins, cell cycle check points, regulation of passage through check points, effects of cell cycle deregulation.	**5**
3	**Apoptosis**: Extrinsic and intrinsic pathways, excessive and insufficient apoptosis.	**4**
4	**Protein turn over**: proteasome, chaperon; protein degradation, ubiquitination, Posttranslational processing of proteins: folding, cleavage, chemical modification.	**5**
5	**Stem cell transplantation**: Embryonic and adult stem cells; unipotency and pluripotency; the isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells; ethical views surrounding human embryonic stem cell research.	**8**

Recommended Books

1. Cell Biology – G. Karp, Wiley
2. Molecular Biology of the Cell – B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P.Walter – Garland Science
3. Molecular Biology of the Gene – J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick –Pearson, San Francisco
4. Lewin's Genes XI – J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick –Jones & Bartlett Learning
5. Molecular Cell Biology - H. Lodish et al. 2012., 7th Ed. W.H Freeman and Company
6. Derivation of human embryogenic Stem cell lined from verified Blastocysts, Human embryonic stem c3lls protocols - Kursad turksen

MBG 307 Agricultural Microbiology **Credits: 2 Class: 30 hours**

This course introduces students to the soil microbial communities and how they govern the soil environment by performing enormous amounts of biochemical reactions which are directly contributing in agricultural practices and also playing a vital role in our sustenance on this planet. It also discusses about biofertilizers and biopesticides made of microorganisms; use of which can reduce the environmental damage caused by chemical fertilizers and making an eco-friendly agricultural system. Plant pathogenic microorganisms and how to prevent plant diseases is also taught in this course.

Course Objectives

1. To understand the soil microbial communities and their role in improvement of soil fertility;
2. To learn about role of microbes as biofertilizers and nutrient recycling agents in soil;
3. To demonstrate the nature of common phytopathogens and their controlling methods.

Learning Outcomes

Upon completion of the course students should be able to:

1. Understand the basic groups of microorganisms and their living activities in soil
2. Knowledge of basic relationship between microbes and plant nutrition
3. Learn the role of microbes in vital role in biochemical cycling throughout the globe
4. Learn about the practical applications of biofertilizers and biopesticides for sustainable agriculture
5. Understand the natures of phytopathogens and ways to control then in the field of plant care.

Unit	Course Content	Class hours
1	**Soil Microorganisms and Soil Fertility**: soil microbes and their major activities; microbial decomposition of organic matters; improvement of soil fertility- physic-chemical properties, microbial metabolites as nutrients and growth regulators, and conversion of nutrients from unavailable form available for plant uptake.	6
2	**Microbes in Rhizosphere, Root Surface and Phyllosphere**: endophytic microbes- types and functional characteristics; mycorrhiza; N_2 fixing symbiotic and non-symbiotic bacteria, formation of root nodules; decomposition of plant and animal residues; biodegradation of pesticides and pollutants in soil.	6
3	**Biogeochemical Cycling of Nutrient Elements:** carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle and their effects in availability of plant nutrients.	4
4	**Biofertilizers and Compost:** biofertilizers- plant growth promoting rhizobacteria (PGPR); bioinoculant mass production using *Rhizobium*, *Azotobacter* and Cyanobacteria; Compost- green manure, town compost, vermicompost, production and applications.	6
5	**Biological Control of Microbial Pathogens and Nematodes**: microbial pesticides; interactions with synthetic pesticides with soil microbes; entomopathogenic fungi and bacteria.	2
6	**Plant Pathogens and Growth Inhibitory Microbes: C**oncept of plant disease; mode of entry of pathogens, disease symptoms, diagnosis and control; Algal, fungal, bacterial and viral diseases; Disease by mycoplasmas and nematodes; Diagnosis and control of plant diseases- blast of rice, rust of wheat, stem rot of jute, grey blight of tea, smut of sugarcane, leaf blight of potato; production of phytotoxic substances by saprophytes and parasites; competition of microorganisms with plants for essential nutrients.	6

Recommended Books

1. An Introduction to Soil Microbiology - M. Alexander, John Wiley, New York
2. Principles and Applications of Soil Microbiology- D.M. Sylvia, J.J. Fuhrmann, P.J Harteland D.A. Pearson, Prentice Hall

3. Soil and Agricultural Microbiology- U. Kumar; Anmol Publication Pvt Ltd.
4. Soil Microorganisms and Plant Growth-S. Rao; IBH Publishing Com., New Delhi
5. Plant Microbiology-R Campbell – Edwards Arnold, London
6. Plant Pathology- G.N. Agrios, Academic Press, New York
7. Biological Indicators of Soil Health - C. Pankhurst, B. Doube and V. Gupta–CAB international, New York

MBG 308 Fermentation Technology Credits: 2 Class: 30 hours

The course emphasizes the art of fermentation techniques using biological and engineering principles.The aim of the course is to review fundamentals and provide an up-to-date knowledge in biological and biochemical technology. The lectures will emphasize and place perspectives on biological systems with industrial practices. The course covers the key component parts of a fermentation process including growth kinetics, strain isolation and improvement, inoculum development, fermentation media, fermenter design and operation, product recovery, and the environmental impact of processes.

Course Objectives

1. To introduce the students to the various concepts of fermentation
2. To introduce the students to the role microorganism play in fermentation process
3. To provide the student with the skills to design and fermentation processes

Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. understand the various concepts of fermentation;
2. design a simple containment system of bioreactor or fermentor;
3. understandthe microbial growth and their role in producing commercial metabolites;
4. Isolate, identify and develop the microbial inoculum for industrial processing;
5. Set and control fermentor/bioreactor for producing maximal products under optimal conditions.

Unit	Course Content	Class hours
1	**Introduction to Fermentation Processes**: range of fermentation processes; chronological development of the fermentation industry; component parts of fermentation process.	3
2	**Fermenter/Bioreactor design**: bioreactor types and configuration, impeller designs and baffles, agitation, aeration; fermentor/bioreactor associated instrument & services.	5
3	**Media for industrial fermentations**: Energy and carbon sources, nitrogen, minerals, addition of precursors and metabolic regulators to media, oxygen requirements, antifoams, medium optimization; submerged, surface and solid state fermentations.	5
4	**Inoculum Development**: Inoculum preparation and scale up for bacterial, yeast and fungal processes.	3
5	**Sterilization of Fermenters and Media**: medium sterilization, the design of batch sterilization processes; the design of continuous sterilization, processes; sterilization of the fermenter; sterilization of feed and air.	5
6	**Microbial growth kinetics**: rate equations for cell growth, substrate utilization and product formation, comparison amongst batch, fed-batch and continuous culture processes	4
7	**Instrumentation and Control**: control systems: manual, automatic and combinations of methods of control. Methods of control of process variables: temperature, pH, flow measurement, pressure measurement and control, agitation and aeration, foam sensing, measurement and control of dissolved oxygen; exit-gas analysis; redox and carbon dioxide electrodes.	5

Recommended Books

1. Principle of Fermentation Technology-P.F. Stanbury, A. Whitakerand S.J.Hall –Butterworth, New Delhi
2. Fermentation Microbiology and Biotechnology-E.M.T. EI-Mansi, C.F.A. Bryce and A. Demain; Taylor and Francis, London
3. Modern Industrial Microbiology and Biotechnology- N. Okafor–CBC Press, New Hampshire
4. Practical Fermentation Technology - B. McNeil and L. Harvey; Wiley
5. Fermentation Technology- M.L. Srivashava; Alpha Science Intl Ltd.

MBG 309 Applied Mycology Credits: 2 Class: 30 hours

The course is designed to review the importance and advances in applications of fungi in agriculture, medicine, food production and the environmental sciences. It includes discussions of fungal associations in the environment, agriculture and forestry, long established and novel applications of fungi in fermentation, the use of fungi in the pharmaceutical industry, the growing recognition of fungal infections, current interests in the use fungal enzymes in biotechnology and the new and emerging field of myconanotechnology.

Course Objectives

1. To introduce students with fungal families with their characteristics and reproduction.
2. To learn about nutrition and culture techniques
3. To familiarize with the vast economic impact of fungi in environment, agriculture, health, and industry.

Learning Outcomes

Upon completion the student will-

1. learn significance of fungi and their relation with other forms of life and environment**.**
2. familiarize with fungal families with respect to their characteristics.
3. familiarize students with fungal physiology and metabolic processes.
4. introduce them with fungal diseases of human, plants and animals and antifungal therapeutic agents.
5. enable them understand the huge economic implications of fungal species in flourishing biotechnological industries of the world, and their positive and negative impacts on agriculture.
6. acquaint students about fungal culture in laboratory settings.

Unit	Course Content	Class hours
1	**Biology and Ecology of Fungi**: Structure and characteristics of fungi; major fungal subdivisions; dispersal strategy of microfungi in the environment; microfungi in indoor environment.	**6**
2	**Fungal Systematics:** history of mycology; recent approaches to microfungal nomenclature; future perspectives of fungal systematics.	**6**
3	**Fungal Physiology and Metabolism**: nutrition in fungi; aerobic and anaerobic respiration in fungi	**5**
4	**Fungal Diseases in Man, Animals and Plants**: Fungal Diseases in man- hypersensitivity, mycotoxicoses and mycoses; general aspects of fungal immunology and pathology; Antifungal therapeutic agents; animal and plant pathogens	**5**
5	**Economic Importance of Fungi to Man and the Environment**: fungal metabolites; Importance of fungi in agriculture; food industry, bioenrgy; pharmaceuticals, environment, and biotechnology.	**4**

6	**Laboratory Methods in Mycology**: collection and transportation of fungal samples; storage and processing of samples for mycological studies; media and growth requirements; methods for microscopic examination; colonial appearance and microscopic features, and methods for laboratory identification.	**4**

Recommended Books

1. Biology of Microfungi- D-W Lee; Springer
2. Introduction to Fungi - J. Webster & R. Weber, Cambridge University Press, Cambridge
3. Modern Mycology – J.W. Deacon –Blackwell Scientific Ltd., Oxford
4. Introductory Mycology - C. J. Alexopoulos, C.W. Mims& M.M. Blackwell**,** John Wiley &Sons,Inc.
5. Fungi: Biology and Applications - Kevin Kavanagh –John Wiley & Sons, Inc.
6. Clinical Mycology - E.J. Anaissie, M.R. McGinnis &M.A. Pfaller, Churchill Livingstone
7. Applied Mycology- M. Rai & P.D. Bridge; CABI

MBG 310 Pharmaceutical Microbiology **Credits: 2** **Class: 30 hours**

This course is designed to introduce students to the environment in a pharmaceutical industry. It includes sources of microbiological contamination and deterioration of different pharmaceutical products, basic concepts and guidelines for maintaining environmental conditions to manufacture, storage and distribution of pharmaceuticals. It also demonstrates the principles and procedures of various tests for safety control for pharmaceutical environment, raw materials and products. The course also elaborate the nature of different biopharmaceutical products including antibiotics, their mode of action and the ways to develop resistance in bacteria.

Course Objectives

1. To familiarize students with the environment and important products of pharmaceutical industry.
2. To acquaint students with designing, processing and preserving of the products.
3. To develop skills in techniques for controlling quality and safety of pharmaceutical products.

Learning Outcomes

Upon completion of the course students should be able to:

1. Describe microbiological aspects of desirable pharmaceutical environments and their maintenance.
2. Understands the nature of different biopharmaceuticals and their applications in treatment.
3. Explain how antibiotics work and describe the ways by which antibiotic resistance develops.
4. Describe the concept of an aseptic area and how it can be designed.
5. Define the processes by which pharmaceutical products can be spoiled.
6. Describe basic tests for determination of quality control and safety of pharmaceutical products.

Unit	Course Content	Class Hours
1	**Environment of Pharmaceutical industry:** Atmosphere, water, raw materials, packaging, personnel, building and its premises; Maintenance of clean and hygienic environment in pharmaceutical industry.	**3**
2	**Biopharmaceutical Products:** Nature and application- antibiotics, insulin, growth hormone, vaccines, interferon, human globulins, suture, etc.	**5**
3	**Antibiotics and Synthetic Antimicrobial Agents**: Antibiotics- sources, nature, and mode of action; Synthetic antimicrobial agents – properties and mode of actions; Mechanisms of microbial resistance to antibiotics.	**7**
4	**Design and Maintenance of Aseptic Area:** Basic concept and principles for designing	**3**

	aseptic area for processing sterile pharmaceuticals and quality testing laboratory; methods for sterilization and maintenance of aseptic conditions.	
5	**Microbial Spoilage and Preservation of Pharmaceuticals:** Spoilage- chemical and physic-chemical deterioration, factors affecting microbiological spoilage, health hazards, sources and control of contamination, outcome of medicament-borne infection; Preservation- effect of preservatives, product pH, packaging of sterile and non-sterile products.	**6**
6	**Microbiological Quality Control and Quality Assurance:** Good manufacturing practice; Quality control procedures; Quality assurance and control of microbiological risks in medicine; Laboratory evaluation aseptic condition of environments, raw materials and products; Principle of testing methods- antibiotic potency, concentration, preservatives and MIC and MBC, tests for sterility, pyrogen and toxicity.	**6**

Recommended Books

1. Hugo and Russell's Pharmaceutical Microbiology - S.P. Denyer, N.A. Hodges and S.P. German, Blackwell Scientific Pub., Oxford
2. Cooper and Gunn's Dispensing for Pharmaceutical Students-J.W. Cooper, G. Colin; C.S. James,Pitman Medical, London
3. Preservatives in the food pharmaceutical and environmental industries- R.G.Board, M.C.Allwood, J. G. Banks, Blackwell, London
4. Essays in Applied Microbiology- J.R. Norris; M.H. Richmond, Wiley, New York, 1981

MBG 311: Microbiological Hazards and Food Safety Credits: 2 Class: 30 hours

Food-borne microbiological hazards are addressing fundamental microbiology concepts and food safety. The course is designed to provide the students with the background necessary to understand the types of food hazards, microbiological hazards to cause spoilage and diseases, transmission of food-borne illness and the assessment of microbiological hazards and how it can be controlled. This module also provides up- to-date information in current topics in food microbiology, including food safety regulations and emerging food safety issues. The course is developed for the introduction to microbial food safety hazards with the educational needs of industry personnel in mind.

Course Objectives

1. To understand the food hazards and their impacts of food spoilage and diseases.
2. To develop surveillance and investigation systems for food-borne disease outbreak
3. To prevent the microbiological food hazard and diseases

Learning Outcomes

After completion of the course the students are able to:

1. Update the knowledge about basic types of national, regional and global food hazards
2. Ability to detect food safety and quality indicators and food-borne disease causing agent
3. Ability to investigate foodborne disease outbreak
4. Ability to solve design surveillance to prevent future outbreak of food-borne diseases

Unit	Course Content	Class hours
1	**Food Hazards:** Categories– physical, chemical and biological hazards; incidence & safety risk assessment; indicators of food safety and quality– criteria for selecting indicators, characteristics of indicator microbes and microbial products; Risk categorization of foods.	7
2	**Food-Borne Microbial Hazards:** Sources, characteristics, transmission, symptoms and prevention of microbial food hazards – by *Salmonella* spp., *Cl. perfringens,Vibrio* sp. *E. coli (EIEC and EHEC), Campylobacter* spp. , *Yersinia enterocolitica*, *Listeria monocytogenes,* viruses and parasites and food intoxication - by *Cl. botulinum, Bacillus*	8

	cereus., Staphylococcus spp.; Mycotoxins; Emerging food-borne diseases.	
3	**Detection of Food Safety Indicators and Food-borne Pathogens:** Conventional and rapid methods for bacteriological identification; Detecting food poisoning toxins; Novel techniques for detections of food hazards.	5
4	**Control of Food Hazards:** Food safety and hygiene; Microbiological risk Analysis- risk assessment, risk communication and risk management; Biological control of hazards- application of bacteriophages, biofilm associated persistence and probiotics.	5
5	**Food Safety Surveillance and Investigation:** objectives, personnel involved, field investigation, laboratory tests, interpretation and preventive measures; development of surveillance systems for controlling food-borne diseases; Food safety regulations.	**5**

Recommended Books

1. Food Safety: Rapid Detection and Effective Prevention of Food-borne Hazards – L. Hu, Apple CRC Press
2. Bad Bug Book: Foodborne Pathogenic Microorganisms and Natural Toxins Handbook – Food and Drug Administration, USA
3. Advances in Microbial Food Safety, vol.2 – J. Sofos; Woodhead Publishing
4. The Microbiology of Safe Food – S.J Forsythe, Wiley Blackwell
5. Genomic of food borne bacterial pathogens– M. Wiedmann and W. Zhang; Springer Science, USA
6. Foodborne Infections and Intoxications- G. Moris and M.E. Potter, HP Riemann & DO Cliver, Elsivier
7. Microbial Food Safety and Preservation Techniques – V.R. Rai and J.A. Bai; CRC Press

MBG 312 Marine Microbiology Credits: 2 Class: 30 hours

This course introduces the students to the marine microbial biosphere, its diversity, habitats, ecology, and applications. It includes the microbiological techniques, quantification of marine microbial population, taxonomy of marine prokaryotes and eukaryotic microorganisms, and microbial diseases of marine plants, vertebrates and invertebrates, and examines the exploitation of marine microorganisms for a range of biotechnological applications. The course will pay special attention into account many new discoveries in the field including the role of microbes in ocean processes and nutrient cycles, the beneficial role of marine microbes in biotechnology, biofuels, and new research on the impact of climate change.

Course Objectives

1. To study marine environment and microbial life
2. To examine the role of microbes in marine ecology
3. To explore the beneficial role of marine microbes in biotechnology

Learning Outcomes

After completing this course, the students will be able to:

1. Explain the principle features of microbial diversity in the oceans
2. Describe and discuss marine microbes in terms of physiological capability and biogeochemical role.
3. Synthesize microbial ecosystem function in pelagic and benthic marine habitats
4. Gather knowledge for creating an integrated approach for environmental management and economic concerns

Unit	Course Content	Class Hours
1	**Marine microbial Diversity**: Marine microbial habitats; Diversity in the environment- classical & molecular; Role of microbes in marine environment- acidification, primary producer, sedimentation, biofilms, microbial cycling of important elements.	5
2	**Microbial Hazard in Marine Environment**: Commensals and pathogens of sea plants, vertebrates and invertebrates; Human pathogens; Man-made hazards- coastal and marine hazards; Pollutant detection, monitoring and bioremediation.	5
3	**Seafood Processing and Preservation**: Microbes associated deterioration of seafood; general techniques for processing of seafood; Guidelines for safe processing and preserving seafoods.	5
4	**Biotechnological applications:** Biomedical potentials of marine products- membrane receptor, antitumor, anti-analgistic antiviral agents; Microalgal polysaccharides, proteins and vitamins; Bioactive metabolites-discovery of bioactive marine natural products-current research and references.	8
5	**Assessment of microbes and microbial products**: Bioprospecting; assessment of biodiversity; screening of bioactive compounds; biotechonogical application of marine microbes; visit a seafood processing industry.	7

Recommended Books

1. Marine Microbiology - B. Austin. Book News, Inc. Portland
2. Marine Microbiology - O. Akesson
3. Marine Microbiology: Ecology and Applications - C. Munn, Garland Science, Taylor & Francis Group, LLC
4. Marine Microbial Diversity - D. Karl and M. Buckley,
5. Ocean and Health: pathogens of the marine environment - R. Colwell and S. Belkin
6. Marine Microbial Ecology - E.J. F. Wood,

MBG 313 Laboratory Works **Credits: 8** **Class: 165 hours**

The third year laboratory course is designed to develop skills for applied microbiology. This applied laboratory curriculum described below represents topics and themes considered essential to the development of cognitive, analytical, communicating and interpersonal skills in advanced microbiology laboratory. Laboratory works typically supplement and integrate closely with the lecture contents of the theoretical courses in a way that is unique to each instructor. Development of laboratory techniques; exercises designed to reinforce concepts covered in this course.

Course Objectives

It is desirable to achieve the applied laboratory skills in microbiological sciences including biosynthetic metabolic systems, molecular cell biology & genetics, clinical microbiology, immunology and virology. The other special desires are developing the advanced technical skills in determining the role of microbes in fermentation, agricultural, food safety and marine environment and its applications in humane welfare, and to develop analytical and communicating skills along with data processing for laboratory reports. Development of laboratory techniques; exercises designed to reinforce concepts covered in this course.

Learning Outcomes

Upon successful completion of the third year laboratory works students will be able to exercise their specialized laboratory skills in service, teaching and innovations in different field of microbiology including biosynthetic metabolic systems, molecular cell biology & genetics, clinical microbiology, immunology, virology, fermentation, agriculture, food safety and marine environment and its applications in humane welfare. The students will also achieve the capability to think and employ insights from others in implementing the project; evaluate a significant challenge or question faced in the project in relation to core concepts, methods or assumptions in microbiology.

Unit	Course Content	Class hours
1	**Biosynthetic Metabolism** 1. Demonstration of culture of autotrophic and phototrophic bacteria 2. Biosynthesis of bacterial extracellular enzymes 3. Demonstration of inorganic biosynthetic metabolism	15
2	**Microbial Molecular Genetics** 1. Isolation of plasmids and chromosomal DNA 2. Detection of DNA by agarose gel electrophoresis 3. Transformation of *E. coli* by plasmid 4. Study of gene expression in *E. coli*	15
3	**Medical Microbiology** 1. Isolation, identification and antibiotic sensitivity pattern of pathogenic microorganisms from clinical specimens: (a) stool, (b) urine, (c) pus, (d) blood, (e) CSF and (f) biopsy. 2. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms) 3. Study of various stages of malarial parasite in RBCs using permanent mounts.	15
4	**Virology** 1. Cultivation and enumeration of bacteriophages 2. Isolation of bacteriophages from raw sewage 3. Detection of HBsAg from patients serum by serological methods 4. Isolation of TMV virus and infecting plants	15
5	**Immunology** 1. Preparation of bacterial whole cell extract 2. Preparation of outer membrane protein 3. Immunization protocol for animals 4. Collection of serum and plasma 5. Separation of blood leucocytes 6. Test for cell viability 7. Phagocytosis by neutrophils	15
6	**Molecular Cell Biology** 1. Molecular cloning. 2. Polymerase chain reaction. 3. Gel electrophoresis. 4. Macromolecule blotting and probing. 5. Microarrays. 6. Allele-specific oligonucleotide	15
7	**Agricultural Microbiology** 1. Study of microflora of soil, rhizosphere and rhizoplane 2. Denitrification and ammonification 3. Nitrogen fixation test 4. Identification of plant pathogens 5. Isolation of cellulose degrading organisms	15
8	**Fermentation Technology** 1. Demonstration of a typical fermentor 2. Demonstration of a fermentation 3. Production of cell mass 4. Production of industrial alcohol	15

9	**Applied Mycology (optional)** 1. Microscopic observation of yeasts and moulds 2. Cultivation and identification of fungi 3. Demonstration of disease causing fungi 4. Demonstration of industrially important fungi	**15**
10	**Pharmaceutical Microbiology (optional)** 1. Monitoring microbiological status of the pharmaceutical environment 2. Assessment of raw materials and finished products (solids, ointments & suspension) 3. Bioassay of antibiotics, vitamins and other pharmaceutics 4. Tests for sterility, pyrogen and toxins of pharmaceutics 5. Tests for spoilage and efficacy of pharmaceutical preservatives	**15**
11	**Microbiological Food Hazards (optional)** 1. Detection of food safety indicator microbes 2. Detection of bacterial hazards in delicatessens 3. Detection of fungal hazards in foods 4. Detection of haemolysin and phospholipase C (toxins) from *B. Cereus* 5. Demonstration of HACCP establishment	**15**
12	**Marine Microbiology (optional)** 1. Monitoring of faecal pollution in marine environment 2. Shore practical: Water quality sampling, sample processing in lab and exercise 3. Demonstration on marine biofouling 4. Phytoplankton sampling, identification and data analysis 5. Demonstration on advances in marine biotechnology	**15**

Note: Students must participate three of the optional units (Unit 9 to Unit 12) of the Laboratory Works which should be related to their theoretical courses of choice.

Recommended Books

1. Microbiology: A Laboratory Manual- J. Cappucino & N. Sherman; Pearson Education Limited
2. Cell and Molecular Biology – P.V. Chaitanya; Prentice-Hall of India Pvt. Ltd.
3. Environmental Microbiology – I. Pepper, C. Gebra and J. Brandecke; Academic Press
4. Principles of Microbiology - R.M. Atlas, WM.T. Brown Publishers.
5. Food Microbiology: A Laboratory Manual – A.E. Yousef and C. carlstrom; Wiley and Sons Inc.
6. Laboratory Protocols in Applied Life Sciences - P.S. Bisen, CRC Press
7. Food Safety: Rapid Detection and Effective Prevention of Food-borne Hazards – L. Hu, Apple CRC Press
8. Laboratory exercises in Marine Microbiology – M.A. Efstratiou, (lab notes in Greek).

MBG 314 Viva Voce **Credits: 2**

A comprehensive viva-voce is mandatory and will be held at the end of the academic session as per regulation of the faculty.

MBG 315 Sessional Activities **Credits: 4**

The Department will determine the tasks and marks for the Sessionals as capstone course. It includes (i) departmental seminars (ii) field works/excursion (iii) assignment, and (iv) visit to industry/research organizations.

Courses for Fourth Year BS (Honours)

The final year topics reflect the current hotspots of bioscience endeavor and the research interests of the faculty members of the Department, and are constantly being updated. The student will undertake an independent in-depth short research project/internship that may involve supervised practical work in a laboratory, or the students may choose to work on educational, industrial, data analysis, bioinformatics or enterprise topics. The course unit details given below are subject to change, and are the latest example of the curriculum available on this course of study

MBG 401 Virology-II **Credits: 4 Class: 60 hours**

The virology course in 4th year level mainly includes the viruses commonly found in this country and around the world. This course is designed to describe the viral agents commonly found in respiratory and gastrointestinal tracts, and the detail study of few viruses having word wide distribution and epidemiological potentials. This course also provides the students with basic concepts on oncogenesis.

Course Objectives

1. To know the common infectious viruses in humans and the life cycle of several viruses in detail
2. To know the virulence properties and associated diseases
3. Understand the epidemiology of infections
4. To be familiar with the therapeutic and preventive strategies of common human viruses and to have a basic concept on oncogenic viruses.

Learning Outcomes

1. After finishing the course, the students will have a comprehensive idea on commonly occurring human viruses in this country as well as globally.
2. Students will detail knowledge on some viruses which are discussed detail which will help them to carryout research activities.
3. Students will know the diagnosis of common viral diseases.

Unit	Course Content	Class hours
1	**Animal Viruses:** Brief introduction to different classes of viruses	3
2	**Viral Infections to the Respiratory System:** common cold; influenza; measles; mumps; rubella; chicken pox; shingles	6
3	**Viral Infections to the Gastrointestinal Tract:** viral diarrhoea	3
4	**Arthropod-Borne Diseases:** diseases caused by Japanese encephalitis virus, yellow fever virus.	6
5	**Herpes Viruses:** general properties; pathogenesis; diseases caused by HSV-I, EBV and CMV.	8
6	**Hepatitis Viruses:** general properties; pathogenesis; transmission; diseases caused by HAV, HBV, HCV, HDV, HEV and HGV	4
7	**Hepatitis B Virus**: detail of virion structure; genome organization; replication; viral proteins; pathogenesis; molecular variants; epidemiology; transmission; prevention; clinical diagnosis	7
8	**Nononcogenic Retroviruses:** HIV: structure; genome organization; transmission; epidemiology; disease pathogenecity; diagnosis and control; treatment strategy; vaccine approaches.	8

9	**Cellular Oncogenes** and **Oncogenic Viruses:** RNA tumour viruses: general features and classification; retroviridae genome structure; replication of HTLV; T cell transformation; DNA tumour viruses; mechanism of oncogenic transformation by DNA viruses; tumour suppressor gene	**5**
10	**Human Papiloma viruses**: General features, epidemiology and oncogenic potential.	**5**
11	**Influenza Viruses:** general properties and replication; antigenic shift and drift; pathogenesis; epidemiology and vaccine approaches.	**5**

Recommended Books

1. Fields Virology (Vol. I & II)- by D.M. Knipe, P.M. Howley, D.E. Griffin, Lippincott Williams, New York
2. Jawetz, Melnick and Adelberg's Medical Microbiology- by K. C. Carroll, S.A. Morse, T.Mietzner, S. Miller, McGraw Hill Education
3. Viral Hepatitis- by Howard C. Thomas, Anna S. F. Lok, S. A. Locarnini, A.J. Zuckerman, Wiley Blackwell
4. Principles of Virology (2 Vol)- by S. J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka, ASM Press,
5. Principles of Molecular Virology- by A. J. Cann, Academic Press

MBG 402 Immunology-II **Credits: 2 Class: 30 hours**

This course is a continuation of Immunology-I and provides an advanced knowledge on Immunology and Immuno-pathology. It discusses mechanisms of immune system that are key to control different pathogenic organisms. Students will be introduced to the general concepts concerning the development and mode of actions of different immuno-pathological diseases. Lectures will also focus on the prevention of the diseases.

Course Objectives

1. To understand how different mechanisms at molecular and cellular levels are providing a continuous surveillance to maintain good health.
2. To introduce the general concepts of Immunodeficiency, including primary T cell and secondary immunodeficiency and Tumour Immunology.
3. To understand the immuno-pathological mechanisms of Hypersensitivity, Autoimmune diseases including tolerance and Transplantation and rejection reactions.

Learning Outcomes

1. Knowledge and understanding: By the end of the course, students will learn the main mechanisms of immune tolerance and autoimmunity.
2. They will have a basic idea about the importance of different components of immune system and how failure of these components can lead to severe health problems.
3. The students are also expected to understand the mode of actions of different types of Hypersensitivities, defense mechanisms against tumor/cancer formation as well as the preventive approaches to combat these health problems.
4. Laboratory Skills: The students will be able to understand the principle and operation of relevant laboratory equipment and critically assess laboratory results.

Unit	Course Content	Class hours
1	**Immunological tolerance:** T-and B-cell development: Early development in thymocyte and bone marrow; mechanism of tolerance; thymic tolerance to self antigens; B cell tolerance; artificially induced tolerance	5
2	**Immunodeficiency:** primary immunodeficiency; deficiencies of innate immunity; primary B cell deficiency; primary T cell deficiency; combine immunodeficiency; secondary immunodeficiency	7
3	**Hypersensitivity:** hypersensitivity type-I, type-II, type-III and type-IV reactions	8
4	**Transplantation:** barriers of transplantation; law of transplantation; role of T lymphocytes in rejection; prevention of rejection	5
5	**Tumour Immunology:** Surface markers of tumour cell; immune response to tumour cells; lymphoproliferative disorders due to tumour growth.	4
6	**Autoimmunity and Autoimmune Diseases:** association of autoimmunity with diseases; genetic factors in pathogenesis; aetiology and treatment of autoimmune diseases. Diagnostic and Prognostic Value of Autoimmune Diseases	3

Recommended Books

1. Immunology – P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt – Mosby Elsevier
2. Roitt's Essential Immunology – P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt – Wiley Blackwell
3. Kuby's Immunology – J.A. Owen, J. Punt, S.A. Stranford – W.H. Freeman and Company, New York

MBG 403 Genomics and Bioinformatics Credits: 2 Class: 30 hours

The course introduces the students to the themes and terminology of bioinformatics. It includes basic genomics and bioinformatics, the physical, mathematical, statistical and computational basis of bioinformatics, and their applications, giving specific detail and including data standards. The applications covered are sequence analysis and annotation, transcriptomics, proteomics, metabolite study, supramolecular organization, systems biology and the integration of-omic data, physiology, image analysis, and text analysis.

Course Objectives

1. To understand the key concepts and principles of genomics and bioinformativd
2. To introduce the basics of genomics and post-genomics with the progress to databases, sequence alignments, analysis of gene, etc.
3. To provide hands on experiences to use bioinformatics tools and develop skilss in the analysis of biological data

Learning Outcomes

Upon completion of the course, the students will able to:

1. Explain the basics of genomics and post-genomics with applications of different techniques of data analysis.
2. Familiar with the basics of bioinformatics and its applications and limitations.
3. Acquire knowledge for database searching and basic sequence analysis.
4. Learn the techniques for analysis of complex data analysis in computer modelling of biological systems.
5. Explain the basis of bioinformatics and computational biology to use its search tools on the interest for multiple sequence analysis to predict protein structure.

Unit	Course Content	Class hours
1	**Genomics:** Genome mapping, genome sequencing, sequence assembly and comparison, genome annotation, comparative genomics, functional genomics, sequence-based approaches, microarray-based approaches; Types and applications of microarray; microarray data visualization techniques and clustering algorithms.	5
2	**Post-genomics:** Comparative genomics, gene prediction, categories of gene prediction programmes, gene prediction in prokaryotes, gene prediction in eukaryotes, promoter and regulatory element prediction, promoter and regulatory elements in prokaryotes, promoter and regulatory elements in eukaryotes, prediction algorithms. Gene expression quantification and functional analysis.	6
3	**Introductory bioinformatics:** Bioinformatics - definition, goal, history and scope, major areas application and limitations; Major databases, types of databases, pitfalls of biological databases, global bioinformatics centers and servers.	4
4	**Database searching, sequence alignment and basic sequence analysis:** information retrieval from biological databases, nucleotide database searching: retrieval of specific genes(s) from database, protein database searching, Pairwise sequence alignment, alignment methods, scoring matrices, statistical significance of sequence alignment, heuristic database searching, Basic Local Alignment Search Tool (BLAST), FASTA, Multiple Sequence Alignment, exhaustive algorithms, heuristic algorithms, profiles and hidden markov models, position-specific scoring matrices, profiles, markov model and hidden markov model, Phylogenetic tree; basics and construction algorithms.	6
5	**System biology**: Overview, history, aims and associated disciplines, systems biology vs. traditional cell and molecular biology, technologies to study systems at different levels, features of complex systems, data integration, computer modeling and simulations, cellular simulations.	4
6	**Applications of computational tools for biological data analysis:** Data analysis tools, Commonly used sequence analysis tools, tools for – Restriction mapping analysis, finding repeats and patterns, sequence alignment, finding genes, ORFs and exons, finding transcriptional elements, analyzing protein physicochemical properties of peptides, analyzing protein primary sequences, predicting protein secondary structure, viewing and analyzing protein 3D data, homology modeling, analysis of protein-protein Interaction, designing protein structures.	5

Recommended Books

1. Essential Bioinformatics - Jin Xiong – Cambridge University Press
2. Bioinformatics for dummies – J.M. Claverie; Cedric notredame–John Wiley, New York
3. Genomes 3 - T.A. Brown – Garland Science, New York
4. Genetics: analysis of Genes to Genomes – D.L. Hartal, M.Ruvolo – Jones and Bartlett Learning, New Delhi
5. Gene Cloning and DNA Analysis: An Introduction - T A Brown - Wiley-Blackwell Science, Oxford
6. Biotechnology: Genomics and Bioinformatics – H.J. Rehm. and G. Reed – Wiley VCH.
7. Discovering Genomics, Proteomics and Bioinformatics - Campbell, A. Malcolm; Heyer, Laurie J. - Pearson Education, San Francisco

MBG404 Genetic Engineering **Credits: 2 Class: 30 hours**

This course would familiarize students with molecular techniques used in rDNA technology. It also provides knowledge about the basic steps in gene cloning which includes the required techniques and tools of genetic engineering.

Course Objectives

1. To understand the basic concept and principle for manipulation of genetic material to achieve the desired goal.
2. To learn the suitable tools generally used in genetic engineering for the desired purposes.
3. To perform expression of the cloned gene (s) for basic and applied research.

Learning Outcomes

Upon completion of the course students should be able to:

1. Isolate chromosomal and extra-chromosomal DNA from different sources.
2. Understand different types of vectors with examples and their host system.
4. Gain knowledge about all the manipulative enzymes involved in gene cloning.
5. Design different ligation system and transformation into host cells.
6. Know the expression hosts and their characteristics.
7. Learn techniques to identify gene location, amplification etc.

Unit	Course Content	Class hours
1	**Extraction of DNA from different sources:** Preparation of total DNA from bacterial, plant and animal cells; preparation of plasmid and phage DNA	4
2	**Techniques in Molecular Genetics:** production of recombinant DNA *in vitro*; amplification of recombinant DNA in cloning vector; construction and screening of DNA libraries; molecular analysis of DNA, RNA and protein by blotting techniques; amplification of DNA by PCR; *in vitro* site-specific mutagenesis, chromosome walking.	**7**
3	**DNA Manipulative Enzymes:** restriction endonucleases and other nucleases; ligases; polymerases; DNA-modifying enzymes; topoisomerases and ligation Systems: blunt and sticky end ligation; putting sticky ends on to a blunt-ended molecule; use of linkers and adaptors.	**5**
4	**Cloning Vectors:** Properties of plasmids; cloning vectors for prokaryotic organisms, plasmid pBR322, bacteriophage M13 and λ; cosmids; phagemids; charomids; cloning vectors for eukaryotic organisms; yeast episomal plasmid (2 μm circle); cloning vectors for higher plants and mammalian cells.	**4**
5	**Introduction of Recombinant DNA into Living Cells:** transformation of bacterial cells and selection of recombinants; introduction of phage DNA into bacterial cell and selection of recombinant phage; transformation of non-bacterial cells.	**4**
6	**Sequencing of DNA:** The Sanger-Coulson method; Maxam-Gilbert Method; Pyro and Next Generation sequencing	**4**
7	**Analysis of Cloned Gene:** transcript analysis, expression and regulation of a cloned gene; identifying and studying the translation product of cloned gene.	**6**

Recommended Books

1. Principle of Gene Manipulation: An Introduction to Genetic Engineering - R.W. Old and S.B. Primrose – University of California Press,
2. Molecular Biology of the Gene – J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, S.C. Harrison; Pearson, Boston.
3. Genetic Engineering – S.M. Kingsman, A.J. Kingsman; Blackwell Scientific Pulication, London.
4. Principles of Genetics – S.D. Peter; M.J. Simmons; Wiley, New Jersey .
5. Gene Cloning: An Introduction – T,A. Brown; Wiley Blackwell.
6. Molecular Cloning: a laboratory manual – J. Sambrook, D.W. Russell. Cold Spring Harbor Laboratory, New York.
7. Current Protocol in Molecular Biology – F.M. Ausubel, R. Brent, R.E. Kingston, D.D. Moore, J.G. Seidman, J.A. Smith – John Wiley and Sons.

MBG 405 Microbial Biotechnology **Credits: 4** **Class: 60 hours**

This course focuses the biotechnological areas where microbes and their metabolic pathways and products can be used. The course will summarize how to improve industrially important microorganisms and their enzymes, exploiting microbes to overproduce metabolites of interest, exploitation of microbes and their products for energy generation, bio-mining, bioremediation etc. Students will also explore where biotechnology may offer an answer to contemporary problems by dealing into the past and evaluating the future of the biotechnology industry. The course will also help the students to develop their own interests in other aspects of biotechnology.

Course Objectives

The course will enable students to learn about the

1. Basic concept and spectrum of biotechnology as well as areas of application of biotechnology.
2. Production of different biotechnological products including recombinant products, use of genetically manipulated organisms and biotechnologically important enzymes.
3. Areas of application certain microbes used in biotechnology with detailed processes such as biotransformation, bioremediation, metal extraction etc.

Learning outcomes

After successfully completing the course, the students will be able to apply their knowledge in the following areas:

1. Understanding the concepts, essential feature and applications of biotechnology
2. Improvement the potentiality of microorganisms and utilizations of beneficial microorganisms
3. Application of biotechnology in mining industry and remediation of pollutants
4. Specific processes and the reactions in the biotransformation and bioremediation.
5. Application in production of biofuels from low-cost raw materials
6. Application of enzymes for various purposes

Unit	Course Content	Class hours
1	**Introduction to Biotechnology:** historical development, scope and essential features of microbial biotechnology; interdisciplinary nature and applications of biotechnology.	4
2	**Improvement of industrially important microorganisms:** conventional routes to stain improvement; isolation of mutants, auxotrophs, resistant mutants, revertant mutants, use of recombinant systems. Application of system biology and bioinformatics for stain improvement.	8
3	**Over production of metabolites of industrially important microorganisms:** Derangement or bypassing of regulatory mechanisms for the over-production of primary metabolites, regulation of over-production in secondary metabolites, empirical methods employed to disorganize regulatory mechanisms in secondary metabolic production.	8
4	**Energy and Biotechnology:** Biomass fuel; fuel-ethanol and methane fermentation; bio-diesel, biofuel cells and bioelectrochemical devices. Genetic manipulation of yeast and bacteria for ethanol production.	8
5	**Materials and Biotechnology:** microbial leaching, metal transformation and immobilization; bio-polymers (PHA, PHB, PLA etc); production and regulation**.**	6
6	**Immobilized Biocatalyst Technology:** Principles, benefits, methods of immobilization of enzymes and cells. Application of immobilized biocatalysts.	8
7	**Biotransformation**: Botransformation and principles**;** Biocatalysis in organic solvents, enzyme reactors in biotransformation, steroid, aromatic compounds and metals etc	8
8	**Chemical Engineering and Biotechnology:** Microbial factors and process engineering factors affecting process performance and economics; future development in industrial biotechnological processes.	5

9	**Biotech for Waste Management**: Microbial waste system, biological processes for industrial wastes and effluent treatment; Future development in biotechnological processes of waste materials. Visit to Biotechnological Research Institutions and Industries	**5**

Recommended Books

1. Biotechnology Principles: Aspects of Microbiology- by J.E. Smith**;** Van Nostrand Reinhold (UK) Co Ltd.
2. Microbial Biotechnology: Principles and Applications – L.W. Kun and Y.K. Lee; World Scientific Publishing Company
3. Biotechnology: Principles and Applications- by Higgins I.J.; Best D.J.; Jones J. – Oxford U
4. Microbial Biotechnology: Fundamentals of Applied Microbiology - Glazer, AN & Nikaido, H. 2007. Cambridge University Press
5. Comprehensive biotechnology: Principles, applications and regulations of biotechnology in industry, agriculture and medicine- by Moo-Young, Murray – Elsevier, New Delhi
6. Introduction to biotechnology- by Brown C. M.; Brown C. B.; Campbell I.; Priest F. G – Blackwell, London

MBG 406 Analytical Techniques in Life Sciences Credits: 4 Class: 60 hours

This course is designed to help students learn how to isolate, purify and identify macromolecules through different analytical techniques, study their interaction in the form of a complex, and estimate them in both qualitative and quantitative ways.

Course Objectives

1. To familiarize students how to use electron and confocal microscopy for essential detection of cellular and sub-cellular structures.
2. To acquaint students with the ways of electrophoretic, chromatographic, spectroscopic and centrifugal techniques for separation, purification and estimation of macromolecules in isolates or in supramolecular complex.
3. To introduce students to skills used in the biotechnology industry for culturing cells: the principles and practices of initiation, cultivation, maintenance, passaging and the preservation of cell lines including applications.
4. To acquaint students with the generation and study of genetically modified mice and other model organisms; consultation on experimental design and analysis; technology development.

Learning Outcomes

Upon completion of the course students should be able to:

1. describe different analytical techniques required to isolate, resolve and purify proteins or nucleic acids, and techniques of their identification and sequencing,
2. describe how study of protein-protein interaction can be addressed,
3. learn the skills used in the biotechnology industry for culturing cells, and application of animal models.

Unit	Course Content	Class hours
1	**Advanced Microscopy:** The Electron microscopy: Principles and methods; Image analysis and Archiving, The Confocal fluorescent: Principles and methods;Image analysis and Archiving	**3**
2	**Centrifugation Techniques:** Principle of sedimentation; sedimentation co-efficients, centrifuges and their use, Differential centrifugation;ultracentrifuge, Density-gradient centrifugation: rate zonal technique and isopycnic technique	**4**

3	**Electrophoresis Techniques:** Principle; Factors affecting electrophoresis; Types and Methods, Native, Gradient, SDS-PAGE, isotechophoresis; Isoelectric focusing and 2D gel electrophoresis, Analysis of protein-protein interaction by gel electrophoresis, Co-immunoprecipitation, Mobility shift assay	**8**
4	**Protein Characterization:** Isolation and quantification of proteins, Preparation of whole cell extract, surface proteins, lipopolysaccharides, chemical and physical methods. Identification of amino acids, Primary structure, amino acids sequence of polypeptide Chains; Biochemical, immunological and molecular characterization of proteins; Sequence analysis and report writing.	**14**
5	**Chromatographic Techniques:** Principle of chromatography; definition, terminology, types of chromatography, Column, thin-layer and paper chromatography, Affinity chromatography: Principles, Tandem affinity chromatography; Exclusion/ gel filtration chromatography: procedure and applications, Molecular imprinting, Ion exchange chromatography; Adsorption chromatography: hydroxylapatite and hydrophobic interaction chromatography- salting in and salting out, Gas-liquid, high performance liquid chromatography, fast protein liquid chromatography	**13**
6	**Spectroscopic Techniques:** Introduction, Light spectrum of electromagnetic radiation, Electronic spectra, Visible, ultraviolet and infrared spectrophotometers, Fluorescence and Spectrofluorimetry; it's applications, Luminescence and luminometry; it's applications; NMR and mass spectrometry; (MALDI-TOF) matrix-assisted laser desorption ionization time-of-flight. X-ray crystallography	**5**
7	**Radioisotope Techniques:** Nature, detection and measurement of radioactivity, Application of radioisotopes in the biological sciences, Safety aspects of the use of radioisotopes	**3**
8	**Cell culture techniques:** Preparation and maintenance of cell culture, Primary cell cultures, Continuous cell-lines, Cell quantification, Cryopreservation of cells, Determination of cell viability, Assay of cell death: TUNEL assay.	**5**
9	**Animal Model:** Inbred strain; Transgenic animal, Knock-in and knock out technology	**5**

Recommended Books

1. Protein Purification: principles and practice – R.K. Scopes – Springer-Verlag, New York
2. Comprehensive Biotechnology: the Principles, applications and regulations of biotechnology in industry, agriculture and medicine - Moo-Young, Murray – Elsevier, New Delhi
3. An introduction to Practical Biochemistry – D.T. Plummer – McGraw-Hill, London
4. Basic biochemical methods – R.R. Alexander – John Wiley, New York
5. A Guide to Principle and Techniques of Practical Biochemistry - Wilson K and Goulding KH
6. Gel electrophoresis of Proteins: A practical approach – B.D.Hames – Oxford University press
7. The Protein Protocols Handbook – J.M. Walker, Humana Press
8. Lehninger Principles of Biochemistry – D.L. Nelson and M. M. Cox, W.H. Freeman and company

MBG 407 Quality Control of Food and Agricultural Products Credits: 2 Class: 30 hours

The course provides an overview of the concepts and applied areas of quality control for foods and agricultural products. The course covers the major areas of quality control systems including organization of management system and processing plant, quality characteristics and standards, food quality and safety assurance systems, waste management in food processing and a wide variety of techniques for quality control in the processing of food products. The course may also serve as a guide for students and researchers to improve the quality control procedures and systems in food agricultural products.

Course Objectives

1. To train the students to be competent working professionals in the food industry, in the production of quality food by imparting better nutritional, sanitation & hygiene concepts.

2. To encourage students to the entrepreneurs and develop the capacity for setting up small scale enterprises with respect to food within the country.
3. To organize functions for creating awareness about the importance of quality and safe processed nutritious food.
4. To provide diagnostic analysis of food products

Learning Outcomes

After completing the course, the students are able to:

1. Understand the concept and principles of quality control management systems of food and agricultural products.
2. Develop the skills in fundamental quality control procedures of food in processing plant.
3. Describe the sanitation and inspection procedures to control food hazards in the processing industry
4. Understand the quality characteristics, food standards and statutes clearly
5. Acquire knowledge on food safety and quality assurance systems by establishing GHP, GMP and HACCP with practical methods of quality control.
6. Develop skills in food and agro-wastes utilization and management.

Unit	Course Content	Class hours
1	**Introduction:** Concept and importance of quality control of food and beverage; Basic principles and applications of quality control; Major areas of quality control – raw materials, process and finished product.	5
2	**Organization of Quality Control:** Organization of quality control management systems; Major problems and techniques of quality control; Improvement of quality control.	5
3	**Microbiological Quality Control:** Fundamentals of microbiological quality control; Chemical and microbiological indicators for quality assurance; standards for monitoring to assess compliance with good practices; Microbial risk assessment.	5
4	**Sanitation and Inspection:** Sanitation and hygiene of processing plant, air and water in processing and cleaning; waste/effluent treatment, packaging; equipment; Personal hygiene and handling of food; Good hygienic practices (GHP) in food industry; Inspection and monitoring system for sanitary quality.	6
5	**Quality Assurance:** Concept of quality assurance; Sampling, testing panel-sensory assessments in quality control and quality assurance; Establishment of hazard analyses and critical control point (HACCP) systems- identification of potential hazards, monitoring system for critical control point (CCP), corrective actions and verifications.	6
6	**Food Laws and Regulations:** National and international food standards, regulations, enforcing agencies and their functions; Mandatory and voluntary guidelines.	3

Recommended Books

1. Quality Control of Food and Agricultural Products – J.-L. Multon; Wiley VCH, New York
2. Quality control in the food industry - S. M. Herschdoerfer–Academic press, London,
3. Quality Control for Value Addition in Food Processing – D.R.R. Sharma and V.K. Joshi; New India Publishing Agency
4. Food Quality Assurance: Principles and Practices – I. Alli; CRC Press

MBG 408 Environmental Pollution and Bioremediation Credits: 2 Class: 30 hours

This course deals with major problems of pollution of the atmosphere, water, the land surface and the food chain. It covers processes responsible for the occurrence and release of pollutants in the environment, dispersion mechanisms, the hazards associated with different types of pollutant,

problems of accumulation of toxic substances, and procedures for the reduction of emissions and remediation of contaminated environments.

Course Objectives

1. To understand the nature of pollutants and its impact in the environment
2. To determine the role of microbes in pollution and bioremediation in environment
3. To overview the recent pollution problems and potential biological remediation techniques

Learning Outcomes

After completion of the course, students will able to-

1. learn the basic principles of microbiology required for understanding the biodegradation of hazardous and toxic organic pollutants.
2. familiar with and have an understanding of problems of pollution of the environment by potentially toxic elements and persistent organic pollutions.
3. learn procedures and prospects for reducing unwanted emissions to the environment and remediation of already polluted systems.

Unit	Course Content	Class hours
1	**Biodeterioration of Materials:** basic concepts, factors involved in biodeterioration; biodeterioration of leather, wool, fur, feather, stones, plastics and rubber; microbial production of bioplastics; Control of biodeterioration: physical, chemical and biological methods.	**6**
2	**Biodegradation of Recalcitrants:** Xenobiotic chemicals in the environment; bio-degradable, persistent and recalcitrant wastes; structure-recalcitrance relationship; concept on ring cleavage, factors affecting microorganisms to degrade xenobiotic, removal of substituent groups and ring opening in model molecules; chloro-organics; organic dyes; phenols; petroleum hydrocarbons.	**5**
3	**Enrichment and Isolation of pollutant degrading Microbes:** recent approaches to enrich and isolate microbes having catabolic properties.	**4**
4	**Approaches to Bioremediation:** environmental modification for bioremediation; microbial seeding and bioengineering approaches to the bioremediation of pollutants; monitoring of the bioremediation of xenobiotic pollutants	**7**
5	**Waste Treatment Technologies:** physical, chemical and biological treatment; activated sludge; advanced treatments; biological removal of nitrogen and phosphorous	**2**
6	**Biotechnological Aspects for Effluent Treatment:** genetic manipulation, enzyme and specialized bacteria; biodegradability testing.	**3**
7	**Toxicity Testing in Wastewater:** impacts of toxicity on wastewater treatment; heavy metals organic toxicants; enzymatic assays and microbial bioassays.	**3**

Recommended Books

1. Microbial Ecology: Fundamentals and Applications- R.M. Atlas & R. Bartha;Addison Wesley Longman, New York
2. Current Perspective in Microbial Ecology- M.J. Klug & C.A. Reddy; American Society for Microbiology, Washington
3. Ecological Systems and the Environment- T.C. Foin; Houghton Mifflin, London
4. Biotreatment Systems, Vol. II- by Wise Donald L – Boca Raton : CRC Press, Inc.
5. Wastewater Microbiology- G. Bitton; Wiley, Florida

MBG 409 Industrial Microbiology Credits: 2 Class: 30 hours

The course is designed to develop the student's ability to apply the techniques used in different phases of industrial microbiology such as discovery, production, bioprocessing and cell storage. It includes the principles and practices in the major applications of microorganisms (natural isolates, laboratory mutants or genetically engineered) to the industrial production of biomass, enzymes, primary and secondary metabolites, pure chemical and other useful products.

Course Objectives

1. To understand and develop concepts in industrial process which in turn resulted in action.
2. To acquaint the art of microbial action in commercial production of valued producrs.
3. To enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product.

Learning outcomes

Upon completion of the course, the students are able to:

1. Describe the main steps and processes used to produce biological products in industry
2. Discover new useful microorganisms and store them reliably for later use
3. Evaluate which molecular techniques are applicable to improve production including transfer of useful genes to microorganisms that are more amenable to large-scale production and the use of molecular techniques to block and enhance specific metabolism
4. Understand ethical and commercial issues such as record keeping, confidentiality, patenting, and licensing
5. Perform microbiological investigations, observe and evaluate the data obtained, and report the findings accurately and precisely
6. undertake an independent investigation to propose microbiological options for developing a new production a large-scale commercial basis

Unit	Course Content	Class hours
1	**Scope of Industrial Microbiology**: Historical development, scope and multidisciplinary nature of industrial microbiology; Applications of microbiology in commercial production; Optimization of industrial process and economic viability; Organization setup in industrial microbiology; Product development, safety regulation, patent and patent laws.	6
2	**Industrial Microorganisms:** microorganisms of industrial importance and their characteristics; Improvement, screening, selection and maintenance of industrially potent microorganisms; media formulation, culture systems & economics.	4
3	**Production of Biomass & Beverages:** Single cell protein (SCP) and microbial biomass protein (MBP); Yeast biomass; Technology for production of alcoholic beverages- beer, wine and distilled spirit; Vinegar.	5
4	**Production of Industrial Chemicals and food additives:** Organic acids- lactic acid, citric acid, alcohol, acetone, butanol, monosodium glutamate and vitamins.	6
5	**Production of microbial enzymes and antibiotics:** Microbial sources of commercial enzymes and their applications; biotechnological approaches for production of enzymes and antibiotics.	5
6	**Industrial Waste Management**: Utilization of domestic, agroindustrial and industrial waste for commercially valued products; Treatment of industrial wastes.	4

Recommended Books

1. Industrial Microbiology: an introduction- M.J. Waites, N.L. Morgan, J.S. Rockey& G. Higton, Blackwell Science, Oxford
2. Modern Industrial Microbiology and Biotechnology- N. Okafor, Science, New Hampshire.

3. Prescott and Dunn's Industrial Microbiology- G. Reed, CBS, New Delhi
4. Industrial Microbiology- B.M. Milier & W. Litsky, McGraw-Hill, New York.
5. Industrial Microbiology- L.E Casida, Wiley, New York.
6. Intelectual Property in Academia: A Practical Guide for Scientist and Engineers - N Reingand, CRC Press

MBG 410 Epidemiology, Public Health and Bioethics Credits: 2 Class hours: 30

In this course, students will learn and apply basic concepts of epidemiology to multiple domains of public health. The course will illustrate and practice using epidemiology to better understand, characterize, and promote health at a population level. The class will engage the students in active and collaborative learning through team activities, individual projects, case studies, group discussion, and individual projects

Course Objectives

1. To apply the basic concepts, principles and tools of epidemiology for appropriate inferences from epidemiologic data.
2. To explain the importance of epidemiology for informing scientific, ethical and economic discussion of health issues.
3. To acquire knowledge of major frameworks of ethics and the basic ethical concepts operative in public health ethics.

Learning Outcomes

Upon completion of the course, the student will able to:

1. Explain the importance, concept and applications of epidemiological approach to control diseases.
2. Investigate on outbreak of a disease and prevention of future outbreak
3. Evaluate the key data sources, basic epidemiology measures, strengths and limitations of epidemiological reports.
4. Understand the basic terms, disciplines and development of public health and family health.
5. Identify the principles and limitations of public health screening programs.
6. Apply concepts, methods, and tools of public health data collection, analysis and interpretation.
7. Comprehend basic ethical and legal principles pertaining to the collection, maintenance, use and dissemination of epidemiologic data.

Unit	Course Content	Class hours
1	**Introduction to Epidemiology:** Definition of epidemiology, uses, and core epidemiologic functions; Epidemiologic approach- defining a case and using counts and rates; Concepts of disease occurrence, natural history and spectrum of disease, chain of infection, epidemic disease occurrence.	4
2	**Investigating on Disease Outbreak:** Introduction to investigating an outbreak; Steps of an outbreak investigation; surveillance system to control disease outbreak.	4
3	**Design of Epidemiological study:** Observational studies; Experimental or intervention studies, descriptive epidemiology an analytic epidemiology; Intervention or experimental studies, randomized and non-randomized trials, controlled trials, clinical trials, field trials and community trials.	4
4	**Health and Health Development:** Public health- history and major disciplines in public health; Family health- family, family health, maternal health, family planning and child health; Health development- The role of health in development, health and the millennium development goal.	4

5	**Health Care and Service:** Primary Health Care (PHC)- components, principles, philosophy, strategy and development of PHC; Community-based health services-community responsibility, community health councils, community involvement in health (CIH) and team approach in health service.	**5**
6	**Public Health Surveillance:** Introduction, Purpose and characteristics of public health surveillance, identifying health problems for surveillance, Identifying or collecting data for surveillance, Analyzing and interpreting data, Disseminating data and interpretations, Evaluating and improving surveillance.	**6**
7	**Bioethics:** Principles and concepts in bioethics debates, including autonomy, nonmaleficence, beneficence and justice.	**4**

Recommended Books

1. Essentials of Epidemiology in Public Health – A. Aschengrau and G.R. Seage; Jones and Bartlett Publishers, Massachusetts
2. Introduction to Public Health – M.L. Fleming and E. Parker– Churchill Livingstone Australia
3. Introduction to Public Health – R.L. Goldsteen, K. Goldsteen, and T. Dwelle.– Springer Publishing Company, New York
4. Principles of Epidemiology in Public Health Practice: An Introduction to Applied Epidemiology and Biostatistics- R. Dicker, F. Coronado, D. Koo and R.G. Parrish–CDC
5. Dictionary of Epidemiology – J,M, Last, Oxford University Press, New York.
6. Good Manufacturing practices for Pharmaceuticals: A Plann for total quality control – S.H. Willing and J.R. Stoker –Marcel Dekker Inc.
7. Pharmaceutical Process Validation – I.R. Berry and R.A. Nash–CRC Press

MBG 411 Microbial Diagnosis in Health Clinics Credits: 2 Class: 30 hours

The course provides the studies of fundamental concepts and methods underlying diagnostic microbiology in the health clinics. It covers the major areas of diagnosis including detection of the agents of infectious diseases by laboratory methods, determining appropriate therapy for the infectious agents, and processing clinical specimens for optimal recovery of infectious agents. Through a series of lectures students will become familiar with the major groups of medically important bacteria, selection of appropriate diagnostic laboratory specimens, and the technical procedures used for recovery and identification will be presented.

Course Objectives

1. To introduce students with basic and applied laboratory techniques in diagnosis of disease
2. To develop skills in identification of pathogens and selection of antimicrobial drugs
3. To strengthen the professional ability in diagnosis and investigation on disease with its prevention measures

Learning Outcomes

Upon completion of the course, the students are able to:

1. Develop skills to collect and maintain the clinical specimens employing proper methods.
2. Apply appropriate laboratory techniques for isolation and identification of suspected pathogens in clinical specimens.
3. Develop skills in immunological and molecular based techniques for rapid detection of pathogen
4. Discuss the mechanism of action of various antibiotics and antimicrobial agents.
5. Perform and interpret antimicrobial susceptibility testing procedures.
6. Demonstrate knowledge of the disease processes associated with specific etiologic agents, associating clinical findings with the agents of common diseases.

Unit	Course Content	Class hours
1	**Specimen Management:** Types of clinical specimen, different approaches to clinical specimen collection, maintenance and laboratory management. Primary Culture - Selection of Culture Media, Specimen Preparation.	4
2	**Diagnostic Studies:** principles of diagnoses of bacterial, fungal, rickettsial, parasitic, spirochetal, viral and mycoplasmal diseases.	5
3	**Microscopic examination:** application of Microscopy in Diagnostic Microbiology, and Types of Microscopy for Diagnosis of Infectious Diseases.	4
4	**Traditional approach for Identification:** Bacterial Identification - Principles of Identification, Organism Identification by cultural and biochemical properties; Analysis of Metabolic Profiles; Commercial Identification Systems.	5
5	**Immunochemical Methods:** Immunochemical Methods Used for diagnostic purpose - Precipitin Tests, Particle Agglutination Method, Immunofluorescent Assays, Enzyme Immunoassays, Haemagglutination Inhibition Assays, and Western Blotting.	5
6	**Molecular based diagnosis:** Nucleic Acid Hybridization Methods: SB, NB, PCR amplification and Derivations of the PCR Method, Real-Time PCR assays, Non-PCR-Based Amplification Methods, hybrid capture assay, dsDNA assay, microarray.	5
7	**Validation of diagnostic assay:** Concepts and applications.	2

Recommended Books

1. Bailey and Scott's Diagnostic Microbiology – by P.M.Tille.Weissfeld, Mosby, St. Louise
2. Textbook of Diagnostic Microbiology- by C.R. Mahon, D.C. Lehman and G. Manuselis Jr., WB Saunders Co., New York
3. Laboratory Diagnosis of Infectious Diseases: Essentials of Diagnostic Microbiology - P.G. Engelkirk and J.D. Engelkirk; Wiliam and Wilkins

MBG 412 Advances in Food Fermentation Techniques Credits: 2 Class: 30 hours

The course is designed to reviews the modern art of fermentation techniques used in a wide range of food and beverage applications, and the technology for enhancing this process is continually evolving. It presents the key aspects of fermented food production including potential microbes for fermentation, ways of controlling and monitoring the quality and safety of fermented foods, advances in fermentation technology, process of particular fermented food products and their health benefits.

Course Objectives

1. To learn the concept, scope and health benefits fermented foods for human consumption;
2. To provide vital information of the traditional and modern art of fermentation of foods;
3. To present on the emerging trends in the production and marketing of fermented in the world.

Learning Outcomes

Upon completion of the course, the students are able to:

1. Understand the concept and advantages of microbial fermentation of foods with their health benefits;
2. Gain practical information on fermenting vegetables, fruits, grains, milk, beans, meats, and related more products
3. Develop the potential microbes and their use in the processing of fermented foods
4. Explain the advancement of modern art of fermentation techniques for different foods.
5. Learn the health benefits, commercial production of probiotic foods and food supplements.

Unit	Course Content	Class hours
1	**Fermented foods:** The past, present and future of fermented foods; microbes involved in food fermentation, types of global fermented foods, advantages and health benefits.	4
2	**Fermented dairy products:** Dahi, Yogurt, Buttermilk (Chach) and Cheese- preparation of inoculums, types of microorganisms and production process.	8
3	**Grain-based fermented foods:** Soy sauce, Bread, Idli and Dosa and Tofu- microorganisms and production process.	3
4	**Fruits and Vegetables based fermented foods:** Pickles, Saeurkraut &Kimchi - microorganisms and production process; beverages.	6
5	**Fermented meat and fish**: Categories, potential microbes involved, and fermentation process of Sausage, Chapa	4
6	**Probiotic foods: T**ypes, potential microbes used in probiotic food; health benefits; prerequisite for commercial production; probiotics as super foods; probiotic food supplements.	5

Recommended Books

1. Handbook of Food and Fermentation Technology – Y,H. Hui, L. Meunier-Goddik, J. Josephsen, W.K. Nip and P.S. Stanfield; CRC Press.
2. Advances in Fermented Foods and Beverages – W. Holzapfel; Woodhead Publishing.
3. A comprehensive Dairy Microbiology, Metropolitan – J.S. Yadav, S. Grover and V.K.Batish;
4. Modern Food Microbiology – J.M. Jay, M.U. Loessner and D.A. Golden; Springer.
5. Microbiology and Technology of Fermented Foods - R.W. Hutkins, Blackwell Publishing, IFT Press
6. Probiotic Foods for Good Health – B.T. Hunter, Basic Health Publications Inc. USA
7. Fermented Food and Beverage of the World – J.P. Tamang and K. Kailasapathy; CRC Press

MBG 413 Laboratory Works and Short Research Project Credits: 8 Class: 165 hours

This applied and professional Laboratory curriculum described below to represent the relevant topics and themes of the theoretical courses and considered essential for the development of skills in service, teaching and research in microbiology. The fourth year students integrate their knowledge and skills into a research project that sets out from an abstract theme. The students will have to conduct an in-depth study of the theme and to come up themselves or often in teams with research questions; the instructor/supervisor will act as a 'hands-on' expert and motivator in this process. Development of laboratory techniques; exercises designed to reinforce concepts covered in this course.

Course Objectives

The main objective of the course is to achieve the specialized knowledge and intellectual skills in the Laboratory Works in different fields of microbiological sciences. The specific objectives include integration of knowledge, exercising designed concepts and developing laboratory skills for service, teaching and research laboratories.

Learning Outcomes

After successful completion of the fourth year laboratory works students will be able to exercise their specialized laboratory skills in service, teaching and innovations in different field of microbiology including virology, immunology, genomics and genetic engineering, biotechnology and food industry, analytical and diagnostic microbiology, disease control and bioremediation of natural and man-made hazards in terrestrial and marine environments. The students will also achieve the capability to complete a substantial research project related to microbiological sciences; seek and employ insights from others in implementing the project; evaluate a significant challenge or question faced in the project in relation to core concepts, methods or assumptions in microbiology; and describe the effects of learning outside the classroom on his or her research or practical skills.

Unit	Course Content	Class hours
1	**Virology** 1. Detection of viral Ags/Abs from patients' sera by immunological techniques 2. PCR amplification of HBV core and surface genes 3. Detection of viral DNA by PCR amplification and dot-blot hybridisation 4. Use of RPHA method for the detection of viral Ag/Ab Titration of virus using immunofluorescent microscope	**15**
2	**Immunology** 1. Detection of antigen and antibody by- (i) gel immunodiffusion technique, (ii) radial immunodiffusion technique, and (iii) crossed immunoelectrophoresis technique. 2. SDS-PAGE and immunoblotting of bacterial proteins 3. Complement fixation tests 4. HLA typing 5. Phagocytosis specific and non-specific	**15**
3	**Genomics and Bioinformatics** 1. Database searching and information retrieval 2. Application of computational tools for – sequence alignment, homology searching, primer design, finding genes, transcriptional elements, analyzingprotein-protein Interaction. 3. Phylogenetic tree construction and mutation analysis 4. Structural bioinformatics: DNA/RNA/protein structure prediction, homology modelling, Drug design. 5. Restriction mapping: In vitro and in-silico study.	**15**
4	**Genetic Engineering** 1. Demonstration of Bacterial Transformation and calculation of transformation efficiency. 2. Methods of nucleic acid isolation (DNA) 3. DNA digestion by restriction enzymes 4. Ligation of DNA fragments 5. Transformation 6. Study of genetic map	**15**
5	**Microbial Biotechnology** 1. Yeast cell immobilization in Ca-alginate gel & enzyme immobilization by Na-alginate method 2. Demonstration on biofuel production 3. Demonstration on biotransformation of organic compouns 4. Demonstration on metal recovery 5. Biotech for effluent treatment	**15**
6	**Analytical Techniques in Life Sciences** 1. Study of fluorescent micrographs to visualize bacterial cells. 2. Separation of components of a given mixture using a centrifuge 3. Separation of sugars by paper chromatography 4. Thin-layer chromatographic separation of amino acids 5. Demonstration of gel filtration/ ion-exchange chromatography 6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE) 7. Determination of organic carbon in soil and waste water 8. Estimation of nitrogen in soil and water.	**15**
7	**Quality Control of Food** 1. Sampling: selection, size, collection, labeling and preparation of food samples 2. Subjective or Sensory evaluation: appearance, texture, colour, odour, flavour, taste and additional quality factors; Paired Preference Test (PPT), Ranking Test (RT),	**15**

	Hedonic Tests (HT) 3. Objective or laboratory analysis: Physical and chemical analysis 4. Objective or laboratory analysis: microbiological analysis 5. Demonstration on quality control reporting system	
8	**Environmental Pollution and Bioremediation** 1. Isolation of biodegradative microbes from environment 2. Detection of Non-culturable state of microorganisms 3. Detection of indicators and pathogenic microbes in potable water 4. Water purification (*viz*., flocculation, chlorination, ozonation etc.) 5. Remediation of metal ions through microbes.	**15**
9	**Industrial Microbiology (optional)** 1. Production of ethanol from molasses 2. Production of citric acid from molasses 3. Production of alpha-amylase from starch 4. Production of biogas from domestic wastes 5. Production of acetic acid by *Acetobacteraceti*	**15**
10	**Epidemiology and Public Health (optional)** 1. Demonstration and data analysis on epidemiologic description of a disease 2. Demonstration on health surveillance systems and control of diseases 3. Demonstration on control of personal hygiene in food and health care 4. Demonstration on bioethics in public health	**15**
11	**Microbiology in Health Clinics (optional)** 1. Determination of blood grouping 2. Coagulation, agglutination and haemagglutination 3. Determination of anti-streptolysin-O (ASO) titre 4. ELISA 5. Direct fluorescent antibody (DFA) detection of microbial pathogens 6. Gene detection and DNA-hybridization analysis in clinical diagnosis 7. Widal test 8. Anti-*Mycobacterium tuberculosis* complex (IgA, IgG and IgM)	**15**
12	**Fermentations of Food (optional)** 1. Isolation and development of potential starter culture for fermented food 2. Produce and package bread using baker's yeast for dough fermentation 3. Produce an indigenous beverage by brewer's yeast 4. Yogurt production by lactic starter 5. Fermentation for vegetables-based products	**15**
13	**Short Research Projects** Guidelines for working in research projects under supervision; Major areas- Environment, Food and Agriculture, Health, Pharmaceuticals, Industrial microbiology, etc. for 3 months	

Recommended Books

1. Microbiology: A Laboratory Manual- J. Cappucino & N. Sherman; Pearson Education Limited
2. Cell and Molecular Biology – P.V. Chaitanya; Prentice-Hall of India Pvt. Ltd.
3. Environmental Microbiology – I. Pepper, C. Gebra and J. Brandecke; Academic Press
4. Principles of Microbiology - R.M. Atlas, WM.T. Brown Publishers.
5. Food Microbiology: A Laboratory Manual – A.E. Yousef and C. carlstrom; Wiley and Sons Inc.
6. Laboratory Protocols in Applied Life Sciences - P.S. Bisen, CRC Press
7. Manual of Industrial Microbiology and Biotechnology – A.L. Demain and J.E. Davies; ASM Press.
8. Practical Microbiology – R.C. Dubey and D.K. Maheshwari; S Chand & Company Ltd.
9. Practical Immunology - C.H. Frank, M.R. Olwyn and Westwood; Blackwell Science Ltd.
10. Microbiology: Laboratory Manual- By Cuppacino Microbiology: Laboratory Manual- By Cuppacino, 10th edition

MBG 414: Viva Voce **Credits: 2**

A comprehensive viva-voce is mandatory and will be held at the end of the academic session as per regulation of the faculty.

MBG 415 Sessionals **Credits: 4**

It includes: (i) careers development and job opportunity in Microbiology, (ii) internship, (iii) visit to industry/research organizations, (iv) field works/excursion, and (v) participation in departmental seminars/workshops. Department will determine the tasks and marks for the Sessionals as capstone course.

Course Offered by the Department of Microbiology for Other Departments

MBG 200 General Microbiology **Credits: 4** **Class: 60 hours**

This course is designed to introduce a comprehensive account of the microbial world including both general and applied aspects. It provides a defined target to understand different group of microorganisms and their applications to various fields for human welfare. This course also includes a brief introduction to microorganisms responsible for diseases of fish, bird and animal as well as aquatic microbiology.

Course objectives

1. To recognize and apply concepts and theories of basic microbiological sciences.
2. To acquaint the basic methods for bacterial isolation, their maintenance and microscopy imaging
3. To introduce characteristics of different microorganisms and their mode of transmission for disease of plants and animals.

Learning outcomes

Upon completion of the course students should be able to:

1. Acquire an understanding of fundamental concepts of microbiology including microbial growth and their nutritional requirement, pure culture technique and microscopy.
2. Demonstrate the ability to accurately measure microbial growth by several techniques
3. Explain the principle and mechanism of different biochemical tests used in the microbiology laboratory.
4. Identify different microbes with their characteristic features and economic importance.
5. Understand the nature of common microbial diseases of birds, fishes and other animals along with their controlling measures
6. Familiar with the fundamentals of microbial genetics
7. Understand the nature of aquatic microbes and their economic importance.

Unit	Course Content	Class Hours
1	**Brief History of the Development of Microbiological Sciences:** Discovery of microorganisms; Origin of life; Spontaneous generation vs biogenesis; Germ theory of disease; Development of laboratory techniques, fermentation, vaccination, antisepsis and chemotherapy; Contributions in historical development of microbiology; Branches of applied microbiology.	3

2	**Microscopy:** Basic concepts on microscope and microscopy; Different types of microscopes and their applications.	**5**
3	**Prokaryotic and Eukaryotic Cells:** Morphological characterization, ultra-structure and chemical composition of prokaryotic cells and eukaryotic cells; Functions of different sub cellular elements.	**4**
4	**Microorganisms:** General characteristics, morphological and physiological properties, classification, and economic importance of bacteria, cyanobacteria, fungi, algae, protozoa and archaea.	**6**
5	**Virus, Virion and Prion:** Morphology, classification and replication of viruses; Characteristics of viroids and prions.	**3**
6	**Growth and Growth Requirements:** Growth and growth curve; Growth measurement- direct and indirect methods; Environmental growth requirements- temperature, pH, salinity, hydrostatic pressure, oxygen; Nutrition of microbes- nutritional requirements; categorization of microbes based on nutritional and environmental growth factors.	**5**
7	**Microbiological Culture:** Culture types- pure, mixed and contaminated culture; Culture media- types, preparation and dispensation; Pure culture techniques- isolation, maintenance and preservation of pure culture; Type culture collections.	**5**
8	**Identification of Bacteria:** Microscopic observation, staining properties, cultural characteristics on solid and liquid media, different biochemical tests to identify bacteria.	**3**
9	**Infectious Diseases and Disease Control:** Disease causing microbes in fish, bird and animals; investigation and prevention of diseases.	**5**
10	**Microbial Genetics:** Basic Concepts & Gene Expression- the genome, gene organization, DNA replication; Genes, Maintenance & Exchange- mutation & repair, gene transfer, .	**4**
11	**Control of microbial Growth:** Microbial control, microbial death rate and action of microbial controlling agents; Control of microbes by physical and chemical means.	**4**
12	**Brief Introduction to Aquatic Microbiology:** Aquatic environment; Microbes associated with fresh water, brakish water and marine environment.	**3**
13	**Laboratory Works** 1. Handling and use of bright-field microscope 2. Staining techniques: simple staining, negative staining and Gram staining 3. Preparation and examination of bacteriological culture media 4. Transfer and maintenance of microbial pure culture 5. Techniques for isolation of pure cultures: pour plate, spread plate and streak plate methods 6. Enumeration of microbial cells by using improved Neubauer counting chamber 7. Enumeration of microbial cells by standard plate count method. 8. Demonstration of antimicrobial activities of antibiotics and antimicrobial agents	**10**

Recommended Books

1. Brock Biology of Microorganisms - M.T. Madigan, J.M. Martinko, P.V. Dunlap, D.P. Clark, Pearson Prentice Hall
2. Microbiology – M.J. Pelczer Jr, E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
3. Microbiology: Concepts and Applications – M.J. Pelczer Jr, E.C.S. Chan and N.R. Krieg; McGraw Hill Inc., New York
4. Microbiology: An Introduction - G.J. Tortora, B.R. Funke and C.L. Case; Pearson, Boston
5. Principles of Microbiology - R.M. Atlas and W.C. Brown Pub

Other Information

Teaching and Learning Methods

The teaching and learning is focused on lectures supported by practical laboratory classes and skill development sessional programmes.

- Most of the theory courses introduced in lectures is consolidated through the laboratory sessions and through group seminars. Lecture materials are supported by recommended books and e-resources. There are multimedia systems widely used to post summary slides of lectures, resources such as articles and recent research papers and information about the organization of the course.
- Many opportunities will exist for students to enhance their communication skills by writing reports in various formats and by giving oral presentations to the colleagues. Seminars are used to offer a group teaching environment, often led by students needs, to review, discuss and consider aspects of taught material from either lecture or laboratory classes.
- Laboratory classes focus on hands-on acquisition of practical skills in the application of key principles, concepts and methods of Microbiology. Laboratory sessions involve problem solving, data collection and observation. Further time is allocated to the analysis, interpretation and evaluation of the results both inside and outside these practical classes.
- Student will develop their skills to undertake self-directed study and to become autonomous, independent learners.
- Students will also be expected to carry out supplementary reading and research to consolidate taught material. All of these practices are combined in student's final year where they will undertake an individual period of research which may be laboratory, field, informatics and/or literature-based.

Organization and Teaching Methods

There will be at least 15 class periods of 50 minutes each at the rate of once per week for a Credit. The majority of these periods will be lecture periods, with revision sessions spaced at regular intervals.

Rationale for Teaching Methods

The core curriculum as defined in the major and supporting course content will be presented and explained in the lectures. Revision classes provide the opportunity to reinforce material and revisit any difficult concepts. Students will not be allowed to make up missed exams, except only in cases of dire emergency (as judged by the instructor on a case-by-case basis).

Policies

It is essential that students come to class, take good notes, and study daily to pass the course. There is a direct correlation between attendance and success in this course. Lectures will start promptly at the appointed time. Regular attendance is expected; a written record is compiled daily. Students are responsible for obtaining and safeguarding handout materials – replacement copies will not always be available. It is not necessary to contact teacher if students are going to be absent for a single class period. All copies of exams are retained as part of the permanent record for this course. To contact teacher outside of scheduled classes, send an E-mail or call by phone for the appointment.

Learner Expectations in Laboratory Works

1. Attend lab (on time) and stay the entire lab period.
2. Read laboratory exercises in lab manual before they are to be performed.
3. Bring lab manual to class.
4. Come prepared to take final exam (i.e. do not wait until the night before to cram).
5. Participate in learning activities and complete tasks on time.
6. Be a good team player and do not let other members of the team do all the work.

Assessment

The course utilizes a variety of assessment methods to meet student's individual strengths and to enable the student to demonstrate achievement of the learning outcomes. Subject knowledge and understanding is mainly tested through tests and examinations, assignments, write-ups of laboratory practical work, oral and presentations.

Laboratory investigations are used to assess a range of intellectual and practical skills. Student's ability to test hypotheses, observe, collate, present, interpret and evaluate findings of an investigation is assessed through the preparation of laboratory reports.

The communication skills, in written and oral formats, of the students are assessed at numerous points throughout the course. Laboratory reports, presentations, assignments and examinations provide the students an opportunity to demonstrate their writing skills. Oral presentations and verbal defenses offer a means for students to demonstrate their verbal communication skills.

The overall balance of assessment on the course is mention in the Rules and Guidelines of the Faculty of Biological Sciences, University of Dhaka.
