University of Dhaka

Faculty of Biological Sciences

Syllabus for Bachelor of Science (Honours) Degree in Microbiology

Sessions: 2019-2020 and onward

Department of Microbiology
University of Dhaka
Dhaka-1000
Bangladesh

Syllabus 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 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 postgraduate 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 (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 Bachelor of Science or 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.

The BS (Honours) Microbiology programme is designed to provide the students with a multidisciplinary approach to study the microbial world and to prepare 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, 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)		Extra Departmental Course (marks)		Viva-voce (marks)	Credits
	Theoretical course	Laboratory works	Theoretical course	Laboratory works		
First	300	100	200	-	50	26
Second	400	100	150	50	50	30
Third	600	200	-	-	50	34
Fourth	700	200	-	-	50	38
Total	2000	600	350	50	200	128

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), it will be made through class attendance/participation, assignments, evaluation of interactive skills and laboratory reports/project reports. 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.

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	- Do -
70% to less than 75%	A-	3.50	- Do -
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	- Do -
55% to less than 60%	B-	2.75	- Do -
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	- Do -
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:

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

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 at 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 at 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 at 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 sit at Retake examination for a maximum of 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 4^{th} 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 at 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 4^{th} 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.

The Syllabus

The Four-Year (Honours) programme is covered by a set of theoretical, practical (laboratory/short research projects) and viva-voce. The programme will span over128 credits; the year-wise course distribution is detailed below. Of these 128 credits, 16 credits shall have to be taken as extra departmental/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 offered by the Department/other departments for the 1st Year, 2nd Year, 3rd Year and 4th Year are mandatory.

First Year BS (Honours)

Course:	6 Major courses	Marks: 400	Credit: 16
	3 Extra departmental courses	Marks: 200	Credit: 8
	1 Viva-voce	Marks: 50	Credit: 2
Total	10 Courses	Marks: 650	Credit: 26

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

Second Year BS (Honours)

Course:	9 Major courses	Marks: 500	Credit: 20
	3 Extra departmental courses	Marks: 200	Credit: 8
	1 Viva-voce	Marks: 50	Credit: 2
Total	13 Courses	Marks: 750	Credit: 30

Course Code	Course Name	Marks	Credit
Major courses			
MBG 201	General Microbiology	50	2
MBG 202	Fundamental Cell Biology	50	2
MBG 203	Environmental Microbiology	50	2
MBG 204	Bacterial Metabolism	50	2
MBG 205	Basic Microbial Genetics	50	2
MBG 206	Medical Microbiology-I	50	2
MBG 207	Basic Food Microbiology	50	2
MBG 208	Fundamentals of Enzymology	50	2
MBG 209	Laboratory Works	100	4
Extra departmental courses			
MBG 210	Biostatistics and Calculus	100	4
CM 222H	Biologically Important Organic Compounds	50	2
CMGL101H	General Chemistry Laboratory	50	2
MBG 211	Viva-Voce	50	2

Third Year BS (Honours)

Course:	12 Major Courses	Marks: 800	Credit: 32
	1 Viva-voce	Marks: 50	Credit: 2
Total	13 Courses	Marks: 850	Credit: 34

Course Code	Course Name	Marks	Credit
Major courses			
MBG 301	Biosynthetic Metabolism	50	2
MBG 302	Microbial Molecular Genetics	50	2
MBG 303	Medical Microbiology-II	50	2
MBG 304	Virology-I	50	2
MBG 305	Immunology-I	100	4
MBG 306	Molecular Cell Biology	50	2
MBG 307	Agricultural Microbiology	50	2
MBG 308	Industrial Microbiology	50	2
MBG 309	Applied Mycology	50	2
MBG 310	Pharmaceutical Microbiology	50	2
MBG 311	Microbiological Hazards and Food Safety	50	2
MBG 312	Laboratory Works	200	8
MBG 313	Viva-Voce	50	2

Fourth Year BS (Honours)

Course:	12 Major Courses	Marks: 900	Credit: 36
	1 Viva-voce	Marks: 50	Credit: 2
Total	13 Courses	Marks: 950	Credit: 38

Course Code	Course Name	Marks	Credit
Major courses			
MBG 401	Virology-II	100	4
MBG 402	Immunology-II	50	2
MBG 403	Genomics and Bioinformatics	50	2
MBG 404	Genetic Engineering	50	2
MBG 405	Microbial Biotechnology	100	4
MBG 406	Analytical Techniques in Life Sciences	100	4
MBG 407	Quality Control of Food and Agricultural Products	50	2
MBG 408	Environmental Pollution and Bioremediation	50	2
MBG 409	Fermentation Technology	50	2
MBG 410	Epidemiology, Public Health and Bioethics	50	2
MBG 411	Microbial Diagnosis in Health Clinics	50	2
MBG 412	Laboratory Worksand Research Project	200	8
MBG 413	Viva-Voce	50	2

Structure of Courses
Courses for the First Year BS (Honours)

MBG 101 Introductory Microbiology Credits: 2 Class: 30 hours

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. PelczerJr, 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; PHILearning Pvt. Ltd.

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

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

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. Nathand 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. Mutschlerand P. Vaupel; Elsevier, New York
5. Human Physiology - S.R. Fox; McGraw-Hill
6. Principles of Anatomy and Physiology - G.J. Tortoraand B. Derrickson, Wiley
7. Essentials of Medical Physiology - K. Sembulingamand P. Sembulingam; Jaypee Brothers

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

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 culturetechniques; Special purpose media for eukaryotic microorganisms; Batch, fed-batch and continuous culture.	7
4	**Culture Preservation:** Long-term and short-termtechniques 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. PelczerJr, E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
3. Microbiology: Concepts and Applications- M.J. PelczerJr, 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. Woolvertonand L.M. Prescott;McGraw-Hill, New York.

MBG 105 Basic Biochemistry Credits: 4 Class: 60 hours

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 of biomolecules.	5
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**

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

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 analysis of spread-sheet 3. Application of graphics programme- Photoshop, Illustrator 4. Applications of database 5. Development of programmes in Python or Bypython	**10**

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

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

Unit	Course Content	Class hours
1	**The Structure of Atoms:** the discovery of electron proton and neutron; cathode rays; radioactivity; □-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; Henry's law; Nernst distribution law	**3**
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 abstractionreactions 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**

Courses for the Second Year BS (Honours)

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

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**

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 andarrangements. **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

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 University Press
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**

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**

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

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, and S. Miller; McGraw Hill Education
2. Essential Clinical Microbiology: an introductory text- E. MCooke and 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. Marinian and 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

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

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,	5

	fluid forces, chemical agents and irradiation.	
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**

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* 5. Resolution and visualization of DNA by Agarose Gel Electrophoresis	**10**

	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

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

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

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

MBG 211 Viva-Voce Credits: 2

Courses for the Third Year BS (Honours)

MBG 301 Biosynthetic Metabolism Credits: 2 Class: 30 hours

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	**5**

	Sulfate, Nitrogen Fixation, Lithotrophy (aerobic chemolithotroph; hydrogen and CO oxidizers; ammonia, sulphur and ferrous ion oxidizers; facultative obligate chemolithotrophs)	

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

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 multicellularorganisms 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,Conjugationand 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,* induction and catabolite repression; tryptophan operon in *E. coli* repressionand attenuation, arabinose operon in *E. coli*;transcriptional, translational and post-translational regulatory mechanisms.	6
5	**Genetic Recombination:** Types of recombination, Models of general recombination,Molecular basis of homologous recombination, Molecular basis of non-homologousRecombination	3
6	**Transposable Genetic Elements:** Transposable elements in prokaryotes; IS elements,Composite transposons, Tn3 element, Mutagenic effects of bacterial transposableelements, the medical significance of bacterial transposons. Transposable elements ineukaryotes: 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

Unit	Course Content	Class hours
1	**Clinical Manifestation, Pathogenesis, Virulence Factors, and Control of the following Pathogenic Microbes:** *Streptococcus* spp. *Staphylococcus* spp*;Corynebacteriumdiphtheriae; Mycobacterium tuberculosis; Vibrio cholerae; Escherichia coli; Salmonella enteric* typhi*; Neisseria* spp.; *Treponemapallidum*	6
2	**Introduction to Clinically Important Parasites:** *Giardia; Entamoeba, Leishmenia, Taenia,, Plasmodium spp*	5
3	**Bacterial strategies for Evading or Surviving HostDefense 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; Nonproteintoxins; 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 virulencetraits 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. Tenoverand 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

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 I **Credits: 4 Class: 60 hours**

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

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 andP.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 - Kursadturksen

MBG 307 Agricultural Microbiology Credits: 2 Class: 30 hours

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 animalresidues; biodegradation of pesticides and pollutants in soil.	6
3	**Biogeochemical Cycling of Nutrient Elements:** carboncycle, 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	2

	bacteria.	
6	**Plant Pathogens and Growth Inhibitory Microbes: C**oncept of plant disease; mode of entry of pathogens, diseasesymptoms, diagnosis and control; Algal, fungal, bacterial and viral diseases; Disease by mycoplasmas andnematodes; 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 HartelandD.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 Industrial Microbiology Credits: 2 Class: 30 hours

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 309 Applied Mycology **Credits: 2 Class: 30 hours**

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 andmycoses; 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 andtransportation 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**

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	**BiopharmaceuticalProducts:**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 aseptic area for processing sterile pharmaceuticals and quality testing laboratory; methods for sterilization and maintenance of aseptic conditions.	3
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

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 andEHEC), Campylobacter* spp. ,*Yersinia enterocolitica*, *Listeria monocytogenes,* viruses and parasites and food intoxication - by *Cl. botulinum,Bacilluscereus., Staphylococcus* spp.;Mycotoxins; Emerging food-borne diseases.	**8**
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 associatedpersistence andprobiotics.	**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 Laboratory Works **Credits: 8 Class: 165 hours**

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	**Industrial Microbiology** 1. Production of ethanol from molasses 2. Production of citric acid from molasses 3. Production of alpha-amylase from starch	15

	4. Production of biogas from domestic wastes 5. Production of acetic acid by *Acetobacteraceti*	
9	**Applied Mycology** 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** 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** 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**

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 313 Viva Voce **Credits: 2**

Courses for Fourth Year BS (Honours)

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

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**

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

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 - JinXiong – 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

MBG 404 Genetic Engineering **Credits: 2 Class: 30 hours**

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 ofplasmids; 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**

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:**	**8**

	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.	
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 engineeringfactors affecting process performance and economics; future development in industrialbiotechnological 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

Unit	Course Content	Class hours
1	**Advanced Microscopy:** The Electron microscopy: Principles and methods; Imageanalysis 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-gradientcentrifugation: rate zonal technique and isopycnic technique	**4**
3	**Electrophoresis Techniques:** Principle; Factors affecting electrophoresis; Types andMethods, Native, Gradient, SDS-PAGE, isotechophoresis; Isoelectric focusing and 2D gelelectrophoresis, Analysis of protein-protein interaction by gel electrophoresis, Co-immunoprecipitation, Mobility shift assay	**8**
4	**Protein Characterization:** Isolation and quantification of proteins, Preparation of wholecell extract, surface proteins, lipopolysaccharides, chemical and physical methods.Identification of amino acids, Primary structure, amino acids sequence of polypeptideChains; Biochemical, immunological and molecular characterization of proteins; Sequenceanalysis and report writing	**14**
5	**Chromatographic Techniques:** Principle of chromatography; definition,	**13**

	terminology,types of chromatography, Column, thin-layer and paper chromatography, Affinitychromatography: Principles, Tandem affinity chromatography; Exclusion/ gel filtrationchromatography: procedure and applications, Molecular imprinting, Ion exchangechromatography; Adsorption chromatography: hydroxylapatite and hydrophobicinteraction chromatography- salting-in and salting-out, Gas-liquid, high performance liquidchromatography, fast protein liquid chromatography	
6	**Spectroscopic Techniques:** Introduction, Light spectrum of electromagnetic radiation,Electronic spectra, Visible, ultraviolet and infrared spectrophotometers, Fluorescence andSpectrofluorimetry; it's applications, Luminescence and luminometry; it's applications;NMR and mass spectrometry; (MALDI-TOF) matrix-assisted laser desorption ionizationtime-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 ofradioisotopes	**3**
8	**Cell culture techniques:** Preparation and maintenance of cell culture, Primary cellcultures, 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

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 ofquality control management systems; Major problems and techniques of quality control; Improvement of quality control.	**5**
3	**MicrobiologicalQuality 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,	**3**

	enforcing agencies and their functions; Mandatory and voluntary guidelines.	

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

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 degradexenobiotic, 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 Fermentation Technology Credits: 2 Class: 30 hours

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

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 andR.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

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– byP.M.Tille.Weissfeld, Mosby, St. Louise
2. Textbook of Diagnostic Microbiology- byC.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 Laboratory Works and Short Research Project Credits: 8 Class: 165 hours

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),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	**15**
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.)	**15**

	5. Remediation of metal ions through microbes.	
9	**Fermentation Technology** 1. Demonstration of a typical fermentor 2. Demonstration of a fermentation 3. Production of cell mass 4. Production of industrial alcohol	**15**
10	**Epidemiology and Public Health** 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** 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	**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 413 Viva Voce **Credits: 2**

Course Offered by the Department of Microbiology for Other Departments

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

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 andeukaryotic 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. PelczerJr, E.C.S. Chan and N.R. Krieg; McGraw-Hill Book Company
3. Microbiology:Concepts and Applications–M.J. PelczerJr, 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

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