SYLLABUS FOR THE DEGREE OF BACHELOR OF SCIENCE (BSc) WITH HONOURS IN MICROBIOLOGY

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Ordinance for the degree of Bachelor of Science with Honours

The degree of Bachelor of Science with Honours (BSc Honours) in Microbiology will extend over four academic years with final examination after the end of each academic year. The final result will be based on the results of the four annual examinations.

Distribution of Marks and Credits

The programme of study for B. Sc. Honours degree in Microbiology will be completed by a student in not more than 6 (six) academic years. Students who will complete the full programme scoring a CGPA of 2.25 or above (equivalent to marks 45% or above) will be awarded BSc (Honours) degree. Other rules and regulations are as per ordinance, Faculty of Biological Sciences, University of Chittagong.

The program will be an integration of major and related courses carrying a total of 4000 marks. There will be major courses, of 2700 marks, related courses of 700 marks, sessional of 400 marks and viva-voce of 200 marks. Courses of 25, 50, 75 and 100 marks will carry 1, 2, 3 and 4 credits, respectively. 20% of the practical marks will be distributed as practical class performance, and other 80% on the basis of annual practical examination. There will be 29 major theoretical courses (2000 Marks; 80 credits), 9 related theoretical courses (500 Marks; 20 credits), 10 major practical courses (700 Marks; 28 credits), and 4 related practical courses (200 Marks; 8 credits).

Table. Distribution of marks and credits

Academic Year	Major Courses		Related Courses		Credits	Sessional and Viva-voce			Total Marks	Total Credits
	Theoretical	Practical	Theoretical	Practical		*Sessional	Viva-voce	Credits		
First	350	100	250	100	32	100	50	6	950	38
Second	350	100	250	100	32	100	50	6	950	38
Third	600	250	-	-	34	100	50	6	1000	40
Fourth	700	250	-	-	38	100	50	6	1100	44
Total	**2000**	**700**	**500**	**200**	**136**	**400**	**200**	**24**	**4000**	**160**

*__Sessional:__ Sessional will include slides and specimen collection, class attendance, tutorial examination, Field works, excursion, practical notebook, reports etc.

Class Attendance, Marks Allocated for Attendance and Eligibility for Examination.

In order to be eligible for appearing at examinations a candidate will attend not less than 70% of the lectures. The Academic Committee of the Department may recommend marginal cases of shortage of attendance (not below 60%) on special ground and documentary evidences. Under the benefit of this provision, the candidate will have to pay the requisite non-collegiate fee as prescribed by the University authorities. The course teachers will submit attendance register to the Chairman of the Department before processing the examination entry form. Distribution of marks for attendance in class will be as follows:

Attendance	Marks	Attendance	Marks	Attendance	Marks
96% and higher	10	81-85%	7	66-70%	4
91-95%	9	76-80%	6	60-65%	3
86-90%	8	71-75%	5	Less than 60%	0

Special English Course

Apart from the credit courses mentioned above, one English course of 100 marks must be taken in the 1st year of the programme. Points secured in this course in excess of 12.0 will be added in calculated CGPA.

Medium of Instruction and Examination

The medium of instruction and answer in the examination scripts will be in English.

Duration and Schedule of Examination

Examinations will be held at the end of each academic year as per academic calendar. The duration of Examinations will be followed as

Marks	Credits	Duration of Examination for theory Courses (Hours)	Duration of Examination for Practical Courses (Hours)
25	1	2	4
50	2	3	6
75	3	4	9
100	4	4	12

Grading System

Letter grading and grade points: Letter grades and corresponding grade points will be awarded as follows:

Range of Marks	Letter Grade	Grade Point
80 % and above	A+	4.00
75 % to less than 80%	A	3.75
70 % to less than 75%	A-	3.50
65 % to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55 % to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40 to less than 45 %	D	2.00
Less than 40%	F	0.00
Incomplete or Absent	X	X

Pass marks.

Course marks	**100**	**75**	**50**	**25**
Pass marks	40	30	20	10

GPA/CGPA Calculation

In the Academic Transcript/Grade sheet, only LG (letter grade), GP (grade points), PS (points secured) and finally GPA and CGPA, not the numerical marks, will be shown.

GPA Calculation: Computation of Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) are as follows: $\boldsymbol{GPA = \Sigma PS / \Sigma Cr}$

Where, PS means Point secured and Cr means credit offered in the year

For example: GPA calculation of one year

Course	Full Marks	OM	EC	LG	GP	Points
MBIO 101	50	38	2	A	3.75	7.50
MBIO 102	50	33	2	B^+	3.25	6.50
MBIO 103	50	29	2	B-	2.75	5.50
MBIO 104	50	28	2	B^-	2.75	5.50
Total	**200**	**–**	**8**	**–**	**–**	**25.00**

***OM=Obtained marks, EC = Earned credit, LG=Letter grade, GP=Grade point**

GPA = 25.00 / 8 = 3.125 = 3.13

CGPA calculation (as an example).

$$\textbf{CGPA} = \frac{\text{TPS (Sum of PS of 4 academic years)} + \text{PS of four years Sessional \& Viva} - \text{voce} + \text{Excess PS of English}}{\text{Total numbers of credits offered in the four years}}$$

Year	Total Points Secured	Total No. of Credits	CGPA
First	91.75	32	
Second	99.00	32	
Third	100.00	34	
Fourth	105.00	38	**471.75/160= 2.95**
Sessional	48.00	16	
Viva-voce	24.00	08	
Excess PS of English Course	04.00	00	
Total	**471.75**	**160**	

Promotion to Higher Class (From 1st Year to 4th Year)

A student is required to fulfil the following conditions for promotion to the next higher class:
A student must earn at least GPA 1.75 without sessional and viva-voce at his/ her respective examination of the year, failing which he/ she will be declared to have failed in the respective examination.
In such case, a student will be allowed to improve his/her GPA of the 1st/2nd/3rd year by appearing at the examination of the immediate next batch only.
At this stage, if he/she earns required GPA for promotion of the 1st/2nd/3rd year examination, but failed in any course/s, he /she will not be allowed to appear in the failed course/s to improve GPA under any consideration for the third time.
Promotion to 2nd/3rd /4th year after the respective examination will be given effect on the basis of the results published by the Controller of Examinations.

Viva-voce

A regular student must appear at the viva-voce of the 1st/2nd/3rd/4th year examination. At the end of each examination, the Examination Committee will hold a viva-voce. The viva-voce marks will not be taken into consideration for the determination of yearly GPA. All marks of 4 viva-voce examinations will be added up to determine LG, GP and PS and to calculate CGPA.

Sessional

A regular student must complete his/her sessional of the 1st, 2nd, 3rd, and 4th year. The sessional marks will not be taken into consideration for the determination of yearly GPA. All marks of 4 sessionals will be added up to determine LG, GP and PS and to calculate GPA
If a student fails to appear at his/her sessional of the 1st, 2nd, 3rd, and 4th year, s/he will be declared to have failed in the respective examination.

Improvement of Grade Points

A student carrying F grade in a course can improve the grade appearing at the examination of the immediate next batch,
Students earning C, D and F grade in any course in the 1st /2nd / and 3rd year may also choose to improve the grade by appearing at the annual final examination in the same course with the next batch. If such a student fails to improve his/ her grade(s), his/her previous grade in the same course will remain valid.
A student will be allowed to improve the grade of a course only once in a particular year.
No improvement will be allowed in English course, Practical courses, class tests/home assignment, Viva-voce, Sessional and Field works as well as in the course(s) in which student did not attend

classes or appear at examination.
For improvement of grade in a course, the student will apply to the Departmental Chairman at least 4 weeks before the start of the annual final examination.
The Departmental Chairman will have to prepare list(s) of candidates for the regular, irregular and improvement categories and send one copy of each to the office of the Controller of Examinations, after the last date of filling up of examination entry forms.

Failed Student

If a student fails to earn required GPA 1.75 in the 1^{st}, 2^{nd} and 3^{rd} year examination, he/she will not be promoted to the next higher class and he/she will be treated as failed student.
The failed student will be allowed to appear in the failed course/s with the batch immediate follows as an irregular candidate, failing which he/she will be dropped out of the program.
If a student fails to appear at the viva-voce of the $1^{st}/2^{nd}/3^{rd}$ year examination be treated as failed student.
If a student fails to pass or fails to appear at the examination twice in a particular year's course or more than twice in the entire program, he/she will be dropped out of the program.

Re-admission

If a student fails to appear at the 1^{st} / 2^{nd} / 3^{rd} / 4^{th} year examination due to shortage of required class attendance or any other reason, he/she will have to get himself or herself re-admitted an irregular student with the batch that immediately follows on recommendation of and within the date fixed by the academic committee of the Department. He/she must have to fulfill the requisite class attendance for appearing at the examination as an irregular candidate. Such benefit he/she will get once and if fails he/she will be dropped out of the program. If re-admitted student earns required GPA for promotion will not be allowed for appear fail courses to improve GPA under any consideration for third time.
Re admission in first year will not be allowed if the student fails to earn 30% class attendance.
A student may be allowed for re-admission not more than once in a particular year and not more than twice in the entire program.

Degree Requirements

For the degree of Bachelor of Science with Honours, a student will require to fulfill the following conditions:
A student must earn a minimum CGPA 2.25 and he/she must earn GPA 1.75 in 1^{st}, 2^{nd}, 3^{rd} and 4^{th} year examination separately, failing which he/she will be declared failed in the program.
A student must earn a minimum GP 2.00 in consolidated viva-voce, failing which he/she will be declared failed in the program.
A student must earn a minimum GP 2.00 in consolidated sessional, failing which he/she will be declared failed in the program.
A student who will score CGPA 4.00 will be awarded B.Sc. Hon's with Distinction and citation so made in the academic transcript.
After completion of four-year courses if a student score CGPA 2.00 to less than 2.25 will be awarded BSc (pass) degree and score CGPA less than 2.00 will be treated as failed.
To calculate CGPA no grades from any source other than that of the prescribed credits will be considered. A student will have to complete the programme in maximum of six consecutive academic years from the session of first admission in the program.

****Any change or modification of ordinance by legal authority will be included in due time.**

COURSES FOR THE FIRST YEAR BSc HONOURS

Courses	Credits
MBIO 101: General Microbiology	3
MBIO 102: Basic Techniques in Microbiology	3
MBIO 103: Microbial Ecology	3
MBIO 104: Biochemistry I	2
MBIO 105: Genetics I	2
MBIO 106: Physical Chemistry	2
MBIO 107: Mathematics and Calculus	2
MBIO 108: Organic Chemistry	2
MBIO 109: Phycology	2
MBIO 110: Mycology	3
MBIO 111: Microbiology Laboratory I	1
MBIO 112: Microbiology Laboratory Techniques	1
MBIO 113: Biochemistry Laboratory I	1
MBIO 114: Genetics Laboratory I	1
MBIO 115: Physical Chemistry Laboratory	1
MBIO 116: Organic Chemistry Laboratory	1
MBIO 117: Phycology Laboratory	1
MBIO 118: Mycology Laboratory	1
MBIO 119: Viva-voce	2
MBIO 120: Sessional	4
Total Credits	**38**

MBIO 101. General Microbiology (3 Credits)

Rationale. The course particularly aims to provide an understanding of the general knowledge of the major groups of microbes such as characteristics, classification identification and economic importance of bacteria, actinomycetes, fungi, algae, protozoa, nematodes and algae, and acellular living entities such as viruses and prions. It will be accomplished by Discussion oriented class lectures, Questioning and Class tests.

Objectives.

- Evolutionary trends of major groups of microorganisms.
- Acquire general knowledge of Bacteria, Actinomycetes, Fungi, Algae, Protozoa and Nematodes.
- Acquire general knowledge of acellular organisms such as viruses, viroids, prions etc.
- Acquire general knowledge on the economic importance of all the major cellular and acellular microbial groups.

Intended Learning Outcomes.

- Explain relationship and apply appropriate terminology relating to the evolution, characteristics and classification of major groups of prokaryotic and eukaryotic microorganisms.
- Acquire knowledge on the comparative characteristics of major microbial groups.
- Acquire knowledge of microbial techniques of obtaining economic products.
- Physical and chemical control microbes of different economically important products.

Lectures	Topics
1-5	**Introduction.** The science of Microbiology; Microbial Cells; Microorganisms and their Environments; Evolution and the Extent of Microbial Life; The Impact of Microorganisms on Humans; The Historical Roots of Microbiology: Hooke, Van Leeuwenhoek, and Cohn; Pasteur and the Defeat of Spontaneous Generation; Robert Koch, Infectious Disease, and Pure Culture Microbiology; The Rise of Microbial Diversity; The Modern Era of Microbiology.
6-10	**The Microbial World.** Basic concept of prokaryotic and eukaryotic organisms, Nomenclature and classification.
1-10	**Class Test 1**
11-12	**Viruses.** History, Classification, nomenclature, morphology, chemical composition, replication, economic importance.
13-14	**Viroids and Prions.** History, general characteristics, economic importance.
15-16	**Bacteria.** General characteristics, Classification, nomenclature, size, shape, structure and function, reproduction, nutrition, economic importance.
17-18	**Archaea.** General characteristics, Classification, nomenclature, size, shape, structure and function.
29-20	**Actinomycetes.** General characteristics, Classification and Economic importance.
11-20	**Class Test 2**
21-23	**Fungi.** General characteristics, Classification, nomenclature, growth and reproduction, nutrition, economic importance
24-25	**Algae.** General characteristics, Classification, nomenclature, growth and reproduction, nutrition, economic importance.
26-27	**Protozoa.** General characteristics, Classification, economic importance.
27-30	**Scope of Microbiology.** Food and Dairy, Soil and Agriculture, Medical, Industry, Health and Sanitation, Environment and Pollution control.
27-30	**Class Test 3**

Books Recommended.

- Brock Biology of Microorganisms. Michael T Madigan, 13th edition.
- Microbiology – M. J Pelczar, K Jr. E. C. S. Chan and N. R Krieg
- Microbiology an Introduction – G. J Tortora *et al.*
- Fundamental principles of Bacteriology – A. J Salle

MBIO 102. Basic Techniques in Microbiology (3 Credits)

Rationale. This course is interested in developing laboratory skills in microbiology. It includes preparing stained smears, culturing microorganisms, and studying microbial growth control methods.

Objectives of the Course.

- Demonstrate safe practices in a microbiology laboratory.
- Demonstrate proper usage, identify the parts/functions of microscopes
- Demonstrate proficiency and use of the following in the laboratory: streak plate isolation technique; bacterial staining techniques; wet mounts; and proper culture handling.

Intended Learning Outcomes.

- Explain what unique characteristics of microorganisms make them challenging subjects for study.
- Briefly outline the processes and purposes of different types of procedures that are used in handling, maintaining, and studying microorganisms.
- Explain the importance of media for culturing microbes in the laboratory.
- Analyze chemically defined and complex media, describing their basic differences and content.

Lectures	Topics
1-4	**Microbiology Laboratory and Safety.** Aims of laboratory investigations, experimental design, Safety guidelines, Risk Assessment, Good microbiological laboratory practice (GMLP), Waste management, Aerosol Management, Introduction to common microbiological laboratory equipment, apparatus, and materials.
5-10	**Microscopy.** Principles, functions, handlings and applications of various types of microscopy including bright field, dark field, phase contrast, fluorescent microscope and differential-interference-contrast microscope, confocal microscopy, TEM, and SEM; Limitations of microscopy; Magnification, resolution, and staining.
11-14	**Culture media.** Culture media, types and applications; Preparation, sterilization, storage and dispensation of culture media for cultivating bacteria, actinomycetes, fungi, algae, viruses, protozoa, and eukaryotic cells.

Lectures	Topics
15-22	**Sterilization and Aseptic Techniques.** Antiseptic and disinfectant; Methods of sterilization; Sterilization *vs* Disinfection; Sterilization of equipment and materials; Choice, preparation, and use of disinfectants; Aseptic techniques- inoculation and other aseptic techniques.
1-22	**Class Test 1**
23-28	**Methods for maintaining, preparing, and using cultures.** Cultivation of aerobic and anaerobic microorganisms in laboratory; Obtaining pure culture: methods, maintaining stock cultures, culture transfer, checking cultures for contamination, preventing contamination of cultures and the environment.
29-36	**Growth and enumeration of microorganisms.** Growth and growth curve; Microbial enumeration techniques: Direct microscopic count, Standard plate pount, Most probable Number (MPN) and Turbidimetric method; Indirect methods for measuring microbial growth.
37-40	**Staining of microorganisms.** Chemical properties of stains, mechanism of staining, and preparation of samples for microscopic observation, techniques of various type of staining.
23-40	**Class Test 2**
41-44	**Microbial Identification.** Identification of microorganisms by microscopic, cultural, biochemical, serological and molecular techniques.
45-50	**Microbial growth control.** Techniques of microbial control by physical and chemical means.
51-54	**Culture preservation.** Aim and principles of culture preservation, short and long-term preservation and management of microbial cultures by various techniques.
41-54	**Class Test 3**

Books Recommended.

- Principles and Techniques of Biochemistry and Molecular Biology- Keith Wilson and John Walker, 7th edition, Cambridge University Press, 2010
- Microbiology- M. J. Pelczar, E. C. S. Chan and Noel R. krieg
- Microbiology an introduction – Tortora, Funkeand Case
- Methods in Microbiology – Norris and Ribbon.
- Brock Biology of Microorganisms-M.T. Madigan, J.M.Martinko and J. Parke

MBIO 103. Microbial Ecology (3 Credits)

Rationale. Understanding microbial ecology is essential for better management of global ecological systems.

Objectives of the Course. Understand the diversity and role of microorganisms in various environments.

Intended Learning Outcomes. Understand interaction between pollutants, the environment, people and the role of microorganisms play in these interactions.

Lectures	Topics
1-10	**Ecology and Evolutions.** The Scope of microbial ecology; Historical overview; Relations of microbial ecology to general ecology and environmental sciences; The origin of life
1-10	**Class Test 1**
11-15	**Populations Interactions.** Interactions Among Microbial Populations: Interactions within a single microbial populations-positive and negative interactions; Interactions between diverse microbial populations: Neutralism, Commensalism, Synergism, Mutualism, Amensalism, Parasitism, Predation, Competition.
16-20	**Microbial Communities and Ecosystem.** Microbial community dynamics-Succession within microbial communities; Structure of microbial communities, Ecosystem, Microbial communities in nature.
11-20	**Class Test 2**
21-30	**Physiological Ecology of Microorganisms.** Abiotic limitations to microbial growth Liebig's law of minimum, Shelford's law of tolerance; Environmental determinants - Temperature, radiation, pressure, salinity, water activity, movement, hydrogen ion concentration, redox potential, magnetic force, organic compounds and inorganic compounds.
31-40	**Microorganism in their natural habitats.** Atmo-ecosphere, Hydro-ecosphere**,** Litho-ecosphere**,** Extreme habitats- hot spring, salt lakes and acid springs.
21-40	**Class Test 3**

Books Recommended.

- Microbial Ecology: Fundamentals and applications. R.M. Atlas and R. Bartha. 4th edition.
- Microbial Ecology: a conceptual approach – J. M. Lynch and N.J. Poole
- Microbiology: Fundamentals and applications, 2nd edition– R. M. Atlas.

MBIO 104. Biochemistry I (2 Credits)

Rationale. The course will provide a foundational level of understanding of the biomolecules and biochemical mechanisms of cell function.

Objectives of the Course.

- Understand biomolecules, including small, large and super-molecular components found in cells with their structure, essential chemical characteristics and functions.
- Explain basic energy metabolism of cells and gain knowledge about common reaction mechanisms in biochemical processes

Intended Learning Outcomes.

- Demonstrate knowledge and understanding of the molecular machinery of living cells
- Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition
- Comprehend the role biochemistry in the practice of medicine and medical research.

Lectures	Topics
1-5	**The Foundations of Biochemistry.** Cellular, chemical, physical, genetic and evolutionary Foundations.
6-10	**Water.** Weak interactions in aqueous systems; Ionization of water, Weak acids and bases; Buffering against pH changes in biological systems.
11-18	**Protein.** Amino acids, peptides and proteins; Working with proteins; Structure of proteins; Protein functions.
1-18	**Class Test 1**
19-25	**Carbohydrates and Glycobiology.** Monosaccharides, disaccharides and polysaccharides; Glycoconjugates; Carbohydrates as informational molecules.
26-30	**Lipids.** Lipid classification; Storage lipids; Structural lipids in membranes.
19-30	**Class Test 2**
31-33	**DNA, RNA and the flow of information.** Nucleic acids; Structures of DNA and RNA.
34-45	**Bioenergetics and Metabolism.** Bioenergetics and thermodynamics; Common biochemical reactions; Glycolysis and gluconeogenesis, and Pentose-Phosphate pathway; Citric acid cycle.
31-45	**Class Test 3**

Books Recommended.

- Lehninger Principles of Biochemistry, 6th edition – David L. Nelson and Michael M. Cox
- Biochemistry, 7th edition – Jeremy M Berg, John L. Tymoczko and LubertStryer
- Fundamentals of Biochemistry, 4th edition – Donald Voet and Judith G Voet

MBIO 105. Genetics I (2 Credits)

Rationale. This course provides an understanding of concepts that are essential to modern biologists. A working knowledge of genetics is important in disciplines ranging from ecology to medicine. This course focuses on genetics in the following branches: Mendelian (classical or transmission) genetics, molecular genetics, and sex-linked inheritance. We begin with Genetics - Iin order to introduce basic concepts and the history of genetics. This knowledge makes the discussion of molecular genetics more relevant and meaningful. We will then discuss the details of molecular genetics and related techniques.

Objectives of the Course.

- Gain an understanding of Mendelian genetics
- Become familiar with molecular genetics
- Understand sex-linked inheritance
- Accumulate concepts on prokaryotic, eukaryotic and viral genetic system

Intended Learning Outcomes.

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

- understand the language and basic concepts of genetics, providing a conceptual framework for future reference
- To understand how traits are inherited and to use this understanding in analyses
- To understand how genetic problems may lead to disease or lethality
- To understand the molecular basis of genetics
- To understand the sex determination and sex-linked inheritance
- To understand the linkage, recombination, and eukaryotic gene mapping
- To understand prokaryotic, eukaryotic and viral genetic system
- To understand variation in chromosome number and structure

Lectures	Topics
1-6	**Introduction to Genetics.** Historical development and great milestones in genetics; Different levels of genetic analysis; Model genetic organisms; Applications of genetics to human endeavors.
7-10	**Chromosome and Cellular Reproduction.** Chromosome with its basic structure and classification; Basic cell types; The cell cycle and control of cell cycle; Mitosis and meiosis.
11-18	**Mendelism, The Basic Principles of Inheritance.** Mendel's experimental organisms; Monohybrid crosses; Dihybrid crosses; The Chromosome Theory of Heredity; The chromosomal basis of Mendel's principles of segregation and independent assortment; Applications of Mendel's principles; Testing genetic hypotheses; Mendelian principles in human genetics; Test cross, and Back cross.

Lectures	Topics
1-18	**Class Test 1**
19-24	**Extensions of Mendelism.** Allelic variations and gene functions; Influence of the environment on gene action; Environmental effects on the expression of human genes; Penetrance and expressivity; Gene interactions and Epistasis; codominance and incomplete dominance; Pleiotropy.
25-30	**Sex Determination and Sex-Linked Inheritance.** Sex determination in Drosophila, humans, and other animals (birds, nematode etc.); Environmental sex determination systems; Sex linked characteristics- X lined, Y linked, and Z linked; Hemophilia- an x linked blood-clotting disorder; color blindness- an x-linked vision disorder; Genes on the human Y chromosome.
31-36	**Variation in Chromosome Number and Structure.** Chromosome rearrangements and chromosomal aberrations; Aneuploidy and Polyploidy.
37-40	**Linkage, Recombination, and Eukaryotic Gene Mapping.** Linkage and recombination between two genes, linkage and recombination between three genes; Physical chromosome mapping- deletion mapping, somatic-cell hybridization, *in situ* hybridization, mapping by DNA sequencing.
19-40	**Class Test 2**
41-45	**Bacterial and Viral Genetic System.** The genetics of viruses- Bacteriophage T4 and Lambda, Lytic and lysogenic cycles; Genetics of prions; Genetics of bacteria- Unidirectional gene transfer and genetic recombinations, gene mapping using conjugation data and plasmid.
46-50	**The Chemical Nature of Gene.** Characteristics of genetic material; Molecular basis of heredity; Proofs that genetic information is stored in DNA; RNA stores the genetic information in some viruses.
51-54	**Packaging of DNA into chromosome.** The bacterial chromosome; Eukaryotic chromosome; centromere and telomere.
41-54	**Class Test 3**

Books Recommended.

- Principles of Genetics. D. Peter Snustad and Michael J. Simmons, 4th Edition, John Wiley and Sons, Inc., USA. 2006.
- Genetics: A Conceptual Approach, Benjamin A. Pierce, 2nd Edition, W. H. Freeman and Company, NY, USA
- Fundamentals of Genetics, B. D. Singh. Kalyani Publisher, New Delhi, India. 2001.

MBIO 106. Physical Chemistry (2 Credits)

Rationale. This course presents an introduction to quantum mechanics and basic principles of physical chemistry.

Objectives of the Course. The course covers key concepts in physical chemistry to understand chemistry, biology and related subjects

Intended Learning Outcomes.

- Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will appreciate the central role of physical chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

Lectures	Topics
1-14	**Behavior of Gases**: Kinetic theory of gases, ideal gas laws, real gases, solubility of gases in liquids, Henry's law and its application.
1-14	**Class Test 1**
15-25	**Properties of Aqueous Solutions**: Vapor pressure, Osmosis, Solubility, Solutions of electrolytes, Solubility product, common ion effect
15-25	**Class Test 2**
26-30	**Acids, bases and buffers**: Acids, basses and buffers in aqueous solutions, pH, acids and bases, titration of an acid with a base buffer mixture and their buffer capacity, Acid-base indicators, pH of dilute aqueous solutions of salts, measurement of pH, dissociation of polyprotic weak acids.
26-30	**Class Test 3**

Books Recommended

- A Text Book of Physical Chemistry – K.K Sharma et al.
- Practical Physical Chemistry – S. findlay.
- Physical Chemistry – Bahl and Tuli.
- A Text Book of Physical Chemistry – S. Glasstone.
- Application of Physical Chemistry for biological systems – R. Chang.

MBIO 107. Mathematics and Calculus (2 Credits)

Rationale. This course is a continuation of topics from Intermediate Algebra.

Objectives of the Course.

- Review the number sets, exponents, and simplifying mathematical expressions.
- Demonstrate proficiency in solving one-variable linear and quadratic equations, graphing linear and quadratic functions.
- Demonstrate proficiency in matrix operations, properties, determinants and their application in solving systems of equations.
- Demonstrate familiarity with the introductory aspects of sequences and series. (optional)
- Demonstrate familiarity with the introductory aspects of combinatorics and probability theory, and mathematical induction. (optional)

Intended Learning Outcomes.

Students will demonstrate skill communicating quantitative information and reasoning effectively for courses in their majors

Lectures	Topics
1-8	Matrices, Matrix operations and linear systems of Equations: Rank of a Matrix. Consistency of a linear system of Equations, Matrix inversion method, Crammer's method. Determinants up to 4^{th} order. Series and power functions, logarithmic series. Functions of a single variable and its domain and ranges. Graphical representation of standard functions.
1-8	**Class Test 1**
9-16	Techniques of finding derivatives of functions of single variable. Geometrical interpretation of derivatives. Successive differentiations, Leibnitz's theorem.
17-24	Integration of functions of a single variable. Techniques of integration by standard formula, method of substitution, Integration by parts, integration of special functions, integrations of trigonometric functions.
9-24	**Class Test 2**
25-30	Definite integrals. Properties of definite integrals. Idea and uses of Beta and Gamma Functions.
25-30	**Class Test 3**

Books Recommended.

- Mohammad and Bhattacharjee: Differential and integral calculus.
- Das and Mukheriee: Differential calculus.
- Das and Mukheriee: Integral calculus.
- Shahidullah and Battacharjee – A Text Book on higher algebra.
- Bernard and Child – Higher algebra.

MBIO 108. Organic Chemistry (2 Credits)

Rationale. This course provides good background for students in life and environmental sciences

Objectives of the Course.

The objective of this course is to give the student a broad understanding of introductory organic chemistry at a fundamental level and an appreciation of its relevance to biology. The foundation will be laid with key concepts of molecular structure and bonding. The chemistry of hydrocarbons will be surveyed and functional groups defining classes of organic compounds will be introduced. Fundamentals of stereochemistry, the 3-dimensional shapes of molecules, and relevance to biological applications will be discussed

Intended Learning Outcomes.

- Know and recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism.
- Recognize the basic practical skills for the synthesis and analysis of organic compounds
- Be able to predict the reactivity of an organic compound from its structure.
- Develop basic skills for the multi-step synthesis of organic compounds.

Lectures	Topics
1-2	**Introduction.** A brief introduction of atomic structure and electronic configuration.
3-5	**Chemical Bonding.** *Ionic Bond:* Electronegativity, dipole moment. Covalent Bond: Potential curve, LCAO method, diatomic molecules and hybridization. *Weak Bonds:* Hydrogen bond and hydrophobic interaction (brief treatment), *Metal Bond:* Transition metal complexes, examples of different bond types in biomolecules.
6-7	**Introduction to Stereochemistry.** Enantiomers, plane polarized light and optical activity, configuration.
1-7	**Class Test 1**
8-10	**Alkanes.** Occurrence, structure, nomenclature, synthesis, Physical and chemical properties.
11-13	**Alkyl Halide.** Nucleophilic substitution reactions, Grignard reagents and other organometallic compounds.
14-17	**Alkenes and alkynes.** Occurrence, structure, nomenclature, synthesis, physical and chemical properties.
8-17	**Class Test 2**
18-21	**Alcohols, Ethers, Epoxides and Diols.** Occurrence nomenclature, structure, synthesis, Physical and chemical properties and use.
22-24	**Aromaticity.** Structure of benzenes, sources of aromatic hydrocarbons, industrially important compounds, nomenclature of benzene derivatives, electrophilic aromatic substitution.

Lectures	Topics
25-27	**Aldehydes and Ketones.** Nomenclature, synthesis nucleophilic addition, reaction, addition, elimination reaction, oxidation-reduction of carbonyl compounds, haloform reaction, enolisation-halo carbonyl compounds, aldol condensation, benzoin condensation.
28-30	**Carboxylic acids and their derivatives.** Nomenclature, synthesis, properties and reactions, decarboxylation reactions, decarboxylic acids, esters.
31-33	**Nitro-compounds and Amines.** Occurrence, nomenclature, synthesis, classification, properties, reactions, use, diazotisation and diazonium compounds.
34-36	**Phenols.** Occurrence, nomenclature, synthesis and reactions; polyhydric phenols.
21-36	**Class Test 3**

Books Recommended.

- Organic Chemistry – Morison and Boyd.
- Advanced Organic Chemistry – B. S. Bahl and Arun Bahl.

MBIO 109. Phycology (2 Credits)

Rationale. Phycology includes the study of prokaryotic forms known as blue-green algae or cyanobacteria and eukaryotic algae like Chlorophyceae, Rhodophyceae Bacillariophyceae group. A number of microscopic algae also occur as symbionts in lichens.

Objectives of the Course. The aim of the course is to point out the multiple significance of algae and possibilities of exploiting them by people in different areas of life (environmental, industry, food and aquaculture). Students will be able to gain basic knowledge about the application of algae in various fields, as well as mastery of basic skills, methods and techniques of applied algology.

Intended Learning Outcomes. Learn methods for sampling, identification and characterization of algae, the algal culture methods and the application of algae to assess environmental problems.

Lectures	Topics
1-4	History, Definition, General Characteristics; Economic importance of algae, Habitat, Classification and evolutionary trends in algae.
5-12	Pigments, Chloroplasts, Pyrenoids, Eye spot, Reproduction of algae, Algal perennation, Range of vegetative and reproductive structure, Life cycle pattern.
1-12	**Class Test 1**
13-20	Laboratory culture and staining, Factors determining the distribution of fresh and marine algae, General characteristics, reproduction and economic importance of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Rhodophyceae.
13-20	**Class Test 2**
21-40	Cyanophyceae- *Nostoc, Oscillatoria*, Chlorophyceae- *Volvox, Oedogonium, Vaucheria, Chara*, Phaeophyceae- *Sargassum*, Xanthophyceae-*Botrydium,* Rhodophyceae-*Polysiphonia.*
21-40	**Class Test 3**

Books Recommended.

- Text book of Algae – B.R Vashista.
- Algae – G.L Chopra.
- Algae – B.P Pandey.
- Text Book of Algae – O.P Sharma.
- Text Book of Algae – N.D. Kamath
- The structure and reproduction of the Algae – Fritsch F.E.

MBIO 110. Mycology (3 Credits)

Rationale. The fungi constitute a very large group of organisms found in virtually every ecological niche. Considering the importance of fungi, this course is designed to introduce students to fungi and impart knowledge on fungal characteristics, classification, economic importance, nutrition and metabolism, different classes and corresponding representative genus.

Objectives of the Course. To gain an appreciation of general mycology such as knowledge on morphology and identification and life cycle of different fungi.

Intended Learning Outcomes.

- Discuss the characteristics of the major classes and orders within the fungal kingdom
- Discuss the importance of fungi from various ecological perspectives

Lectures	Topics
1-2	**Brief History of Mycology**
3-18	**An Overview of Fungi.** Characteristics, distribution, evolutionary trends, nomenclature and systematics, classification, reproduction, modes of nutrition, mycelial modification (fruit bodies) and economic importance of fungi; Fungal cell walls and hyphal tip growth; fungal organelles; Nutrition and metabolism of fungi.
1-18	**Class Test 1**
19-32	**Detailed study of the Genus under following classes.** Chytridiomycetes: *Synchytrium*; Oomycetes: *Saprolegnia, Phythophthora, Pythium*; Zygomycetes: *Rhizopus, Mucor*; Ascomycetes: *Saccharomyces, Aspergillus*; Basidiomycetes: *Agaricus, Erysiphae, Ustillago*.
19-32	**Class Test 2**
33-34	**General discussion on the Form Class.** Deuteromycetes with its importance.
35-38	**Industrial Uses of Fungi.** *Mucor, Aspergillus, Penicillium,* Yeast etc.
39-42	**Fungi in Human Diseases.** *Epidermophyton, Trichophyton, Microsporum, Candida, Aspergillus.*
33-42	**Class Test 3**

Book recommend

- Introductory Mycology – C. J. Alexopolous and C. W Mims.
- Introduction to Fungi – J. Webster.
- A Text of Fungi – H. C Dube
- Fungi – L. C. Hawker
- Introduction to Fungi – J. E. Smith

MBIO 111. Microbiology Laboratory I (1 Credits)

Rationale. This is a laboratory course intended to provide the student with a broad background in microbiology laboratory practice and theory. The course will cover major laboratory methods including microscopy, evaluation of microbial metabolism, microbial growth and death, environmental microbiology, water and food microbiology, medical and industrial microbiology

Objectives of the Course

- Provide students with an understanding of important facts, concepts, and the investigative procedures of a microbiology laboratory.
- Train students in the proper use and maintenance of the research grade laboratory microscope with emphasis on oil immersion methods.

- Train students in aseptic technique, prophylaxis, and the proper methods relating to the safe manipulation and maintenance of microorganism.
- Train students in fundamental laboratory methodology to include the use of differential media, metabolic/enzymatic testing and associated reagents.
- Provide students with a hands-on familiarity with basic research procedure and associated critical and investigative thinking skills utilizing identification of unknown microorganisms.
- Provide students with an understanding of medically relevant (pathogenic and non-pathogenic) microorganisms.
- Become proficient in laboratory skills and safety protocols. •
- Apply the scientific method: formulate testable questions/hypotheses, predict expected results, make careful observations, collect and analyze/interpret data, and draw appropriate conclusions.
- Begin to gain proficiency in scientific writing (laboratory reports and notebook entries)
- Embark in active learning opportunities in the laboratory.
- Demonstrate good lab citizenry and the ability to work with others.

Intended Learning Outcomes

- Compare and distinguish the basic groups of microbes, including prokaryotic microbes (Archaea, Bacteria), and Viruses, and eukaryotic microbes.
- Understand the processes needed for one bacterium to become two, and understand the mechanisms involved.
- Compare and contrast major pathways of catabolism, specify the relative energy yield from each pathway, list the key products of each pathway, and describe biochemical pathways used for microbial taxonomy.
- Compare and contrast major pathways of biosynthesis and list the key products of each pathway.
- Draw a typical microbial growth curve, and predict the effect of different environmental conditions on the curve.
- Compare and contrast eukaryotic and prokaryotic genomes, and gene expression in each group.
- Compare and contrast the acquisition of novel genetic information in microbes via mutations and genetic exchange, specifically conjugation, transformation and transduction
- Specify the role of microbes in global C, N, S, and P cycles, and list examples of microbes that contribute to key metabolic aspects of these cycles.
- List different types of symbiotic interactions between microbes and other organisms, including commensalism, mutualism, and parasitism, and provide examples of each.
- Summarize common features of microbial pathogens, with emphasis on bacterial and viral pathogens.
- Summarize mechanisms of animal defenses to infection, including primary defenses, innate immunity, and acquired immunity.

Topics

1) **Introduction.** Safety guidelines, Risk assessment, Spillage management, Aerosols; Good Microbiological Laboratory Practice (GMLP); Introduction to Laboratory Resources- Equipment, Apparatus and Material
2) **Fundamental Skills for the Microbiology Laboratory.** Aseptic Transfers and Inoculation Methods: Transfer from A Broth Culture to Sterile Broth; Transfer from Agar Slant Culture to Sterile Agar Slant; Transfers from Plate culture to sterile Broth.
3) **Streak Plate Methods of Isolation.** Inoculation of Agar Plates Using the Quadrant streak Method; Zigzag inoculation of Agar Plates Using a cotton swab or Loop; Inoculation of Agar Plates with a cotton swab in Preparation for a Quadrant streak Plate
4) **Spread Plate Methods of Isolation**
5) **Microbial Growth.** Study of Diversity and Ubiquity of Microorganisms; Colony Morphology; Growth Patterns on Slant; Growth Patterns on Broth
6) Study of Aerotolerance
7) Cultivation of Anaerobes
8) The Effect of Temperature, pH, Osmotic Pressure on Microbial Growth
9) Microscopy and Staining
10) Introduction to the Light Microscope; Calibration of the Ocular Micrometer
11) Determination of size and shape of microorganisms
12) Bacterial Structure and Simple Stains: Simple Staining; Negative Staining
13) Differential and Structural Stains: Gram Staining; Acid-Fast Staining; Capsule Staining; Endospore Staining; Flagella Staining
14) The Hanging Drop Slide and Bacterial Motility

MBIO 112. Microbiology Laboratory Techniques (1 Credit)

Rationale

This is a laboratory course intended to provide the student with a broad background in microbiology laboratory practice and theory. The course will cover major laboratory methods including microscopy, evaluation of microbial metabolism, microbial growth and death, environmental microbiology, water and food microbiology, medical and industrial microbiology

Objectives of the Course

- Provide students with an understanding of important facts, concepts, and the investigative procedures of a microbiology laboratory.
- Train students in the proper use and maintenance of the research grade laboratory

microscope with emphasis on oil immersion methods.

- Train students in aseptic technique, prophylaxis, and the proper methods relating to the safe manipulation and maintenance of microorganism.
- Train students in fundamental laboratory methodology to include the use of differential media, metabolic/enzymatic testing and associated reagents.
- Provide students with a hands-on familiarity with basic research procedure and associated critical and investigative thinking skills utilizing identification of unknown microorganismal specimens.
- Provide students with an understanding of medically relevant (pathogenic and non-pathogenic) microorganisms.
- Become proficient in laboratory skills and safety protocols. •
- Learn to follow experimental procedures.
- Apply the scientific method: formulate testable questions/hypotheses, predict expected results, make careful observations, collect and analyze/interpret data, and draw appropriate conclusions.
- Begin to gain proficiency in scientific writing (laboratory reports and notebook entries)
- Embark in active learning opportunities in the laboratory.
- Demonstrate good lab citizenry and the ability to work with others.

Intended Learning Outcomes

- Compare and distinguish the basic groups of microbes, including prokaryotic microbes (Archaea, Bacteria), and Viruses, and eukaryotic microbes.
- Understand the processes needed for one bacterium to become two, and understand the mechanisms involved.
- Compare and contrast major pathways of catabolism, specify the relative energy yield from each pathway, list the key products of each pathway, and describe biochemical pathways used for microbial taxonomy.
- Compare and contrast major pathways of biosynthesis and list the key products of each pathway.
- Draw a typical microbial growth curve, and predict the effect of different environmental conditions on the curve.
- Compare and contrast eukaryotic and prokaryotic genomes, and gene expression in each group.
- Compare and contrast the acquisition of novel genetic information in microbes via mutations and genetic exchange, specifically conjugation, transformation and transduction
- Specify the role of microbes in global C, N, S, and P cycles, and list examples of microbes that contribute to key metabolic aspects of these cycles.
- List different types of symbiotic interactions between microbes and other organisms, including commensalism, mutualism, and parasitism, and provide examples of each.
- Summarize common features of microbial pathogens, with emphasis on bacterial and viral pathogens.
- Summarize mechanisms of animal defenses to infection, including primary defenses, innate immunity, and acquired immunity.
- Compare and contrast beneficial and harmful uses of organisms, including applications in biotechnology and bioterrorism.

- Have a solid grasp of the scope of the microbial world and its role in shaping this planet and all its inhabitants
- Demonstrate a good knowledge base in biological concepts and be able to integrate knowledge with critical thinking skills to become problem solvers.

Topics

Culture Media, Sterilization and Disinfectants

1. Study of Culture Media, Sterilization and Disinfectants
   i. Culture Media Preparation
   ii. Storage of Media
   iii. Sterilization vs. disinfection
   iv. Use of Autoclave
   v. Sterilization of Equipment and Materials
2. Evaluation of Alcohol: Its Effectiveness as a Skin Degerming Agent
3. Evaluation of Antiseptics: The Filter Paper Disk Method
4. Study of Different Types of Selective Media

Bacterial Population Counts

5. Study of Standard Plate Count/Total Viable Count (TVC)
6. Study of Turbidimetric Methods
7. Direct Enumeration of Bacteria
8. Enumeration of coliform and fecal coliform by most probable number (MPN) method

Microbial Interactions

9. Demonstration of Bacterial Commensalism, Synergism, Antagonism

MBIO 113. Biochemistry Laboratory I (1 Credit)

Rationale

This course will introduce some of the experimental techniques and concepts used in biochemistry.

Objectives of the Course

The primary objective of this course is for students to (1) learn fundamental approaches for experimentally investigating biochemical problems, (2) learn the theoretical foundations for the methods used, and (3) understand the applicability of the biochemical methods to realistic situations.

Intended Learning Outcomes

- Explain the chemical nature of proteins
- Describe/recognize the structure of mono-, di-, and polysaccharides, describe their physical and chemical properties and their function in living organisms.
- Predict the products of chemical reactions of carbohydrates.
- Describe what happens during carbohydrate digestion, glycolysis, glycogenesis, and glycogenolysis.
- Perform laboratory experiments related to the above course learning objectives, record observations, gather and analyze data, and present the results in written form.

Topics

1. Measurement of pH of biological liquids with pH-meter (ion meter).
2. Measurement of pH of biological liquids with universal indicator paper
3. The analysis of chromatograms of protein hydrolysates.
4. Biuretic reaction for detection of peptide bond
5. Dialysis of proteins
6. Detection of the isoelectric point of casein
7. Ways if irreversible precipitation of protein from solutions
8. Quantitative determination of glucose in blood by a glucose-oxidase method.
9. Qualitative Analysis of Carbohydrate
10. Qualitative Analysis of Protein
11. Qualitative Analysis of Lipid

MBIO 114. Genetics Laboratory I (1 Credit)

Rationale. Although the principle concepts of genetics have been known for only 100 years, genetic selection has been conducted for many centuries on domesticated animals (i.e. dogs) and food crops (i.e. corn). The field of genetic research, although still in its infancy, represents a fundamental aspect of human biology. While recent advances in genetic research have provided a greater ability to diagnosis and treat various human abnormalities, such as cancer, they have also produced many ethical and political considerations, which are still hotly debated and remain unresolved.

Objectives of the Course.

This class will provide you with an understanding of the principles and concepts of genetics. Specific objectives of this course are to provide an understanding and discuss ramifications of: 1) Inherence, 2) Gene Structure, 3) Gene Function, 4) Gene Mutation, and 5) Ethical issues related to genetic research and its applications.

Intended Learning Outcomes.

- Explain the processes of DNA replication, transcription, and translation, including the role of RNA.
- Explain concepts and technologies that are appropriate to the corpus of knowledge expected of a biochemistry graduate
- Think clearly, with a sound knowledge of the issues surrounding the central role of biochemistry in all aspects life science.
- utilise your skills to discover information for yourself and critically analyse, review and evaluate this in the light of your subject knowledge.
- work safely in the laboratory and utilise a range of analytical techniques that are directly related to the needs of your future workplace role.
- undertake independent study in an aspect of biochemistry utilising a range of appropriate information resources and investigative tools.

Topics

1. Isolation of Pure Culture by Streak Plate Method Using Toothpick
2. Picking and Patching of Bacterial Colonies
3. Mutant Isolation by Replica Plating
4. Study of a model genetic organism (*Drosophila*/ *C. elegans*/ *Arabidopsis thaliana*/ *Mus musculus*
5. Scoring of phenotypes and computation of Mendelian ratios by running Chi-square test
6. Pedigree analysis
7. Study of mitosis cell division in onion root tip or flower bud

MBIO 115. Physical Chemistry Laboratory (1 Credit)

Rationale

Physical chemistry can be defined as the application of physics to chemistry. The physics explains the world around us by building various models. The models such as kinetic theory of gases, collision theory of reactions etc. are purely classical-based. In contrast, for subatomic world, one needs to go beyond classical world and invoke the laws of quantum mechanics to describe small particles like electron. The general goal of learning physical chemistry is to obtain an in-depth understanding of why and how chemical reactions occur, which in turn may enable us to accurately design reactions leading to novel molecules of the future.

Objectives of the Course

- Fundamental concepts and practical usage of instrumentation for spectroscopic, chromatographic, electrochemical, and mass-spectrometric analysis.
- Calibration/quantitation procedures for analysis of a variety of materials.

Intended Learning Outcomes

- Define the concepts of calories and specific heat
- Be able to quantify the ideas (not overshadowed by mathematics) about the behavior of molecules and systems in order to be able to cope with experimental control.
- Be able to distinguish the usefulness of mathematics in Physical Chemistry and be inspired by the charm of their application.

Topics

1. Good Laboratory Practice (GLP)
2. Common laboratory glassware and apparatus
3. Study of the use of analytical balance
4. Preparation of different types of solution:
    i. Molar solution
    ii. Molal solution
    iii. Normal solution
    iv. Percent solution
5. Concentration conversion of acid and bases (percent to molar or normal and vice versa)
6. Measurement of pH by using pH meter
7. Determination of strength of acid and bases by titration
8. Heat Associated with Chemical Change
9. Chemistry of Antifreeze: Density and Freezing Point
10. Boiling-Point Elevation by Dissolved Substances
11. Factors Affecting Freezing-Point Depression in Water.
12. Molar Heats of Reaction for Hydrochloric Acid (HCl) and Sodium Hydroxide (NaOH).
13. Charles' Law
14. Boyle's Law

MBIO 116. Organic Chemistry Laboratory (1 Credit)

Rationale. This course introduces the student to basic techniques and procedures in isolation, purification, and characterization of organic compounds and simple reactions used in the organic chemistry laboratory.

Objectives of the Course

- Conduct organic chemistry experiments using proper safety procedures, recognizing and responding appropriately to potentially hazardous situations, and recognizing the necessity of safe laboratory
- communicate information gathered from the laboratory manual and other sources of literature pertaining to the experiments being performed

Intended Learning Outcomes

- Apply knowledge obtained in Organic Chemistry lecture to problem solving and critical thinking in the laboratory.
- Predict the outcome of several common organic reaction types through a basic understanding of starting materials, functional groups, mechanism, and typical reaction conditions.
- The general outcome goals are that students will understand the classification, structure, nomenclature, reactions, reaction mechanisms, and synthesis of carbon compounds including halocarbons, alkenes, and alcohols.

Topics

1. Introduction and Review
2. Structure and Properties of Organic Molecules
3. Structure and Stereochemistry of Alkanes
4. The Study of Chemical Reactions
5. Stereochemistry
6. Alkyl Halides: Nucleophilic Substitution and Elimination
7. Structure and Synthesis of Alkenes
8. Reactions of Alkenes
9. Conjugated Systems and Orbital Symmetry
10. Aromatic Compounds
11. Reactions of Aromatic Compounds
12. Identification organic functional groups:
    –OH; -CHO; =C=O; –COOH; $–NH_2$; $–CO-NH_2$

MBIO 117. Phycology Laboratory (1 Credit)

Topics

1. Preparation of various fixatives used in algae preservation
2. Study of fresh water algae
3. Study of marine water algae
4. Study of museum specimens
5. Culture and characterization of blue green algae

MBIO 118. Mycology Laboratory (1 Credit)

Topics

1. Techniques of growing fungi on culture media
2. Preparation of stains and mounting media
3. Preparation fixed fungal slide
4. **Detailed study of:**
   - i. *Phytophthora*
   - ii. *Albugo*
   - iii. *Mucor*
   - iv. *Saccharaomyces*
   - v. *Neurospora*
   - vi. *Aspergillus*
   - vii. *Penicillium*
   - viii. *Candida*
   - ix. *Curvularia*
   - x. *Alternaria*
   - xi. *Fusarium*
   - xii. *Dreschlera*
   - xiii. *Colletotrichum*
   - xiv. *Uromyces*
   - xv. *Synchytrium*
   - xvi. *Macrophomina*
   - *xvii.* *Botryodiplodia*
   - xviii. *Puccinia*
   - xix. *Ascobolus*
   - xx. *Agaricus* and
   - xxi. Locally available members of fungi covered in the theory
5. **Isolation and identification of fungi from environmental and clinical samples**

MBIO 119. Viva-voce (2 Credits)

There will be viva-voce examination after the completion of theoretical and practical examinations

MBIO 120. Sessional (4 Credits)

Laboratory performance (20) + Practical Note Book (10) + Class Test (60) + Class Attendance (10)

COURSES FOR THE SECOND YEAR BSc HONOURS

Courses	Credits
MBIO 201: Bacteriology	3
MBIO 202: Medical Microbiology	3
MBIO 203: Agricultural Microbiology	2
MBIO 204: Biochemistry II	3
MBIO 205: Genetics II	3
MBIO 206: Human Physiology	3
MBIO 207: Biostatistics	3
MBIO 208: Biophysics	2
MBIO 209: Computer Fundamentals	2
MBIO 210: Microbiology Laboratory II	1
MBIO 211: Microbiology Laboratory III	1
MBIO 212: Biochemistry Laboratory II	1
MBIO 213: Genetics Laboratory II	1
MBIO 214: Biostatistics Laboratory	1
MBIO 215: Human Physiology Laboratory	1
MBIO 216: Biophysics Laboratory	1
MBIO 217: Computer Fundamentals Laboratory	1
MBIO 218: Viva-voce	2
MBIO 219: Sessional	4
Total credits	**38**

MBIO 201. Bacteriology (3 Credits)

Rationale. The aim of this course is to know about bacteria specially their size, shape, structure, pathogenesis, reproduction. It also covers systemic pathogenic bacteria including mycoplasmal, rickettsial and chlamydial diseases of humans, their pathogenesis etc. Areas of study include: aerobic Gram-positive cocci, bacilli and acid-fast bacilli and Enterobacteriaceae, as well as methods of testing their susceptibility to antibacterial agents.

Objectives of the Course. The course will provide basic knowledge of bacteria with special consideration to their importance within medicine

Intended Learning Outcomes.

- Know the structure, morphology and life cycle of medically relevant bacteria.
- Account for systematics of bacteria and classification of bacteria, especially the methods that are used for classification.
- Account for the growth, physiology and metabolism of bacteria, especially the processes

that are of significance for the etiological ability of bacteria.

- Account for mechanisms of transmission, virulence, pathogenicity of pathogenic microorganisms and methods for treatment and prevention of medical important microorganisms.
- Account for the mechanisms of action of antibiotics and the genetic and evolutionary mechanisms behind bacterial development of resistance to antibiotics.
- Account for the factors that influence the virulence of pathogenic microorganisms

Lectures	Topics
1-4	**Introduction on bacteria.** General Characteristics, Taxonomy and Classification and Economic importance.
5-14	**Morphology and structure of bacterial cell.** Size and shape, Cell organelles including cell wall, cell membrane, cytoplasm, capsule, flagella, Pili and fimbriae; Cell wall of eubacteria and Archaea, plasmids and endospore.
15-25	**Nutritional requirements, growth and reproduction of bacteria**. Nutritional types of bacteria (Photoautotrophs, Photoheterotrophs Chemoautotrophs and chemoheterotrophs including parasitic, saprophytic and symbiotic processes) and nutrition; Bacterial reproductive processes and growth; Factors affecting bacterial growth; Chemotaxis;
1-25	**Class Test 1**
26-30	**Bacteria and Human.** Normal human microbial flora, Bacterial toxins (Exotoxin, endotoxin, enterotoxin and neurotoxin) and antimicrobial chemotherapy.
31-40	**Common bacteria.** Gram positive cocci (Streptococci and Staphylococci), Gram negative cocci (*Neisseria gonorrhoeae* and *N. meningitidis*), Gram positive spore forming rods (*Bacillus* and *Clostridium* sp.), Gram positive non-spore forming rods (*Corynebacterium diphtheriae*, *Listeria monocytogenes*, *Gardnerella vaginalis*), Gram negative rods of enteric tract (*E. coli*, *Salmonella* sp. *Shigella* sp., *Vibrio* sp., *Campylobacter* sp., *Helicobacter* sp., *Pseudomonas* sp.,), Gram negative rods of respiratory tract (*Haemophilus* sp., *Bordetella* sp.)
26-40	**Class Test 2**
41-46	**Bacteria with special features.** Anoxygenic phototrophic bacteria; Oxygenic phototrophic bacteria; Gliding fruiting and nonfruiting bacteria; Sheathed, budding/Appendage bacteria; Archaeobacteria; General characteristics and economic importance of rickettsia, chlamydia, mycoplasma and spirochete.
41-46	**Class Test 3**

Books recommended.

- Review of Medical Microbiology and Immunology. Warren E. Levinson. 14th edition. Tata McGraw-Hill. 2016.
- Microbiology. E.C.S. Chan, Michael J. Pelczar, Jr. and Noel R. Krieg. 5th Edition. Tata McGraw-Hill.
- Bacterial Physiology and Metabolism. Byung Hong Kim and Geoferry M Gadd. Cambridge University Press.
- Brock Biology of Microorganisms. Michael T Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl. 13th edition. Pearson Education Inc.

MBIO 202. Medical Microbiology (3 Credits)

Rationale. Medical Microbiology is a central discipline in the medical sciences and is concerned with the pathogenesis, diagnosis, prevention and treatment of infectious diseases. This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.

Objectives of the Course.

The goals of the course are for students to gain a basic knowledge and understanding of:

- Etiology (infectious agents responsible) and epidemiology (transmission and susceptibility patterns)
- Pathogenesis (how the organisms cause disease), symptoms (symptoms that help in diagnosis, how these symptoms relate to disease) prevention (vaccines, hand washing, etc.) and treatment (drug or other treatment options).
- Complications (spectrum of disease, other complications of infection).

Intended Learning Outcomes

Describe the role of microorganisms in a range of diseases, including the nature of the disease-causing organisms as well as their routes of transmission and how we can control them.

Lectures	Topics
1-10	**General Considerations:** History of infectious diseases; Connecting concepts– infections, diseases, pathogenicity and virulence; Epidemic, endemic and sporadic diseases.
11-18	**Principles of Bacterial Pathogenicity:** Bacterial structure in relationship to pathogenicity; Colonization and invasion by bacterial pathogens; Host-Parasite interactions and development of disease; Bacterial defense against phagocytosis; Non-specific host defense through skin and blood; Bacterial Defense against specific immune responses; Bacterial toxins; Inflammation and Phagocytosis process.

Lectures	Topics
1-18	**Class Test 1**
19-26	**Principles of Disease and Epidemiology:** Pathology, Infection, and Disease; Etiology and epidemiology of Infectious Disease; Classifying Infectious Disease; Pattern of Disease; Sources and transmission of infections; Portal of entries; Nosocomial infection; Emerging Infectious Disease.
27-36	**Microorganisms and Human Disease:** Microbial diseases of the skin, eyes; Microbial diseases of the nervous system; Microbial diseases of the cardiovascular and lymphatic system; Microbial diseases of the respiratory system; Microbial diseases of the digestive system; Microbial diseases of the urinary and reproductive system.
19-36	**Class Test 2**
37-55	**Human Pathogens.** Common cold infection; *Staphylococcus aureus; Haemophillus influenza; Mycobacterium tuberculosis; Clostridium tetani; Escherichia coli; Treponema pallidum; Clostridium tetani; Streptococcus pneumoniae; Bordetella pertussis; Corynebacterium diphtheriae; Salmonella enterica typhi and paratyphi; Neisseria meningitides; Vibrio cholerae.* Poliomyelitis and rabies. **Cutaneous/superficial/Subcutaneous and Systemic Myctic Infections.** Dermatophytes, gas gangrene, ringworm, candidiasis, aspergillosis
37-55	**Class Test 3**

Books recommended.

- Medical microbiology (7th Edition) Patrick R. Murray et al.
- Microbiology: An introduction (11th Edition) Gerard J. Tortora et al.
- Bacterial Pathogenesis: A molecular approach (3rd Edition) Brenda A. Wilson et al.
- Manual of Clinical Microbiology (9th Edition) Patrick R. Murray et al.
- Molecular Medical Microbiology (2nd Edition) Yi-Wei Tang et al

MBIO 203. Agricultural Microbiology (2 Credits)

Rationale. The course particularly aims to provide understanding of soil microbes and their role in soil fertility and crop production; the uses of microorganisms in organic matter decomposition, agro-processing and plant disease control. These will be accomplished through lectures or discussion followed by interrogation and class tests, study tours etc.

Objectives of the Course

- Understand the basic characteristics of soil microorganisms and their role in soil fertility, plant nutrition and growth.
- Understand the use of microbes in agro-processing
- Study the role microbes as plant pathogens and their controlling strategies using

genetically modified plant

Intended Learning Outcomes

- use the knowledge of activities of microorganisms in soil and their interactions with plants and animals;
- understand the interactions among microorganisms and plants; acquire knowledge of pathogenic microbes and their control measure to increase the yield of economic crops.

Lectures	Topics
1-6	**Soil and Microorganisms:** Major groups of Microorganisms in soil; Role of microbes in soil fertility and plant nutrition.
7-15	**Plants and Microorganisms:** Microbiology of flower, seeds fruits, leaves and stems; Rhizosphere and rhizoplane microflora, R**:** N ratio, role of rhizosphere microflora on plant growth and development. Nitrogen fixation, plant growth promoting bacteria, Root nodule formation and Biochemistry of nitrogen fixation-Nitrogenase and hydrogenase.
1-15	**Class Test 1**
16-22	**Application of Microorganisms in Agriculture:** Use of microorganisms as fertilizer and plant nutrition; Use in biological nitrogen fixation; Mycorrhiza in plant nutrition; Microorganisms and composting; Microorganisms and green manuring; Use of microorganisms as biopesticides- insect pest control, non-insect pest control, plant disease control, weed control.
23-28	**Microorganisms in Agro processing:** Jute and flax retting; Microbiology of coir production; Microbiology of preservation and storage of forage crops; Curing of tea, cocoa and coffee; Processing of tobacco; Microbiology of paper making.
29-34	**Microbial degradation of Organic matter:** Microbiology and Biochemistry of Cellulose, Hemicellulose and lignin. Decay of wood; Grains- deterioration and toxicity; Deterioration of other products.
16-34	**Class Test 2**
35-40	**Microbes as plant pathogens:** Concept of disease in plants; Diagnosis and control of plant disease, Problems from microorganisms; Symptoms, disease cycle and control measures of Bacterial diseases - Blight of rice, Citrus canker, Wilt of potato; and that of Fungal diseases - Blast of rice, Late blight of potato, Rust of wheat, Smut of sugarcane, Wilt of cotton, Tikka leaf spot of ground nut.
41-46	**Microorganisms, Biotechnology and Agriculture:** Genetic engineering for disease resistance in plants. Genetic engineering with microbial genes for plant improvement, transgenic pant development and microbes, cell culture for plant improvement.
35-46	**Class Test 3**

Books recommended.

- An Introduction to Soil Microbiology – M. Alexander.
- Agricultural Microbiology- N. Mukherjee and T. Ghosh
- Soil Microorganisms – T. R. G. Gray and S. T. Williams.
- Soil Microorganisms and Plant Growth – N. S. Subba Rao.
- Plant Microbiology – R. Campbell.

MBIO 204. Biochemistry II (3 Credits)

Rationale. Biochemistry II is the advanced thoughts of biochemistry contents. Microbes itself and when microbes invade human body, require following many biochemical systems. In addition, various types of studies, for example, protein identification, drug development, biosynthesis of biomolecules etc are important for the microbiologists in research and applied scales.

Objectives of the Course

- Understand various types of analytical techniques that are related with proteins, carbohydrates, fats,
- Acquire knowledge in enzymes and biomolecule

Intended Learning Outcomes

- Understand the various types of identifications, purification methods of proteins, carbohydrates and fats, which they will be able to apply in microbiology and biochemistry researches as well as in industrial areas.
- Learn the in-depth studies of enzymes that will help them to understand the modes, mechanisms and applications of various types of enzymes.
- Know the details studies of biosynthesis of biomolecules, which will help the students to closely understand the synthetic pathways of the basic biomolecules.
- Drug development contents will help the students to learn challenges and mechanisms.

Lectures	Topics
01-11	**Analytical Biochemistry:** Exploring Proteins and Proteomes: Working with proteins- Protein purification and sequencing; Protein denaturation and folding; Hemoglobin- Portrait of a Protein in Action; Exploring carbohydrates and fatty acids.
12-18	**Lipids and membranes:** Properties of Lipid Aggregates; Biological Membranes; Membrane Assembly and Protein Targeting; Lipoproteins.
19-23	**Metabolism:** Electron transport and Oxidative Phosphorylation; Lipid metabolism
1-23	**Class Test 1**

Lectures	Topics
24-34	**Enzymes:** An introduction to enzymes; How enzyme works; Enzyme Kinetics as an approach to understanding mechanism; Examples of enzymatic reactions; Catalytic and regulatory strategies of enzymes.
35-38	**Drug Development:** The challenges; Drug discovery and development process.
24-38	**Class Test 2**
38- 50	**Synthesizing the Molecules of Life:** Biosynthesis of Amino Acids, Nucleotide, Membrane Lipids and Steroids; Protein synthesis; Integration of Metabolism.
38-50	**Class Test 3**

Books recommended

- Lehninger Principles of Biochemistry 6th edition – David L. Nelson and Michael M. Cox
- Biochemistry 7th edition – Jeremy M Berg, John L. Tymoczko and LubertStryer
- Biochemistry 4th edition – Donald Voet and Judith G Voet

MBIO 205. Genetics II (3 Credits)

Rationale

The course presents the basic principles of genetics in a clear and logical sequence. Through the discussion of replication and other gene expression systems, this course offers a viewpoint of many areas of biological enquiry which will be needed to understand the advance molecular biology.

Objectives of the Course

The course will help students to advance their understanding and knowledge in:

1. Replication of DNA and chromosome, mechanisms of transcription, translation and RNA processing.
2. Genetic notation and genetic code
3. Molecular basis of mutation, DNA repair mechanism, inherited human diseases.
4. Transposable elements, transcriptional regulation in Prokaryotes and Eukaryotes
5. Developmental genetics such as cloning experiments, immunogenetics

Intended Learning Outcomes

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

- Understand the mechanisms of replication, transcription and translation in prokaryotes and eukaryotes.
- Explain the mutation types, cause and phenotypic effect.
- Demonstrate the importance of the knowledge of transposable genetic elements and regulatory systems of gene expression.
- Understand the gene manipulation to get desired patterns of animals, flowers and genetic changes contributing cancer.

Lectures	Topics
1-10	**DNA and RNA.** Structure; DNA replication -requirements, modes, direction and origin; DNA replication in prokaryotes, archaea, eukaryotes and viruses; The central dogma; RNA-classes, structures and functions.
11-22	**Transcription and Translation.** Transcription in bacteria and eukaryotes, gene organization, exons, introns, processing of pre-mRNA; Post-translational modification, genetic code, one gene one enzyme hypothesis, overlapping genes; Ribosome- **s**tructure and function; translation and protein synthesis in prokaryotes and eukaryotes; Post translation modification of proteins.
1-22	**Class Test 1**
23-30	**Mutation.** Molecular basis of mutation, basic features of mutation-somatic vs germinal, spontaneous vs induced, induced mutation by chemicals, radiation; Mutation and phenotypic effect, Ames test, DNA repair mechanisms; Inherited human diseases with defect in DNA repair.
31-36	**Transposable Genetic Elements.** Transposable elements in bacteria, composite transposons, Tn3 elements, retroviruses and retrotransposons, transposable genetic elements, genetic and evolutionary significance of transposable elements.
37-44	**Regulation of Gene Expression.** Levels of gene control, regulatory elements, DNA-binding proteins, regulation in bacteria; operon structure, *lac* and *tryp* operon of *E. coli;* Negative and positive control: inducible and repressible operons; Attenuation, antisense RNA, riboswitches and RNA-mediated repression, transcriptional control in bacteriophage lamda.
23-44	**Class Test 2**
45-48	**Translational Control.** Transcriptional control in eukaryotic cells, gene control through mRNA, RNA stability, RNA silencing, translational and post-translational control.
49-54	**Development of genetics.** Cloning experiments, the genetics of pattern formation in *Drosophila*, flower development in *Arabidosis;* Programmed cell death, immunogenetics-antibody diversity, MHC gene, T-cell receptor diversity, genetic changes contributing cancer; Molecular evolution and evolutionary genetics
	Class Test 3

Books recommended

- Genetics: A Concptual Approach, Benjamin A. Pierce, 2nd Edition, W.H Freeman and Company,NY, USA
- Principles of Genetics, D. Peter Snustad and Micheal J. Simmons, 6th edition, John Wiley andSons,Inc, USA

MBIO 206. Human Physiology (3 Credits)

Rationale. Physiology forms the basis of all human disease. As such, if we wish to understand how nutrients and specific diets work, either positively or negatively within the body, it is essential to understand the physiological and biochemical systems, which regulate health and disease in humans. Fundamentally, macro-and micronutrients have significant role on the growth and maintenance of the human body from birth through to old age. An understanding of such actions is critical as a foundation to topics dealing with malnutrition and over-nutrition. The impact of specific nutrients on the functioning of each physiological system at the cell or organ level is necessary prior to an understanding of how over or under supply of such nutrients effect influences health and disease.

Objectives of the Course

- To demonstrate an in-depth understanding of neurophysiology, respiratory system, cardiovascular and lymphatic system, gastrointestinal tract physiology, endocrinology and reproductive system.
- To identify how changes in normal physiology lead to disease
- To perform physiological tests that examines the function of various components of a body system.

Intended Learning Outcomes

On completion of the course

- Students will have gained an understanding of the fundamentals of human physiology and nutrition, including topics in homeostasis, the various physiological systems and how they function, and concepts of nutrient balance required to support such systems.
- Students will be able to describe the function of the specialist organs in the body and have some understanding of the importance of nutrition to these systems.
- Furthermore, students should be able to complete basic laboratory tasks relevant to nutrition and physiology.

Lectures	Topics
1	**Introduction to Physiology.** Physiology focuses on mechanisms of action, Structure and function are inseparable.
2-4	**Levels of Organization in the Body.** The chemical level: Various atoms and molecules make up the body, The cellular level: Cells are the basic units of life, The tissue level: Tissues are groups of cells of similar specialization, The organ level: An organ is a unit made up of several tissue types, The body system level: A body system is a collection of related organs, The organism level: The body systems are packaged together into a functional whole body, Body cavities and membrane.
5-7	**Digestion and digestive system.** Mechanisms and control of the secretion and composition of digestive juices, Digestion, absorption and assimilation of foodstuffs, Detail study liver and pancreas.

Lectures	Topics
8-12	**Blood circulatory system.** Composition, formation, destruction and function of blood, Hemostasis, Blood grouping, Hemoglobin dissociation curve, Tissue fluid and capillary exchange, Cardiovascular system, Physiology of heart, Cardiac cycle and heart sound, Cardiac output, Physiology of circulation, Maintaining Blood Composition, pH, and Temperature.
13-15	**Lymphatic System.** Structure and function of lymphatic system, Lymphatic vessels, Primary lymphatic organ and Secondary lymphatic organ.
1-15	**Class Test 1**
16-20	**Respiratory system.** Respiratory system and respiratory stimulants, Structures and functions of lungs, Gaseous exchanges mechanism through respiratory surface, Transport of CO_2 and O_2.
21-25	**Excretory system.** Structure of kidney, Formation of Urine Molecular mechanism of Ultra filtration and selective reabsorption.
26-28	**Homeostasis.** Corrective mechanism, Negative feedback, Some example of homeostasis control mechanism of body, water potential, temperature and blood glucose concentration.
16-28	**Class Test 2**
29-35	**Nervous system and Coordination.** Structure and function of CNS, PNS and meninges, Mechanism of voluntary and reflex action, Transmission of nerve impulses: Resting potential, Action potential, Transmission of Action potential and Carrying information.
36-38	**Endocrinology.** Functions, Mechanisms and properties of different hormones, Mechanism of hormone action.
39-45	**Reproductive system.** Structure and functions of the different parts of male and female reproductive system, Female menstrual cycle, Development of embryo and fetus in the mother uterus.
29-45	**Class Test 3**

Books recommended

- Understanding Human Anatomy and Physiology —By Sylvia S. Mader
- Textbook of Medical Physiology- Arthur C Guyton and John E Hall
- Human Physiology- From Cells to Systems- L. Sherwood

MBIO 207. Biostatistics (3 Credits)

Rationale. Biostatistics is the application of statistical principles to questions and problems in medicine, public health or biology. This course is designed to teach microbiology students the basic principles of biostatistics. In this course, you will learn how to effectively collect data, describe data, and use data to make inferences and conclusions about real world phenomena

Objectives of the Course

The goals of the course are for students to gain a basic knowledge and understanding of:

- Populations and samples
- Population parameters and sample statistics
- Sample/population mean, variance, and standard deviation
- Statistical inference
- Tools for describing central tendency and variability in data;
- Methods for performing inference on population means and proportions via sample data;
- Statistical hypothesis testing and its application to group comparisons.

Intended Learning Outcomes

Having successfully completed this course you will be able to:

- Understand what biostatistics is and how it is used in the field of public health
- Recognize the importance of data collection and its role in determining scope of inference
- Understand the basic principles of probability and how they relate to biostatistics
- Demonstrate a solid understanding of interval estimation and hypothesis testing.
- Choose and apply appropriate statistical methods for analyzing one or two variables.

Lectures	Topics
1-3	**Introduction to Biostatistics.** Introduction, Basic Concepts, Measurement and Measurement Scales, Sampling and Statistical Inference, The Scientific Method and the Design of Experiments, Computers and Biostatistical Analysis.
4-5	**Descriptive Statistics.** The Ordered Array, Grouped Data: The Frequency Distribution.
6-7	**Descriptive Statistics.** Measures of Central Tendency, Measures of Dispersion.
8-10	**Basic Probability Concepts.** Two Views of Probability: Objective and Subjective, Elementary Properties of Probability, Calculating the Probability of an Event, Bayes' Theorem, Screening Tests, Sensitivity, Specificity, and Predictive Value Positive and Negative.
11-12	**Probability Distributions.** Probability Distributions of Discrete Variables, The Binomial Distribution, The Poisson Distribution, Continuous Probability Distributions, The Normal Distribution, Normal Distribution Applications.
13-14	**Sampling Distributions.** Sampling Distributions, Distribution of the Sample Mean,

Lectures	Topics
	Distribution of the Difference Between Two Sample Means, Distribution of the Sample Proportion, Distribution of the Difference Between Two Sample Proportions.
1-14	**Class Test 1**
15-22	**Estimation.** Confidence Interval for a Population Mean, The t Distribution, Confidence Interval for the Difference Between Two Population Means, Confidence Interval for a Population Proportion, Confidence Interval for the Difference Between Two Population Proportions, Determination of Sample Size for Estimating Means, Determination of Sample Size for Estimating Proportions, Confidence Interval for the Variance of a Normally Distributed Population, Confidence Interval for the Ratio of the Variances of Two Normally Distributed Populations.
23-29	**Hypothesis Testing.** Hypothesis Testing- A Single Population Mean, The Difference Between Two Population Means, Paired Comparisons, A Single Population Proportion, The Difference Between Two Population Proportions, A Single Population Variance, The Ratio of Two Population Variances; The Type II Error and the Power of a Test, Determining Sample Size to Control Type II Errors.
30-33	**Analysis of Variance.** The Completely Randomized Design, The Randomized Complete Block Design, The Repeated Measures Design, The Factorial Experiment.
15-33	**Class Test 2**
34-36	**Simple Linear Regression and Correlation:** The Regression Model, The Sample Regression Equation, Evaluating the Regression Equation, Using the Regression Equation, The Correlation Model, The Correlation Coefficient, And Some Precautions.
37-39	**Multiple Regression and Correlation:** The Multiple Linear Regression Model, Obtaining the Multiple Regression Equation, Evaluating the Multiple Regression Equation, Using the Multiple Regression Equation, The Multiple Correlation Model.
40-45	**The Chi-Square Distribution and The Analysis of Frequencies:** The Mathematical Properties of the Chi-Square Distribution, Tests of Goodness-of-Fit, Tests of Independence, Tests of Homogeneity, The Fisher Exact Test, Relative Risk, Odds Ratio, and the Mantel–Haenszel Statistic.
34-45	**Class Test 3**

Books recommended

- Biostatistics- a foundation for analysis in the health sciences. 10th Edition. Wayne W. Daniel and Chad L. Cross.

MBIO 208. Biophysics (2 Credits)

Rationale. Biophysics is an evolving course which applies physics to biological systems and promotes an understanding of their physical properties and behavior. It provides students with an advanced and in-depth analysis of the ways in which the laws of physics apply to small living systems. This course introduces students to the physical and chemical properties of biological macromolecules, including proteins and nucleic acids.

Objectives of the Course. This course aims to study the strategy and tactics of biophysical concepts of macromolecules, the conformational analysis and forces that determine the protein and nucleic acid structure. This course also emphasis to study and analyze the size and shape of the macro molecule using different techniques like X-ray crystallography, and NMR.

Intended Learning Outcomes.

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

- Understand Interatomic bonds and interactions, such as covalent bonds, orbital theory, inter- and intramolecular interactions, the hydrophobic effect, etc.
- Understand the uses of electromagnetic radiation for the analysis of structure, dynamics, interactions and chemical reactions of biological molecules.
- Describe X-ray crystallography, mass spectroscopy and nuclear magnetic resonance (NMR) methods as applied to biological systems, in particular the information which they can provide, but also their limitations.

Lectures	Topics
1-10	**Laws of Physics and Chemistry:** Introduction; Quantum Mechanics; The Electronic Structure of Atom; Molecular Orbitals and Covalent bonds; Molecular Interactions; Stereochemistry and Chirality; Thermodynamics; Radioactivity.
11-17	**Physico-Chemical Techniques to Study Biomolecules:** Hydration of Macromolecules; Role of Friction; Diffusion; Sedimentation; The Ultracentrifuge; Viscosity; Rotational Diffusion; Light Scattering; Small Angle X-ray Scattering.
1-17	**Class Test 1**
18-25	**Spectroscopy:** UV/Visible Spectroscopy; Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD); Fluorescence Spectroscopy; Infrared Spectroscopy; Raman Spectroscopy; Electron Spin Resonance.
26-32	**X-ray Crystallography:** Crystal Symmetries; Crystal Systems; Point Groups and Space Groups; Growth of Crystals of Biological Molecules; X-ray Diffraction; Structure Solution; Refinement of the Structure.
18-32	**Class Test 2**
33-40	**NMR Spectroscopy:** Basic principles of NMR; NMR Theory and Experiment; NMR parameters; NMR application in Chemistry, Biochemistry and Biophysics.

Lectures	Topics
41-45	**Molecular Modeling:** Building the structure of H_2O_2, protein, nucleic acid; Optimizing the model.
33-45	**Class Test 3**

Book recommended

- Biophysics- Vasantha Pattabhi and N. Gautham
- Principles and Techniques of Biochemistry and Molecular Biology; edited by Keith Wilson, John Walker, 7th Edition, Cambridge University Press
- Biochemistry laboratory; Modern theory and techniques. Rodney Boyer.

MBIO 209. Computer Fundamentals (2 Credits)

Rationale. An introduction to computer concepts, logic, and computer programming.

Objectives of the Course. To understand the fundamental computational concepts underlying most programming languages, a range of problem-solving techniques using computers, the role of programming within the overall software development process, the solution of small problems using a programming language

Intended Learning Outcomes.

- Students should be able to summarize steps to take when the computer is not working properly or needs repair.
- Students should be able to recognize basic computer hardware architecture constructs such as instructions sets, memory, CPU, external devices, and data representation.
- Students will demonstrate basic internet usage
- Students should be able to perform basic file operations

Lectures	Topics
1-3	**Introduction.** Brief history and type of computer application areas, working principle of a computer system.
4-8	**Hardware.** Organization and architecture, mother-boards and microprocessors, memory units- primary memory, secondary memory I/O devices, ISA and PCI Bus architecture.
1-8	**Class Test 1**
9-15	**Software.** Classifications, system software, operating system – importance, types and basic functions, introduction to Windows and UNIX operating systems, application of software, database, spreadsheet and word processing software.

Lectures	Topics
15-20	**Programming in C.** Levels of programming languages, assembler compiler and interpreter, constants, variables and data types, programs with simple input output operations, decision making, branching and looping.
9-20	**Class Test 2**
21-25	**Applications:** Multimedia systems, computer networks, basic concepts on LAN, WAN and internet systems, internet services.
26-30	**Maintenance:** Power supply stability, grounding effects of surge and sag and their protection, stabilizer and UPS, effect of static charge and handling of computer cards and chips, computer viruses and their protections
21-30	**Class Test 3**

Book recommended.

- Fundamentals of Computers-V. Rajaraman

MBIO 210. Microbiology Laboratory II (1 Credit)

Rationale

This course will provide a conceptual and experimental background in microbiology sufficient to enable students to take more advanced courses in related fields.

Objectives of the Course

- Classify and identify microorganisms based on characteristics
- Identify unique structures, capabilities, and genetic information flow of microorganisms.
- Discuss how microscopy has revealed the structure and function of microorganisms.
- Understand the range of metabolic diversity exhibited by microorganisms, impact of metabolic characteristics on growth, and control of growth.
- Describe evidence for the evolution of cells, organelles, and major metabolic pathways from early prokaryotes and how phylogenetic trees reflect evolutionary relationships.
- Describe the causes and consequences of mutations on microbial evolution and the generation of diversity as well as human impacts on adaptation.
- Classify interactions of microorganisms on human and non-human hosts as neutral, detrimental, or beneficial.

Intended Learning Outcomes

- Compare and distinguish the basic groups of microbes, including prokaryotic microbes (Archaea,
- Bacteria), and Viruses, and eukaryotic microbes.
- Understand the processes needed for one bacterium to become two, and understand the mechanisms involved.
- Compare and contrast major pathways of catabolism, specify the relative energy yield

from each pathway, list the key products of each pathway, and describe biochemical pathways used for microbial taxonomy.

- Compare and contrast major pathways of biosynthesis and list the key products of each pathway.
- Draw a typical microbial growth curve, and predict the effect of different environmental conditions on the curve.
- Compare and contrast eukaryotic and prokaryotic genomes, and gene expression in each group.
- Compare and contrast the acquisition of novel genetic information in microbes via mutations and genetic exchange, specifically conjugation, transformation and transduction,
- Specify the role of microbes in global C, N, S, and P cycles, and list examples of microbes that contribute to key metabolic aspects of these cycles.
- List different types of symbiotic interactions between microbes and other organisms, including commensalism, mutualism, and parasitism, and provide examples of each.
- Summarize common features of microbial pathogens, with emphasis on bacterial and viral pathogens.
- Summarize mechanisms of animal defenses to infection, including primary defenses, innate immunity, and acquired immunity.

Topics

1. **Collection, processing and preservation of different types of samples**
2. **Preservation of microorganisms by-**
    i. Serial subculture
    ii. Mineral oil
    iii. Sterile soil technique (for fungi)
3. **Study of biochemical test for identifying bacteria.**
    i. Indole Production test
    ii. MR test
    iii. VP test
    iv. Citrate utilization test
    v. Nitrate reduction test
    vi. Casein Hydrolysis
    vii. Gelatin Hydrolysis
    viii. Catalase activity for H_2O_2 production
    ix. Oxidase test
    x. Deep glucose agar test
    xi. Sugar fermentation test
    xii. H_2S production
    xiii. Urease Activity
    xiv. Bile esculin test
    xv. Growth in tellurite
    xvi. Pigment production
    xvii. Novobiocin sensitivity
    xviii. Luminescent
    xix. Lysine decarboxylase
    xx. Ornithine decarboxylase

MBIO 211. Microbiology Laboratory III (1 Credit)

Rationale. This course will provide a conceptual and experimental background in microbiology sufficient to enable students to take more advanced courses in related fields.

Objectives of the Course

- Classify and identify microorganisms based on characteristics
- Identify unique structures, capabilities, and genetic information flow of microorganisms.
- Discuss how microscopy has revealed the structure and function of microorganisms.
- Understand the range of metabolic diversity exhibited by microorganisms, impact of metabolic characteristics on growth, and control of growth.
- Describe evidence for the evolution of cells, organelles, and major metabolic pathways from early prokaryotes and how phylogenetic trees reflect evolutionary relationships.
- Describe the causes and consequences of mutations on microbial evolution and the generation of diversity as well as human impacts on adaptation.
- Classify interactions of microorganisms on human and non-human hosts as neutral, detrimental, or beneficial.

Intended Learning Outcomes

- Compare and distinguish the basic groups of microbes, including prokaryotic microbes (Archaea,
- Bacteria), and Viruses, and eukaryotic microbes.
- Understand the processes needed for one bacterium to become two, and understand the mechanisms involved.
- Compare and contrast major pathways of catabolism, specify the relative energy yield from each pathway, list the key products of each pathway, and describe biochemical pathways used for microbial taxonomy.
- Compare and contrast major pathways of biosynthesis and list the key products of each pathway.
- Draw a typical microbial growth curve, and predict the effect of different environmental conditions on the curve.
- Compare and contrast eukaryotic and prokaryotic genomes, and gene expression in each group.
- Compare and contrast the acquisition of novel genetic information in microbes via mutations and genetic exchange, specifically conjugation, transformation and transduction,
- Specify the role of microbes in global C, N, S, and P cycles, and list examples of microbes that contribute to key metabolic aspects of these cycles.
- List different types of symbiotic interactions between microbes and other organisms, including commensalism, mutualism, and parasitism, and provide examples of each.
- Summarize common features of microbial pathogens, with emphasis on bacterial and viral pathogens.
- Summarize mechanisms of animal defenses to infection, including primary defenses, innate immunity, and acquired immunity.
- Compare and contrast beneficial and harmful uses of organisms, including applications in
- biotechnology and bioterrorism.

Topics

1. Study of microbial Ammonification
2. Study of microbial Nitrification
3. Study of microbial Denitrification
4. Isolation and study of *Rhizobiumspp.*
5. Isolation and identification of *Azotobacter*spp.
6. Isolation and study of Mycorrhiza
7. Determination of Total Organic Carbon (TOC)
8. Study of BGA as biofertilizer

MBIO 212. Biochemistry Laboratory II (1 Credit)

Rationale. This course will introduce some of the experimental techniques and concepts used in biochemistry.

Objectives of the Course. The primary objective of this course is for students to (1) learn fundamental approaches for experimentally investigating biochemical problems, (2) learn the theoretical foundations for the methods used, and (3) understand the applicability of the biochemical methods to realistic situations.

Intended Learning Outcomes

- Explain the chemical nature of proteins
- Perform laboratory experiments related to the above course learning objectives, record observations, gather and analyze data, and present the results in written form.

Topics

1. The analysis of chromatograms of protein hydrolysates.
2. Biuretic reaction for detection of peptide bond
3. Dialysis of proteins
4. Detection of the isoelectric point of casein
5. Ways of irreversible precipitation of protein from solutions
6. **Effect of Physico-Chemical Parameters on Microbial Enzyme Activity**
    i. Temperature; ii. pH; iii. NaCl
7. **Qualitative Analysis of Enzyme Activity**

i.	Amylase	vi.	Albuminase
ii.	Cellulase	vii.	Reductase
iii.	Protease	viii.	Catalase
iv.	Casinase	ix.	Urease
v.	Gelatinase	x.	Oxidase

8. **Quantitative estimation of enzyme activity:** a) Amylase; b) Cellulase; c) Protease

MBIO 213. Genetics Laboratory-II (1 Credit)

Rationale. Survey of current status of microbial genetics (bacteria, fungi, viruses, protozoa and other microorganisms). Mutagenesis, isolation and characterization of mutants. Adaptation and genetics. Gene transfer and its mechanism: cloning vectors, transformation, transduction and lysogeny and, conjugation and conversion. Expression and regulation of genes. General and specialized methods and techniques in microbial genetics. Experiments with virulent phages, temperate phages and lysogenic bacteria, fungi and other lower eukaryotic organisms. Application of microbial genetics to various sectors: agriculture, medicine, food, environment, etc.

Objectives of the Course

- Enable students to understand the relevance of microbial genetics in biotechnology
- Acquaint the students with the mechanics of experimentation and the methods and techniques of experimental genetics
- Familiarize the students with the genetic principles in a first hand manner as they see these principles operate in a controlled experimental setting
- Introduce students to genetics laboratory skills like bacterial transformation, viral transduction, bacterial conjugation, restriction endonuclease digestion of DNA, gel electrophoresis and amplification of DNA by Polymerase Chain Reaction, and microarray technology.

Intended Learning Outcomes

- understand the importance of microbial genetics;
- explain how microorganisms are used to study the genetic mechanisms of other organisms (plants and animals); and relate microbial genetics to biotechnology
- carry out basic experiments to manipulate gene/s to modify or produce trait;
- isolate DNA and gene products; and demonstrate genetic engineering

Topics

1. Bacteria Mutation
2. Bacterial Transformation
3. Bacterial Conjugation
4. Viral Transduction
5. Isolation of auxotrophic mutant
6. Genetic experiments with phages, bacteria and lower eukaryotic organisms.
7. Isolation of Antibiotic Resistant Mutants
8. Study of UV induced mutagenesis in bacteria

MBIO 214. Biostatistics Laboratory (1 Credit)

Rationale. The course provides an introduction to the scientific view and fundamental assumptions of statistics. Students are further introduced to principles of implementation and analysis of statistical studies.

Objectives of the Course

- Understand basic statistical concepts
- Understand the measurement level and distribution characteristics of variables
- Learn statistics software and explain statistical description
- Describe and explain point and interval estimates, hypothesis testing (parametric and non-parametric), correlation, simple and linear regression, reliability and validity

Intended Learning Outcomes

- describe and discuss basic statistical concepts
- assess the distribution characteristics of variables
- describe the concepts of statistical description and inference and how they are used
- define a problem that is statistically researchable
- use an established statistics software programme in order to make basic statistical analyses
- carry out random selection and describe the collected material
- formulate and test hypotheses
- carry out correlation and regression analyses
- present the results of their own completed analyses
- discuss reliability and generalisability
- draw conclusions in relation to a defined problem formulation
- critically assess quantitative scientific papers in relation to the statistical methods used

Topics

1. Central Tendencies
2. Graphical Representation of Data (Histogram, Bar Chart, Pie Chart)
3. Measurement of Dispersion
4. Skewness and Kurtosis
5. Correlation and Regression
6. Sampling Technique
7. ANOVA (One Way, Two Way)
8. Statistical Testing X^2 Test, F Test, T Test)
9. Biological data analysis using SPSS, GraphPad PRISM

MBIO 215. Human Physiology Laboratory (1 Credit)

Rationale. This course provides students with an understanding of the function and regulation of the human body and physiological integration of the organ systems to maintain homeostasis.

Objectives of the Course

The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses. It is expected that the student understand the unique role of each organ and organ system in maintaining health. Students should be able to describe the functions of the distinctive cells that comprise each major organ and when appropriate define the role of physiological functional units.

Intended Learning Outcomes

- Integration of the organ systems to maintain constancy of the internal environment
- Regulation of homeostasis by neuronal, endocrine, and local chemical messengers
- Role of the Autonomic Nervous System in regulating organ function
- Adaptive responses to exercise and the role of exercise in maintaining health
- Adaptive physiological responses to stress, infectious organisms, and toxins
- Changes in bodily function through the life span

Topics

1. Total and Differential Count of Blood Cell
2. Determination of Bleeding Time, Clotting Time and Prothrombin Time
3. Determination of Osmotic Fragility Of RBC.
4. Blood Grouping
5. Serum Bilirubin Determination
6. Blood Glucose Determination
7. Hemoglobin
8. ESR
9. Anatomy of Kidney, Liver and Lung
10. Blood Pressure Measurement by Using Sphygmomanometers

MBIO 216. Biophysics Laboratory (1 Credit)

Rationale. This laboratory course consists of experiments used in biological science with an emphasis on spectroscopy.

Objectives of the Course

- Understand fundamental instrumental methods.
- Explain various methods available to purify and characterize biological molecules based on their physical and chemical properties.
- Understand various methods and techniques used in biological science

Intended Learning Outcomes

- The student will be able to communicate and discuss fundamental instrumental methods.
- The student will be able to communicate and discuss the various methods available to purify and characterize biological molecules based on their physical and chemical properties.
- The student will be able to organize the results, discuss the obtained results on the basis of their knowledge, and write a formal lab report.
- The student will be able to apply the knowledge to analyze biological molecules and structures using appropriate methods and techniques.

Topics

1. Imaging the dynamics of subcellular organization. The availability of neuronal kers, e.g., EGFP-labeled actin, will enable study the dynamics of cellular outgrowth using time-lapse fluorescent microscopy.
2. Correlation spectroscopy, using coherent light scattering, to determine the diffusion constant and thus size of macromolecular structures.
3. Nuclear magnetic resonance on solid and liquid samples for the chemical identification of molecules. This utilizes both conventional proton Nuclear Magnetic Resonance (NMR) and pulsed (spin echo) NMR to identify molecules and their interaction with the solvent. Small magnets are available for this purpose
4. Centrifugation
5. Laser Light Scattering
6. Atomic Absorption (AS);
7. Gas Chromatography Mass Spectrometry (GCMS
8. Fluorescent Microscopy
9. Single Molecule and Super Resolution Microscopy: Fluorescent labeling of cell components for imaging beyond the diffraction limit

MBIO 217. Computer Fundamentals Laboratory (1 Credit)

Rationale. This course gives a general understanding of how a computer works, introduces the student to assembly-level programming and prepares for future courses.

Objectives of the Course

- develop a vocabulary of key terms related to the computer and to software program menus
- identify the components of a personal computer system
- demonstrate mouse and keyboard functions
- demonstrate window and menu commands and how they are used
- demonstrate how to organize files and documents on a USB/hard drive
- compose, format and edit a word document
- send email messages (with or without attachments)
- navigate and search through the internet
- navigate through WebCT

Intended Learning Outcomes

- Recognize basic computer hardware architecture constructs such as instructions sets, memory, CPU, external devices, and data representation.
- Use software tools to work in different office and research environments

Topics

1. **Office Management**
   i. Word Processing
   ii. Spreadsheet Analysis
   iii. Powerpoint Presentation
   iv. Database System- MS Access
2. **Basic Internet Operation and Website Design**

MBIO 218. Viva-voce (2 Credits)

There will be a viva-voce examination after the completion of theoretical and practical examinations

MBIO 219. Sessional (4 Credit)

Slides and specimen collections (10) + Practical Note Book (10) + Field work (10) + Class Test (60) + Class Attendance (10)

COURSES FOR THIRD YEAR BSc HONOURS

Courses	Credits
MBIO 301: Virology I	3
MBIO 302: Immunology I	3
MBIO 303: Molecular Biology	3
MBIO 304: Principles of Biological Techniques	3
MBIO 305: Food, Fisheries and Beverage Microbiology	3
MBIO 306: Pharmaceutical Microbiology	3
MBIO 307: Microbial Physiology	2
MBIO 308: Diagnostic Microbiology and Pathology	2
MBIO 309: Environmental Microbiology	2
MBIO 310: Microbiology Laboratory IV	3
MBIO 311: Analytical and Industrial Microbiology Laboratory	3
MBIO 312: Medical Microbiology Laboratory	2
MBIO 313: Pharmaceutical Microbiology Laboratory	2
MBIO 314: Viva-voce	2
MBIO 315: Sessional	4
Total credits	**40**

MBIO 301. Virology I (3 Credits)

Rationale. The course of Virology I is intended to explain the concept of viruses as infectious agents for the reason that all living organisms have viral parasites and the emergence of various viral diseases are the reasons of global disease outbreaks which have altered our history many times over. The course includes history of virology, viral structure, replication strategy of bacteriophage, plant, insect and animal viruses including prions and virions.

Objectives of the Course.

The course will help students to:

- Know the main virus groups and the human viruses causing the most important diseases.
- Recognize the structure of viruses
- Understand the replication strategy of viruses
- Understand pathogenesis of diseases caused by viruses
- Know tools and techniques in study of the structure, life cycle, pathogenesis and diagnosis of viruses and their clinical signs

Intended Learning Outcomes.

At the ending of the course, the students will be able to

- Describe the elementary features and chemical composition of a virus to be successful.
- Explain some fundamental mechanisms of viral-induced pathogenesis including the processes of entry into cells, control of gene transcription and where relevant translation and gene product stability, control of and mechanisms of genome replication, virion

assembly and egress from the cell.

- Identify how viruses spread from person to person
- Recognize an epidemic or pandemic of virus infection
- To visualize cytopathic effects of viruses.
- Recognize current strategies to prevent virus infection or pathogenesis by vaccination, by immunological intervention and by pharmacological intervention.

Lectures	Topics
1-5	**Introduction.** The virus and virion, origins of virology, virus taxonomy, virus nomenclature.
6-10	**Structure.** Background, types of virus structure and their characteristics.
10-15	**The infectious cycle.** Viral growth, virus cultivation, advancement in cell culture level, virus counting (plaque assay).
16-20	**Viral genetics.** Mutation, virus-virus and virus-host interaction that affect phenotypes, mapping mutations and genes, approaches to gene function.
21-25	**Multiplication of viruses.** Attachment and entry, RNA/DNA synthesis, assembly, maturation, and egress.
1-25	**Class Test 1**
26-30	**Pathogenesis.** Molecular and genetic determinants of virulence, selected mechanisms of viral virulence and cytopathogenicity, transmission of viral infection, patterns of viral infection,
31-35	**Viral persistence.** Mechanisms of viral persistence, examples of viruses that persist in humans.
36-40	**Insect, animal and plant viruses.** Overview of insect, animal and plant viruses, Mode of action of virus in insect, plant and animal infection.
26-40	**Class Test 2**
41-45	**Bacteriophages.** History, morphology and composition of bacteriophages, growth of virulent bacteriophage, lysogenic and lytic development, defective phages and phage like objects.
46-50	**Interferon and cytokines.** Characteristics, types, induction, action and therapeutic uses of interferon and cytokines.
51-60	**Viral infection and control:** Pathogenesis of viral diseases, prevention, control and treatment of viral infections. A brief knowledge on vaccines and antiviral drugs.
40-60	**Class Test 3**

Books recommended.

- Fundamental Virology - Bernard N Fields, David M Knipe, and Peter M Howley (ed.), 3rd Edition
- Virology Volume I and II - Bernard N Fields, David M Knipe, and Peter M Howley (ed.), 3rd Edition
- Human Herpesviruses/Advances in Experimental Medicine and Biology book series - Yasushi Kawaguchi, Yasuko Mori, and Hiroshi Kimura
- Basic Virology - Edward K Wagner and Marlinez J Hewleet, 3rd Edition
- Medical Microbiology - Jawetz, Melnick and Adelbergs
- Principles of Virology - SJ Flint, LW Enquist, and VR Raconiello, 2nd Edition
- Biology of Microorganisms - TD Brock

MBIO 302. Immunology I (3 Credits)

Rationale. This course offers the essential knowledge of immunology and its theoretical and practical aspects. In addition, through the discussion of diverse immunological topics, this course enhances our explanations about basic immune system and their functional role to protect us from infection.

Objectives of the Course. The objective of this course is to learn about the basic structure of immune system and their protective function. The primary emphasis of this course will be on the mechanisms involved in immune system development and responsiveness.

Intended Learning Outcomes

At the conclusion of the course, students will be able to advance their understanding and knowledge in:

- The fundamental components of immune system and their function
- Basic immunological principles and mechanism of protective function
- Complement and cytokines and their function
- Components of Innate and adaptive immune system
- Developmental pathway of adaptive immune cells (T cells and B cells)

Lectures	Topics
1-4	**Overview of the immune system:** A historical perspective of immunology, Important concepts for understanding the mammalian immune response, the good, bad and ugly of the immune system.
5-8	**Cells, Organs, and Micro-environments of the Immune System:** Cells of the immune system, primary lymphoid organs, secondary lymphoid organs
9-14	**Receptors and Signaling: B and T-Cell Receptors:** Receptor-ligand interactions, common strategies used in many signaling pathways, frequently encountered

Lectures	Topics
	signaling pathways, structure of antibodies, signal transduction in B cells, T-Cell receptors and signaling
15-18	**Receptors and Signaling: Cytokines and Chemokines:** General properties of cytokines and chemokines, six families of cytokines and associated receptor molecules, cytokine antagonists, cytokine-related diseases, cytokine-based therapies
1-18	**Class Test 1**
19-26	**Innate Immunity:** Anatomical barriers to infection, phagocytosis, natural killer cells, induced cellular innate responses, inflammatory responses, ubiquity of innate immunity, inflammatory responses, regulation and evasion of innate and inflammatory responses, interactions between the innate and adaptive immune systems
27-32	**The Complement System:** The major pathways of complement activation, the diverse functions of complement, the regulation of complement activity, complement deficiencies, microbial complement evasion strategies, evolutionary origins of the complement system
33-38	**The Organization and Expression of Lymphocyte Receptor Genes:** The puzzle of immunoglobulin gene structure, multigene organization of Ig genes, mechanism of V(D) J recombination, B-Cell receptor genes and expression, T-Cell receptor genes and expression
39-44	**The Major Histocompatibility Complex and Antigen Presentation:** The structure and function of MHC molecules, organization and inheritance of the MHC, role of the MHC and expression patterns, endogenous and exogenous pathway of antigen processing and presentation, cross-presentation of exogenous antigens, presentation of nonpeptide antigens
19-44	**Class Test 2**
45-50	**T-Cell Development:** Lineage commitment within thymus, early thymocytes development, positive and negative selection of thymocytes, final maturation of thymocytes and exit from thymus, other mechanisms that maintain self-tolerance.
52-56	**B-Cell Development:** The Site of Hematopoiesis, B-Cell development in the bone marrow, development of B-1 and marginal-zone B cells, comparison between B- cell and T-cell development
45-56	**Class Test 3**

Books Recommended.

1. Immunology (KUBY); Judith A. Owen, Jenni Punt, Sharon A. Stranford, 7th Edition
2. Cellular and Molecular Immunology; Abul K. Abbas Andrew H. Lichtman, Shiv Pillai, 8th Edition
3. Roitt's Essential Immunology; Ivan M. Roitt and Peter J. Delves, 10th Edition

MBIO 303. Molecular Biology (3 Credits)

Rationale

This course starts with Mendel's experiments and the principles they revealed which providing the organizing framework knowledge. Later, it deals with the biological activity between biomolecules in the various systems of a cell, including the interactions between DNA, RNA, and proteins, as well as the regulation of these interactions which enhances the underlying molecular explanation. So, it provides the basics of molecular biology.

Objectives of the Course

The course will help students to advance their understanding and knowledge in:

- Genetic inheritance, nucleic acids as genetic material, their structure and maintenance of genome, replication of DNA and recombination
- Mechanisms of transcription, translation and RNA splicing
- Genetic notation and genetic code
- Transcriptional regulation in Prokaryotes and Eukaryotes

Intended Learning Outcomes

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

- Understand the Mendelian view and structure of the DNA, RNA and the proteins;
- know the interesting replication of DNA and molecular basis of recombination;
- learn the various expression of genome and gene regulation

Lectures	Topics
1-8	**Background:** Historical background-from Mendel to genetic engineering, the principles of dominance and segregation, the principles of independent assortment; Gene and gene functions- concepts of gene, evolution of the concept of gene function and gene structure.
9-18	**Macromolecules:** Structure and function of macromolecules; DNA, RNA and proteins; Chargaff's rule; forms of DNA and versatility of RNA; Genome- structure and evolution of genomes, yeast and human genomes; Chromatin and the nucleosome; Nature of DNA damage, mismatch repair, direct repair, base-excision repair, nucleotide-repair and other types of DNA repair mechanisms.
1-18	**Class Test 1**
19-26	**Recombination and Transposable Elements:** Homologous recombination at molecular level and site-specific recombination; Transposition of DNA; Mechanisms, mutagenic effect and regulation of transposition; General characteristics, mutagenic effect and medical significance of transposable elements.
27-32	**Expression of Genome:** RNA polymerases, prokaryotic and eukaryotic promoters, assembly and synthesis, processing of transcripts and RNA splicing.

33-36	Mechanisms of translation; structure and role of t-RNA in protein synthesis, cellular components and mechanisms of polypeptide synthesis.
19-36	**Class Test 2**
37-40	Basic features of genetic code, wobble hypothesis and post translational modification of proteins.
41-48	**Regulation:** Transcriptional control in prokaryotes, negative and positive control; Transcriptional control in eukaryotes, gene control through RNA stability and RNA silencing; Gene regulation in developments and evolution.
37-48	**Class Test 3**

Books recommended

- Molecular Biology of the Gene, Seventh Edition-James D Watson, Tania A. Baker, Alexander Gann, Michael Levine, Richard Losick.
- Principles of Genetics, D. Peter Snustad and Micheal J. Simmons, 6th edition, John Wiley and Sons, Inc, USA.

MBIO 304. Principles of Biological Techniques (3 Credits)

Rationale. This course is designed to familiarize the students with the basic principles of important biochemical methods and techniques with an aim to develop their expertise in applying them for real application.

Objectives of the Course. The main objective of this course is to introduce students to some methodologies which are important in conducting research in many branches of biology.

Intended Learning Outcomes.
By taking part in this course, the student will be able to:

- Understand the basic principles and limitations of various biochemical techniques used for the purification and analysis of target biomolecules. This would enable the students to select the suitable process to study a target biomolecule.
- Interpret the experimental data generated from widely used biochemical techniques.
- Understand the applications of various biological techniques including fluorescence, luminescence, gel electrophoresis to achieve measurement or detection in biological experiments.

Lectures	Topics
1-4	**Basic principles.** Aims of laboratory investigation, Units of measurement, Weak electrolytes, Quantitative biochemical measurements, Safety in the laboratory.
5-10	**Cell culture techniques.** The cell culture laboratory and equipment, Safety considerations in cell culture, Aseptic techniques and good cell culture practice, Types of animal cell characteristics and maintenance in culture, Stem cell culture, Bacterial cell culture, Potential use of cell cultures.

Lectures	Topics
10-15	**Microscopy.** Introduction to microscopy (Resolution, Numerical aperture, magnification), The light microscope (Principle of operation and different parts), The electron microscope (Principle of operation, specimen preparation, types of electron microscope), Optical sectioning, Imaging living cells and tissues.
16-20	**Centrifugation.** Basic principles of sedimentation, Preparative and analytical centrifugation, Types of centrifuges, Care and safety aspects of centrifuges.
1-20	**Class Test 1**
21-25	**Electrophoretic techniques.** General principles, Support media, Electrophoresis of proteins and nucleic acids, Capillary electrophoresis, Microchip electrophoresis.
26-30	**Chromatographic techniques:** Principles of chromatography, Chromatographic performance parameters, High-performance liquid chromatography (HPLC), Ion-exchange chromatography, Affinity chromatography, Gas chromatography.
31-40	**Spectroscopy** **Spectrophotometric techniques.** Ultraviolet and visible light spectroscopy, Fluorescence spectroscopy, Light scattering, Atomic spectroscopy. **Spectroscopic techniques for structure and interactions.** Infrared and Raman spectroscopy, Surface plasma resonance, Electron paramagnetic resonance, Nuclear magnetic resonance, X-ray diffraction, Small-angle scattering. **Mass spectrometric techniques.** Ionization, Mass analyzers, Detectors, Structural information by tandem mass spectrometry, Analyzing protein complexes, Computing and database analysis.
41-47	**Protein structure, purification, characterization and function analysis.** Ionic properties of amino acids and proteins, Protein structure, Protein purification, Protein structure determination, Protein function.
21-47	**Class Test 2**
48-55	**Immunochemical techniques.** Antibodies and its commercial production, Antibody detection techniques, Immuno microscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Immunocapture polymerase chain reaction, Immuno affinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies, the future uses of antibody technology.
56-65	**Enzymes.** Properties and factors affecting enzyme activity, Enzyme steady-state kinetics, Michaelis-Menten equation, Lineweaver-Burk plot in explain enzyme inhibition, Analytical methods for the study of enzyme reactions, Control of enzyme activity.
48-65	**Class Test 3**

Books recommended.

- Principles and Techniques of Biochemistry and Molecular Biology; edited by Keith Wilson, John Walker, 7th Edition, Cambridge University Press.
- Biochemistry laboratory; Modern theory and techniques. Rodney Boyer. 2nd Edition. Pearson Education Inc.
- Lippincott's Illustrated Reviews: Biochemistry. Richard A. Harvey and Denise R. Ferrier. 5th Edition

MBIO 305. Food, Fisheries and Beverage Microbiology (3 Credits)

Rationale

Food, Fisheries and Beverage Microbiology discusses the microorganisms which inhabit, create or contaminate food. Food microbiology unites the disciplines of microbiology and food technology, facilitating advances in providing safer food for the world. It covers basic and applied aspects of microorganisms of importance to food safety and food spoilage as well as benefit to food supply. Better understanding of the microorganisms that cause disease and spoilage in foods will lead to better ways of controlling them. This course aims to provide instruction in the general principles of food microbiology. It is assumed that students will have receive adequate introduction to microbiology per se. The course covers the microbial contamination and spoilage of food, fisheries and beverages, basics of food processing and preservation, food borne illness, the principles to control microbial growth; as well as qualitative and quantitative microbiological analysis and microbiological quality control.

Objectives of the Course

- Gain an understanding of spoilage microorganisms and how their effects on food
- Gain an understanding of how various types of food processing affects the microflora of food products
- Become familiar with procedures and techniques used to detect and enumerate microorganisms in foods
- Think critically about problems and issues concerning beneficial and harmful microorganisms in foods.
- Integrate their basic knowledge of microbiology, chemistry, biochemistry, food processing with an understanding of how these relate to the microbiology of foods.
- Ensure quality food by risk assessment and risk management

Intended Learning Outcomes

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

- Explain the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Explain the significance and activities of microorganisms in food.
- Describe the characteristics of foodborne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.
- Explain why microbiological quality control programs are necessary in food production.
- Discuss the microbiology of different types of food commodities

- Apply the principles of quality assurance to a food production process
- Apply HACCP to a food production process
- Apply hygiene and sanitation methods to processing plants and various food processing equipment
- Apply Good Manufacturing Practices to a range of processing operations across a range of food commodities

Lectures	Topics
1-2	**Historical Background of Food Microbiology**
2-6	**Food and Microorganisms.** Food as a substrate for microorganisms, importance of microorganisms in food industry, sources of food contamination, contamination of foods; General principles underlying spoilage: Chemical changes caused by microorganisms, factors affecting microbiological spoilage of food and fish products.
07-14	**Food Preservation.** Principles of food preservation, preservation methods: High temperatures, low temperatures, drying, food additives and radiations.
15-20	**Contamination and Spoilage of Different Kinds of Foods.** Contamination of preserved foods; Spoilage of meat and meat products, fish and other seafoods, milk and milk products, vegetables and fruits, poultry and eggs.
	Class Test 1
21-25	**Foodborne Diseases.** Food infections and intoxications; Food poisoning and food-borne illness; Bacterial, fungal and algal toxins; Investigation of food-borne disease outbreak.
26-30	**Methods for the Microbiological Examination of Foods.** Indicator organisms; Direct examination, cultural techniques, Alternative and rapid methods for the detection of specific organisms and toxins; Milk quality detections including phosphatase and, methylene blue reduction tests.
31-35	**Microbiological Quality of Foods.** Quality and criteria, sampling schemes, quality control using microbiological criteria, control at source; Hazard analysis and critical control point (HACCP) concept; Good manufacturing practices (GMP).
21-35	**Class Test 2**
36-40	**Fermented and Microbial Foods.** Fermenting organisms: yeast and bacteria; Fermented milks, cheese; Fermented vegetables, meats and fish; Vinegar; Mould fermentations and Probiotics.
41-45	**Microbiology of fish.** Chemical composition and nutritional aspects of fish; Factor affecting types and load of microflora on freshly caught fish; Control of spoilage; Incidence of normal microbial flora on skin, gills and intestine of fish; Pathogenic microbes in fish; Procedure for microbial examination of fish; Fish poisoning; Symptoms of rotten fish; Stages of sea food spoilage.

Lectures	Topics
46-48	**Beverages.** Classification of beverages; Production process and microbiological aspects of carbonated non-alcoholic, alcoholic and carbonated stimulating beverages.
49-50	**Food Packaging.** Objectives of packaging; Types of different packaging materials and its microbial aspects; Properties of an ideal packaging material; Packaging of Frozen food and fish products.
36-50	**Class Test 3**

Books recommended

- Modern Food Microbiology, 3rd ed. – James M. Jay
- Food Microbiology: Advances and prospects- Roberts and Skinner
- Food Microbiology – W. C. Frazier
- Prescott and Dunn's Industrial Microbiology – G. Reed
- Microbiology of Frozen foods – R. K. Robinson
- Fish processing and preservation – G. Subbulakshmiand S. A. Udipi
- Food Microbiology- M. R. Adams and M. O. Moss
- Sanitation in food processing- John A. Troller
- Quality control in the food industry-Vol-1, S. M. Herschdoerfer
- Fish processing and preservation- G. Subbulaksmi
- Food Science- N. N. Porter and Hotchkiss
- Food Microbiology- M. R. Adams and M. O. Moss

MBIO 306. Pharmaceutical Microbiology (3 Credits)

Rationale

Pharmaceutical microbiology course is the basic requirement for the pharmaceutical companies to ensure their quality products. The companies need to face international audit to expand their trade in international areas. Microbiologists in a pharmaceutical company are inevitable, because they are the leading part of quality assurance section. The course has been designed to meet the standards and contents required by pharmaceutical companies in Bangladesh and abroad.

Objectives of the Course

- Microbiological laboratory and production (sterile and non-sterile) working areas of Pharmaceutical industry;
- The influencing risk factors of the working areas, instruments and the contamination control measures as well as validation practices;
- Several types of products, antimicrobial drugs and antimicrobial agents and their quality controlling tests;
- Sterilization and hygiene practices that are followed in pharmaceutical working industries;

- Production and quality controlling tests of vaccines, immunological and other sterile products.

Intended Learning Outcomes

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

- The students will learn the requirements for a standard working area, designing materials, personnel and management practices, the risk factors to disqualify the areas, and the controlling systems.
- The microbiologists are strongly recommended for sterile productions areas and products. They will learn several types of sterile products, their importance. Similarly, antibiotics and nonsterile products are also important from microbiological perspectives.
- They will learn the validation practices of several types of processes, instruments and areas that are very important for the pharmaceutical industries.
- Sterilization methods and factory hygiene practices will help them to enhance their knowledge to maintain the quality assurance of the industries and help them to learn the reduction of risk factors in terms of critical points.
- The study of mode of actions of antibiotics and antimicrobial agents will help to understand the scenario of generations of antibiotics, the resistance mechanisms of these agents and the scope of new drug development. The study of vaccines and immunological drugs will help to learn the production, preservation and control measures of these drugs.

Lectures	Topics
1-8	**Microbial Ecology Affecting Pharmaceutical Industry.** Air: microbial content, reduction of microbial count; Water: types – raw or mains, softened, deionized or demineralized, distilled or reverse osmosis membrane filtered water, distribution system, disinfection – chemical treatment, filtration or light, checking microbial quality by filtration; Skin and respiratory tract flora: microbial transfer from operators, hygiene and protective clothing; Raw materials; Packaging; Building: walls and ceilings, floors and drains, door-window-fitting; Equipment: pipelines, cleansing, disinfection and sterilization, microbial checks.
9-18	**Microbial Spoilage, Infection Risk and Contamination Control of Pharmaceutical Ingredients or Products.** Microbial spoilage: susceptibility to attack, observable effects, intricate factors; Health hazard: microbial toxins; Source, extent and control of contamination: in manufacture and in use; Factors determining the outcome of a medicament-borne infection; Preservation of medicines using antimicrobial agents. Quality assurance and the control of microbial risk in medicines: quality control, quality inspection, quality operation, quality management; Post-market surveillance; Microbiological quality test of raw materials and non-sterile finished products by pour, spread or drop plate, most probable number (MPN), and filtration methods; contamination test for *E. coli, Salmonella, Pseudomonas* and *Clostridium* species.
1-18	**Class Test 1**

Lectures	Topics
19-25	**Chemical Disinfectants, Antiseptics and Preservatives.** Factors determining choice of antimicrobial agent; Types of agent: acids and esters, alcohols, aldehydes, biguanides, halogens, heavy metals, hydrogen peroxide and peroxygen compounds, phenols, surface-active agents, diamidines, dyes, quinoline derivatives.
26-32	**Antibiotics and Antimicrobial Agents.** Sources and types of antibiotics; Mechanism of action of β-lactams, tetracyclines, rifamycins, aminoglycosides, macrolides, lincosamides, chlorampenicol, polypeptide antibiotics, glycopeptides, sulphonamides trimethoprim, cotrimoxazole, quinolones, polymixins; Antifungal antibiotics; Synthetic antimicrobial agents; Antiviral drugs; Drug combinations; Antibiotic sensitivity and potency tests: disc tests, dilution tests, E-tests, MIC, MBC, MFC; Bacterial resistance to antibiotics: origins and mechanisms resistance, multiple drug resistance; Non-antibiotic antimicrobial agents: mode of action and resistance.
33-40	**Principles of Good Manufacturing Practice.** Prerequisites of good manufacturing practice (GMP); Control of microbial contamination during manufacture: general aspects – risk assessment (hazard analysis critical control points [HACCP], failure mode and effects analysis [FMEA]), environmental cleanliness and hygiene, quality of starting materials, water, process design, quality control and documentation, packaging-storage-transport; Clean and aseptic areas for manufacturing sterile products- general and additional requirements, environmental monitoring, eliminating human intervention; Guide to good pharmaceutical manufacturing practice (GPMP)
19-40	**Class Test 2**
41-47	**Sterile Pharmaceutical Products.** Types of sterile products: injections, non-injectable sterile fluids, ophthalmic preparations, dressings, implants, absorbable haemostats, surgical ligatures and sutures; Instruments and equipment; Sterilization considerations: decision trees, problems of drug stability.
48-55	**Sterilization Procedures and Sterility Assurance.** Sensitivity of microorganisms: survivor curves, expression of resistance – *D*-value, Z-value, *F*-value; Sterilization methods – heat (moist/dry), gaseous (ethylene oxide/formaldehyde), radiation (gamma-ray/electron accelerators/ultraviolet), filtration (liquid/gases); Further sterilization or reduction technologies: high-intensity light, low temperature plasma, tyndallization, pasteurization, etc.; Sterilization control and sterility assurance: bioburden determinations, environmental monitoring, validation and in-process monitoring of sterilization procedures: physical, chemical and biological indicators; Sterility test – direct inoculation or membrane filtration; Pyrogen test using rabbits or limulus amoebocyte lysate reagent.
56-60	**Manufacture and Quality Control of Immunological Products.** Vaccines: Types; The seed lot system; Production of bacterial and viral vaccines; Quality control of vaccines: in process and final product control; Preparation and quality control of in-vivo diagnostics immune sera and human immunoglobulins.
41-60	**Class Test 3**

Books recommended

- Pharmaceutical Microbiology – W.B. Hugo and A.D. Russel (7th Ed.)
- Pharmaceutical Microbiology – W.B. Hugo and A.D. Russel (8th Ed.)
- Dispensing for Pharmaceutical Students – Cooper and Gums
- Guide to Microbiological Control in Pharmaceuticals and Medical Device – Stephen P. Denyer and Rosamund M. Barid (2nd Ed.)
- Pharmaceutical Biotechnology – Daan J. A. Crommelin and Robert D. Sindelar

MBIO 307. Microbial Physiology (2 Credits)

Rationale. The course will provide a foundational level of understanding of the cell structure, growth factors, metabolism of microorganisms.

Objectives of the Course. Gain a basic knowledge and understanding of Membrane transporters, transport systems in microbes, the physiology and biochemistry of microbes and the energetic aspects of respiratory processes.

Intended Learning Outcomes

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

- Demonstrate an advanced understanding of selected topics in microbial physiology (cell structure, growth, biosynthesis, transport, etc.)
- Explain the principles of the energy-yielding and consuming reactions, the various catabolic and anabolic pathways, the transport systems and the mechanisms of energy conservation in microbial metabolism
- Identify the various physiological groups of bacteria/archaea with their special features, their applications and ways to study them

Lecture	Topics
1-6	**Membrane transport, Nutrient Uptake and Protein Excretion.** Metabolite transport; Specific transport system; Export of cell surface structural components.
7-14	**Glycolysis.** EMP pathway, Gluconeogenesis, Hexose monophosphate pathway, Entner-Doudoroff pathway, Phosphoketolase pathway.
15-22	**TCA cycle, electron transport and oxidative phosphorylation.** Tricarboxylic acid cycle, Replenishment of TCA cycle intermediates, Energy transduction in prokaryotes, Role of ATP in biological energy transduction process, Proton motive force, Electron transport (oxidative) phosphorylation.
1-22	**Class Test 1**
23-30	**Nitrogen metabolism.** Nitrogen fixation, Assimilation of inorganic nitrogen, General reaction of amino acids- decarboxylases, deaminases, transaminases, racemases, the stick land reaction.

Lecture	Topics
31-36	**Responding to Environmental Changes.** Sensory Systems; The Immune System; Molecular Motors.
37-42	**Metabolic diversity.** Phototrophy, Autotrophy, Chemolithotrophy, Chemoorganotrophy, Fermentation, Anaerobic respiration.
22-42	**Class Test 2**
43-50	**Microbial Stress Response.** Osmotic stress and osmoregulation; Aerobic to anaerobic transitions; Oxidative stress, Thermal stress, heat and cold shock response; pH stress and acid tolerance; Nutrient stress; Extremophiles; Quorum sensing.
43-50	**Class Test 3**

Books recommended

1. Microbial Physiology by A. G. Moat and J. F. Foster.
2. Bacterial Physiology and Metabolism by Byung Hong Kim and Geoferry M Gadd.

MBIO 308. Diagnostic Microbiology and Pathology (2 Credits)

Rationale

The clinical presentation of an infectious disease reflects the interaction between the host and the microorganism. This interaction is affected by the host immune status and microbial virulence factors. Signs and symptoms vary according to the site and severity of infection. Diagnosis requires a composite of information, including history, physical examination, radiographic findings, and laboratory data. In our increasingly populated and mobilized world, infectious disease remains a core public health issue. In this course student should consolidate their understanding of infectious microorganisms and their extraordinary ability to adapt and survive. Moreover, student will be able to know about molecular mechanisms of microbial drug resistance and different types of diagnostic methods.

Pathology is a core part of Microbiology, which involves the study of diseases, such as infections and cancers, at the genetic, molecular, cellular, and organ levels.Students will learn general principles about the processes involved in disease

Objectives of the Course

- To introduce students with basic and modern laboratory techniques.
- To develop skills in the isolation and identification of microorganisms, and investigation of anti-microbial agents.
- To engage students in professional practice in microbiology laboratories.
- To contribute to the students' achievement in understanding fundamental principles of disease and recognizing disease states across the range of species, focusing upon human being

Intended Learning Outcomes

On successful completion of this module the learner will be able to:

- Provide an overview of the role and operation of the clinical microbiology laboratory in the pathology service.
- Investigate the characteristics of the common microorganisms associated with infectious diseases in humans.
- Review the strategies used for isolation and identification of disease-causing organisms from various clinical samples including urine, faces, blood, sputum and CSF.
- Practice techniques for characterization of bacteria from clinical specimens.
- Describe the methods used for antimicrobial susceptibility testing in the clinical laboratory.
- Perform laboratory tests to investigate anti-microbial agents

Lectures	Topics
1- 4	**Antimicrobial Agents.** Microbial resistance to antimicrobial agents; Detection and characterization of antimicrobial resistance genes in pathogenic bacteria.
5-12	**Sample Collection and diagnostic studies.** General principles for specimen collection and handling; Different approaches to sample collection and examination of cerebrospinal fluid (CSF), urine, blood, sputum, fecal specimens, pus and skin materials; Diagnosis of virus, mycoplasma, rickettsia and sexually transmitted diseases; Procedures for the storage of microorganisms; Antibacterial susceptibility testing; Quality assurance and SOP.
1-12	**Class Test 1**
13-22	**Immunoassays for the diagnosis of infectious diseases.** Collection of serum and antiserum; Monoclonal and polyclonal antibodies; Antigen-antibody reactions: principles, agglutination reactions, complement fixation and opsonization test, neutralization reactions, precipitation reactions- simple immunodiffusion and different types of immunodiffusion test, electro immunodiffusion and different types of electro-immunodiffusion, immuno-electrophoresis, fluorescent-antibody techniques, immunoassay-EIA, RIA, ELISA, immunofluorescence and immunoblotting.
13-22	**Class Test 2**
23-30	**Accessory detection systems.** Nucleic acid hybridization techniques, Nucleic acid amplification techniques; Biotin-Avidin detection system; Chemiluminescence/ bioluminescence; Plasmid fingerprinting.
31-42	**Details study of Human Pathogens.** *Helicobacter pylori; Klebsiella pneumoniae; Shigella sp; Listeria monocytogenes; Neisseria gonorrhoeae; Ehrlichia; Borrelia; Yersinia pestis; Pseudomonas aeruginosa, Mycoplasma, Rickettsia and Chlamydia.*
31-42	**Class Test 3**

Books recommend

- Medical Microbiology and Immunology: Examination and Board Review (5th Ed.) – W. Levinson and E. Jawets. Prentice-Hall Internaional Inc. 1996.
- Manual of Clinical Microbiology (9th edition) - Patrick R. Murray and Ellen Jo Baron, Michal A. Petter and James H. Jorgensen. BSM press, Washington D. C. 2007
- Medical Microbiology (3th edition) – Patrick R. Murray, Ken Rosenthal and Michael Pfalled. Mosby Inc. Missouri 63146. 1997.
- District Laboratory Practice in Tropical Countries (Part 1 and 2) 2nd edition- Monica Cheesbrough.

MBIO 309. Environmental Microbiology (2 Credits)

Rationale

Environmental microbiology deals with study of microorganisms in the field of environment. This course is devoted to the advancement of understanding of structure and activities of microbial communities, interactions with microorganisms, microbial processes and microbial life in extreme and unusual environments.

Objectives of the Course

- To know how complex ecosystem operate
- To understand the use of microbes to clean up toxic wastes or pollutants
- To learn more about fundamental microbiology and microbial ecology and how this relates to geochemical processes in natural and managed environments

Intended Learning Outcomes

- The mechanisms microbes use to obtain energy for growth and other purpose and how these biochemical processes link with geochemical cycling of the elements
- Several methods for identifying and enumerating bacteria in natural environments
- How to quantitatively measure specific microbial activities in the environment

Lectures	Topics
1-5	**Population Interactions.** Interactions Between Microorganisms and Plants: Interactions with plant roots- The Rhizosphere, Mycorrhizae; Nitrogen fixation in nodules; Interactions with aerial plant structures.
6-10	**Interactions between microorganisms and animals.** Microbial contributions to animal nutrition; Predation on microorganisms by animals; Commensal and mutualistic intestinal symbionts; Digestions within the rumen; Mutualistic association of invertebrates with photosynthetic, Chemolithotrophic and Methanotrophic microorganisms; Fungal predation on animals; Other symbiotic relationship; Ecological aspects of animal disease.

Lectures	Topics
1-10	**Class Test 1**
11-20	**Biogeochemical Cycling.** Biogeochemical cycling- reservoirs and transfer rates; The Carbon cycle- Carbon transfer through food webs, carbon cycling within habitats, Methanogenesis and methylotrophy, Acetogenesis, Carbon monoxide cycling, Limitations to microbial carbon cycling. The nitrogen cycle; The hydrogen cycle; The oxygen cycle. The sulfur cycle; The phosphorous cycle; The iron cycle; Other cycling. **Microbial degradation.** Microbial degradation of polysaccharides and lignin, Biodegradation and Heterotrophic production in aquatic environments.
11-20	**Class Test 2**
21-30	**Quantitative Ecology.** Numbers, Biomass and Activities: Sample collection and processing; Detection of microbial populations- phenotypic detection, lipid profile analysis, molecular detection; Detecting nonculturable bacteria; Determination of microbial biomass; Measurement of microbial metabolism.
21-30	**Class Test 3**

Books recommended

- Microbial Ecology: Fundamental and Applications. R.M. Atlas and R. Bartha.
- Microbial Ecology: A Concept Approach. J. M. Lynch and Poole.
- Microbiology. M. J. Pelczar, Jr. ECS Chan and NR Greig.
- Microbial Ecology: Organisms, habitants and activities. Heinz and Stolph.
- Microbiology. R. M. Atlas
- Brock Biology of Microorganisms. M.T. Madigan, J.M. Martinko and J. Parker

MBIO 310. Microbiology Laboratory IV (3 Credits)

1. Identification of an unknown bacteria
2. Isolation and identification of *E. coli* from water/food sample
3. Isolation and identification of *Salmonella* from salad/ poultry products
4. Isolation and identification of *Bacillus* from soil sample
5. Isolation and identification of *Pseudomonas*
6. Isolation and identification of actinomycetes
7. Determination of microbial growth curve
8. Identifying archaea and bacteria using the internet and computer-assisted gene analysis
9. The API 20E System
10. The Enterotube II system
11. Examination of milk for bacteria
12. Methylene blue reduction test
13. Enumeration of bacteriophage from drain water by plaque assay method
14. Study of isolation and identification of common seed fungi from oil seeds
15. Study of morphology of vesicular mycorrhizal fungi
16. Study of rhizosphere microorganisms.

MBIO 311. Analytical and Industrial Microbiology Laboratory (3 Credits)

1. Detection of antigen/antibody by ELISA
2. Quantitative estimation of protein
3. Quantitative estimation of reducing sugar
4. Study of the structure and operation of various parts of lab fermenter
5. Study of Microbial alcohol production
6. Study of Microbial citric acid production
7. Microbiology of Yogurt Production
8. Study of dough fermentation by baker’s yeast
9. Separation of amino acids by thin layer chromatography (TLC)
10. Separation of sugars by thin layer chromatography (TLC)
11. Study of plant pigments separation by paper chromatography
12. Separation of components of a solution by high performance liquid chromatography (HPLC)

MBIO 312. Medical Microbiology Laboratory (2 Credits)

1. Detection of *Treponemapallidum* antigen by VDRL test
2. Widal test
3. Determination of Anti-Streptolysin O (ASO) antibody titre
4. Demonstration of antibacterial action of different antibiotics on Gram positive and Gram-negative bacteria by disk diffusion, agar cup or similar techniques
5. Isolation and identification of *Staphylococcus aureus* from skin
6. Isolation and identification of *Shigella/Salmonella/E. coli* from stool sample
7. Isolation and identification of *Vibrio* from stool sample
8. Identification of causative organism and antibiotic sensitivity pattern of gastrointestinal, respiratory, and urinary tract infection
9. Mortality and Morbidity Weekly Report
10. Epidemic Simulation

MBIO 313. Pharmaceutical Microbiology Laboratory (2 Credits)

1. Swab test
2. Sensitivity and potency test of antibiotics
3. Detection of presence of endotoxin/pyrogen by LAL test
4. Isolation and Identification of pathogenic microorganisms from supplied sample (TVC, total coliform, total fecal coliform, and related pathogens)
5. Determination of minimum inhibitory concentration (MIC)
6. Determination of minimum bactericidal concentration (MBC)
7. Determination of minimum fungicidal concentration (MFC)
8. Total viable count of air by settle plate method
9. Sterility testing using membrane filtration
10. Screening and Identification of antibiotic producing microorganisms from soil sample
11. Determination of LD_{50} dose for given antigen

MBIO 314. Viva-voce (2 Credits)

There will be viva-voce examination after the completion of theoretical and practical examinations

MBIO 315. Sessional (4 Credits)

Slides and specimen collections (10) + Practical Note Book (20) + Class Test (60) + Class Attendance (10)

COURSES FOR THE FOURTH YEAR B. Sc. HONOURS

Courses	Credits
MBIO 401: Virology II	3
MBIO 402: Immunology II	3
MBIO 403: Cell Biology	3
MBIO 404: Medical Parasitology	2
MBIO 405- Genetic Engineering	3
MBIO 406: Bioinformatics	3
MBIO 407: Environmental Pollution and Bioremediation	3
MBIO 408: Pharmaceutical Biotechnology	3
MBIO 409: Microbial Biotechnology	3
MBIO 410: Research Methodology	2
MBIO 411: Cell Biology Laboratory	3
MBIO 413: Molecular Biology Laboratory	3
MBIO 414: Environmental Microbiology Laboratory	2
MBIO 415: Bioinformatics Laboratory I	2
MBIO 416: Viva-voce	2
MBIO 417: Sessional	4
Total credits	**44**

MBIO 401. Virology II (3 Credits)

Rationale. The course of Virology-II gives an emphasis on developing an understanding of the pathogenesis or replication strategies of different representative DNA and RNA viruses and the effects of virus infection on cell growth control and survival at the molecular level with prevention and treatments methods. It includes detail studies on viral respiratory, gastrointestinal infections, Hepatitis viruses, Retroviruses, Oncogenic viruses and HIV

Objectives of the Course

- Understand how viruses enter target cells, amplify their genomes and exit from the target cells.
- Develop the understanding of the experimental systems used to elucidate individual steps in virus life cycles and their interactions with host cells.
- Know how host cell-virus interactions leading to production of progeny virus and interactions involved in establishing and maintaining long-term interactions, such as latency and oncogenesis.
- Describe the growth behavior differences between normal cells and cells transformed by oncogenic DNA and RNA viruses
- Describe the processes involved in the anti-tumor effects of ‘anti-tumor’ viruses.
- Recognize the ways to inhibit infections or utilize them for medical benefit

Intended Learning Outcomes

- Explain pathogenesis of diseases caused by viruses
- Distinguish replicative virus infection from virus latency
- Recognize the molecular mechanisms of control of the process and activation of viral genomes during reactivation.
- Understand tumor suppressor genes; describe how the corresponding gene products are involved in normal cell growth control, how tumor suppressor gene products intersect growth control/survival pathways, and how tumor viruses interact with these products and their intersecting pathways.
- Recognize an epidemic or pandemic of virus infection
- Recognize current strategies to prevent virus infection or pathogenesis by vaccination, by
- Immunological intervention and by pharmacological intervention. immunological intervention and by pharmacological intervention.
-

Lectures	Topics
1-4	**General principle.** Pathogenesis, prevention and treatment of viral infections in brief.
5-10	**Positive strand RNA viruses**. Picornaviruses (Polioviruses, their replication, and pathogenesis); Flaviviruses (Dengue viruses, their replication, and pathogenesis).
11-15	**Negative strand RNA viruses**. Orthomyxoviruses: Influenza pathogenesis and bird flu.
16-23	**Double strand RNA viruses**. Reoviruses (Rotaviruses and their replication); Retroviruses: structure, classification, and life cycle; Reverse transcription; retroviruses: HIV, viral pathogenesis, and AIDS.
1-23	**Class Test 1**
24-27	**Small DNA viruses**. Parvoviruses: viruses and their replication.
28-36	**Large DNA viruses.** Herpesvirus (Herpes simplex viruses, Cytomegalovirus, and Epstein-Barr virus): replication and viral pathogenesis.
37-44	**Hepatitis viruses.** HBV-structure, replication, pathogenesis and genetic variants, epidemiology, transmission and prevention.
23-44	**Class Test 2**
45-52	**Oncogenic viruses.** RNA tumor viruses-retroviridae, general features and classification. HTLV-genome structure and replication, T-cell transformation. DNA tumor viruses- EBV-structure, genome organization, transmission and epidemiology, disease pathogenicity, treatment and vaccine approaches.
53-57	**Other form of virus particles.** Viriods, prions, and delta virus.
58-60	**Antiviral agents and gene therapy.** Vaccines, antiviral drugs, and antiviral gene therapy (with examples).
45-60	**Class Test 3**

Books recommend

- Fundamental Virology - Bernard N Fields, David M Knipe, and Peter M Howley (ed.), 3rd Edition
- Virology Volume I and II - Bernard N Fields, David M Knipe, and Peter M Howley (ed.), 3rd Edition
- Human Herpesviruses/Advances in Experimental Medicine and Biology book series - Yasushi Kawaguchi, Yasuko Mori, and Hiroshi Kimura
- Basic Virology - Edward K Wagner and Marlinez J Hewleet, 3rd Edition
- Medical Microbiology - Jawetz, Melnick and Adelbergs
- Principles of Virology - SJ Flint, LW Enquist, and VR Raconiello, 2nd Edition

MBIO 402. Immunology II (3 Credits)

Rationale. This course offers the advanced knowledge of immunology and its theoretical and practical aspects. In addition, through the discussion of diverse immunological topics, this course enhances our explanations about advanced immune system and their functional role to protect us from infection.

Objectives. Learn about the various elements and mechanisms of immune system and their protective function. The primary emphasis of this course will be on the diverse functional role of immune system and responsiveness against infectious disease and cancer.

Intended Learning Outcomes

- Understand humoral immune cells and response, Hypersensitivity and autoimmunity.
- Response against infectious diseases and vaccine development
- Immunodeficiency disorders and cancer immune response
- Experimental methods used in immunology

Lectures	Topics
1-4	**T-Cell Activation, Differentiation, and Memory.** T-Cell activation and the two-signal hypothesis, T-Cell differentiation, T-Cell memory,
5-10	**B-Cell Activation, Differentiation, and Memory Generation:** T-dependent B-Cell responses, T-independent B-Cell responses, Negative regulation of B cells
10-15	**Effector Responses: Cell-and Antibody-Mediated Immunity:** Antibody-mediated effector functions, Cell-mediated effector responses, Experimental assessment of cell-mediated cytotoxicity
1-15	**Class Test 1**
16-18	**The Immune Response in Space and Time:** Immune cell behavior before antigen is introduced, Immune cell behavior during the innate immune response, Immune cell

Lectures	Topics
	behavior during the adaptive immune response, Immune cell behavior in peripheral tissues
19-24	**Allergy, Hypersensitivities, and Chronic Inflammation:** Allergy: a Type I hypersensitivity reaction, Antibody-mediated (Type II) hypersensitivity reactions, Immune complex-mediated (Type III) hypersensitivity, Delayed-type (Type IV) hypersensitivity (DTH), Chronic inflammation
25-30	**Tolerance, Autoimmunity, and Transplantation:** Establishment and maintenance of tolerance, Autoimmunity, Transplantation immunology.
16-30	**Class Test 2**
31- 33	**Infectious Diseases and Vaccines:** The importance of barriers to infection and the innate response, Viral infections, Bacterial infections, Parasitic infections, Fungal infections, Emerging and re-emerging infectious diseases, Vaccines
34-36	**Immunodeficiency Disorders.** Primary immunodeficiencies, Secondary immunodeficiencies
37-40	**Cancer and the Immune System.** Terminology and common types of cancer, Malignant transformation of cells, Tumor antigens, The immune response to cancer, Cancer immunotherapy
41-45	**Experimental Systems and Methods:** Antibody Generation, Immunoprecipitation-based Techniques, Agglutination reactions, Antibody assays based on antigen binding to solid-phase supports, Methods to determine the affinity of antigen-antibody interactions, Microscopic visualization of cells and subcellular structures, Immunofluorescence-based imaging techniques, Flow cytometry, Magnetic activated cell sorting, Cell cycle analysis, Assays of cell death, Biochemical approaches used to elucidate signal transduction pathways, Whole animal experimental systems
31-45	**Class Test 3**

Recommended Books

- Immunology (KUBY)- Judith A. Owen, Jenni Punt, Sharon A. Stranford, 7th Edition
- Cellular and Molecular Immunology- Abul K. Abbas Andrew H. Lichtman, Shiv Pillai, 8th Edition
- Roitt's Essential Immunology- Ivan M. Roitt and Peter J. Delves, 10th Edition

MBIO 403. Cell Biology (3 Credits)

Rationale

The course provides an understanding of the fundamentals of cell biology as well as prepares the student to evaluate and design new research in the cutting-edge areas of modern cell biology.

Objectives of the Course

- Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Apprehend how these cellular components are used to generate and utilize energy in cells
- Learn the general principles of how ions and molecules traverse cell membranes.
- Explain the mechanisms by which eukaryotic cells communicate with each other using extracellular signal molecules such as hormones and growth factors.
- Understand how the cell cycle is controlled and coordinated

Intended Learning Outcomes

- Explain structure, function and regulation of proteins in prokaryotic and eukaryotic cells, molecule transportation across the membrane.
- Explain and compare different principles of how extracellular signals can reach the cell interior, be amplified, transmitted and terminated, and exemplify how signal routes are integrated and how specificity can be achieved.
- Account for the molecular mechanisms regulating and controlling cell division and the cell cycle and exemplify how extracellular signals affect cell division

Lectures	Topics
1-6	**An overview of cell and cell research:** The Origin and Evaluation of Cells, the prokaryotic cell, the eukaryotic cell, organelles. Cells as Experimental Models, Tools of cell biology: Growing cells in culture; Microscopy and Biochemistry; Genetics and genome.
7-12	**Protein structure and function:** structure, folding, regulation of protein function
13-18	**Membrane Structure:** lipid bilayer; membrane proteins; synthesis of phospholipids, sphingolipids and cholesterol.
1-18	**Class Test 1**
19-24	**Transmembrane transport of ions and small molecules:** transmembrane transport; transport of glucose and water; ATP-powered pumps and the intracellular ionic environment; Non-gated ion channels and the resting membrane potential; Cotransport by Symporters and Antiporters; Transcellular transport.
25-30	**Moving Proteins into Membranes and Organelles:** Targeting proteins to and across the ER membrane; Insertion of membrane proteins into the ER; Protein modifications, folding, and quality control in the ER; Targeting of proteins to Mitochondria and Chloroplasts; Targeting of Peroxisomal Proteins; Transport into and out of the Nucleus

Lectures	Topics
31-36	**Vesicular Traffic, Secretion, and Endocytosis:** Techniques for Studying the Secretory Pathway; Molecular Mechanisms of Vesicle Budding and Fusion; the secretory pathway; Endocytosis.
19-36	**Class Test 2**
37-42	**Cell Signaling:** Principles; Cell Signaling and Functions Controlled by Kinases; Cell Signaling and Functions Controlled by Phosphatases.
43-50	**Signal Transduction and G Protein-Coupled Receptors:** Signal Transduction: From Extracellular Signal to Cellular Response; Studying Cell-Surface Receptors and Signal Transduction Proteins; G Protein–Coupled Receptors: Structure and Mechanism; G Protein–Coupled Receptors That Regulate Ion Channels; G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase; Protein–Coupled Receptors That Trigger Elevations in Cytosolic Ca^{2+}.
37-50	**Class Test 3**

Books Recommended

- Molecular Cell Biology. Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher and Hidde Ploegh. 7th edition. W.H. Freeman and Co. New York. 2013
- Molecular Biology of Cell. Bruce alberts, Alexander johnson, Julian lewis, David morgan, Martif raff, Keith Roberts and Peter walter. 6th edition. Garland Pub. NewYork 1989
- The Cell: A Molecular Approach. Geoffrey M. Cooper and Robert E. Hausman. 4th Edition.: ASM Press. Washington, D.C. 2009.

MBIO 404. Medical Parasitology (2 Credits)

Rationale. This course provides students with an understanding of parasitic infections of humans (especially those caused by protozoa and helminthes). It is designed to give a broad overview of general parasitology, with respect to types of parasites, nature of parasitism, advantages and disadvantages of parasitism and identification of novel antiparasitic reagents. Briefly, the course will cover the biology of the parasites, life cycles, epidemiology, clinical features, laboratory diagnosis, treatment and prevention of human parasitic infections.

Objectives of the Course

- To expose students to the knowledge of host-parasite relationship.
- To help students to acquire knowledge concerning biological, epidemiological and ecological aspects of parasites causing diseases to humans.
- To develop student's awareness of the pathogenesis, clinical presentations and complications of these parasitic infections.

- To help the students to select the diagnostic methods in order to reach the final proper diagnosis.
- To help the students to know the general outline of treatment, the best drug of choice, prevention and control of parasitic diseases.
- To develop students' knowledge about endemic parasitic problems and their impact upon health

Intended Learning Outcomes

- understand the basic biology and life cycles of human parasites and explain the nature of host-parasite relationship
- understand human parasitic infections, including epidemiology, clinical features, laboratory diagnosis, treatment and prevention,
- Acquire a basic level of skill in the laboratory diagnosis of human parasitic infections and ability to critically analyze the results of laboratory investigations.

Lectures	Topics
1- 4	**Introduction to Parasitology.** Taxonomy and classification of human parasites; Specimen collection, Transport and processing; Reagents, Stains and media; Algorithms for detections and identifications of parasites.
1-4	**Class Test 1**
5- 22	**Detail study of parasites.** *Plasmodium* and *Babesia; Leishmania and Trypanosoma; Toxoplasma;* Pathogenic and Opportunistic free living Amebae; Intestinal and Urogenital Amoebae; Flagellates and Ciliates*; Isospora; Cyclospora and Sarcocystis; Cryptosporidium; Microsporidia;* Nematodes- *Ascaris lumbricoides*, *Enterobius vermicularis*, and *Trichuris trichiura*; Filarial Nematodes – Lymphatic parasites, *Onchocerca volvulus, Mansonella* sp.; Cestodes- *Diphyllobothrium latum* and *Tenia* sp.; Trematodes: Schistosomes and *Paragonimus*; Less common Helminths: *Anisakis trichinella* and *Dracunculus medinensis*; Arthropods of Medical importance: *Diptera, Sphonaptera, Phthiraptera* and direct injury caused by other vectors.
5-22	**Class Test 2**
23- 30	**Antiparasitic agents and susceptibility test methods.** Antiparasitic agent; Mechanisms of resistance to Antiparasitic agents; Susceptibility test methods.
23-30	**Class Test 3**

Books Recommended

- Manual of Clinical Microbiology-Part 6 (9th edition) - Patrick R. Murray and Ellen Jo Baron, Michal A. Petter and James H. Jorgensen. BSM press, Washington D. C. 2007
- Medical Microbiology (3^{th} edition) – Patrick R. Murray, Ken Rosenthal and Michael Pfalled. Mosby Inc. Missouri 63146. 1997.
- District Laboratory Practice in Tropical Countries (Part 1 and 2) 2^{nd} ed- Monica Cheesbrough.

MBIO 405. Genetic Engineering (3 Credits)

Rationale. This course offers a viewpoint and a range of experimental approaches that find application in many areas of biological enquiry. At the molecular end of the subject, the availability of sequence information and genomic analysis, together with sophisticated techniques for gene replacement, and analysis of gene expression patterns, gives us much more powerful tools for looking at the way genes work to make us what we are.

Objectives of the Course

- Understand genomic structure, sequencing metods of DNA, analysis and separation of biomolecules.
- Understand various basic tools and techniques of modern biology, which is necessary in all aspects of genetic engineering.
- Application of genetic engineering in industries, medical, forensic side and also to get transgenic plants and animals

Intended Learning Outcomes

- Understand the fundamental knowledge of genetic information, structure of biomolecules, gene expression, regulation, transcriptome and proteome;
- Develop a clear understanding about nucleic acids working (isolation of DNA and RNA, handling labelling, digestion, ligation);
- Learn the methodology of gene manipulation;
- to get a broad education in all aspects of genetics and know how these relate not only to biological problems but also to many human welfare

Lectures	Topics
1-4	**Introduction:** Aims and scope, basic cell types, organization of living systems and flow of genetic information.
5-12	**Gene and genome**: Gene and genome, anatomy of a gene, gene structure in prokaryotes and eukaryotes; Gene expression; Mechanisms of transcription and translation; Regulation of gene expression; Genome size and organization; Transcriptome and proteome.
13-26	**Working with Nucleic acids:** Isolation, handling and quantification of nucleic acids; labelling nucleic acids, labelling by primer extension and nucleic acid hybridization, gel electrophoresis; basic DNA sequencing; Principles of sequencing, preparation of DNA fragments for sequencing; Maxam-Gilbert (chemical) and, Sanger-Coulson (dideoy or enzymatic) sequencing; Reading and automation of sequencing; Restriction endonucleases, polymerases and DNA ligase.
1-26	**Class Test 1**
27-30	**Gene Manipulation:** Methods of gene manipulation; host cells, plasmid vectors and designing plasmid, bacteriophage vectors, hybrid vectors, vectors for eukaryotic cells, artificial chromosomes.

31-38	Getting DNA into cells; transformation, transfection, packaging of DNA *in vitro;* Cloning from mRNA-synthesis of cDNA, cloning cDNA into vectors, making genomic library.
39-44	Advanced cloning strategies, cloning large DNA fragments in BAC and YAC vectors; Feature of polymerase chain reaction (PCR), primers, polymerase for PCR, nested PCR, inverse PCR, RAPD and application of PCR.
45-48	Genetic selection and screening methods and analysis of cloned genes based on blotting techniques and restriction mapping.
27-48	**Class Test 2**
49-56	**Importance of genetic engineering.** Recombinant proteins; Genetic engineering in industries, diagnosis, medical and forensic side; Transgenic plant and animals; Ti plasmids as vectors for plant cells, making transgenic plant and animals, their applications; Human genome project, transcriptome, proteome, metabolomes and interactomes.
49-56	**Class Test 3**

Books Recommended.

1. Old R W and Primose SB Sixth edition," Principles of gene manipulation", BlackWell Scientific Publications, 2001.
2.Molecular Biology of the Gene-J.Watson
3. Genetic Engineering-Kingsman and Kings man
4. Bernard R. Glick and Jack J. Pesternak Third edition, " Molecular Biotechnology: Principles and Applications of recombinant DNA", American Society for Microbiology.2003
5. An Introduction to Genetic Engineering- Desmond S. T. Nicholl.

MBIO 406. Bioinformatics (3 Credits)

Rationale. Bioinformatics is rapidly becoming an essential technology at the forefront of medical and life sciences research. The capability of performing genome wide large-scale analyses and sophisticated proteomics techniques offered by the bioinformatics discipline are required to address complex biological issues.

Objectives of the Course. This course will introduce you the principles and key concepts of bioinformatics with basics about DNA, RNA and protein, progress to databases, sequence alignments, evolutionary history reconstruction, genome annotation, and analysis of gene and protein expression. Computer-based labs will provide you hands-on experience with databases and bioinformatics tools and develop your skills in the analysis of biological data.

Intended Learning Outcomes. Upon successful completion of the course, the students should be able to explain the basics of bioinformatics and computational biology and use bioinformatics search

tools online for mining data, pairwise and multiple sequence alignments and predict protein structures

Lectures	Topics
1-3	**Bioinformatics.** Introduction, Importance, prospects, limitations, a brief understanding of biotechnology and microbiology.
4-6	**Bioinformatics databases.** Types of databases (primary and secondary databases), Nucleotide sequence databases (EMBL, Genebank, DDJB, UniGene, SGD, EMI gemones, Genome biology), protein sequence databases (SwissProt/ TrEMBL, PIR, UniProt), protein structure databases (Protein data bank, SCOP, CATH), Literature databases (PubMed).
7-10	**Sequence alignment and database searching.** ***a) Pair-wise sequence alignment.*** Dotplot, Dynamic programming- scoring matrix, PAM, BLOSUM, local and global alignment, Needleman-Wunsch and Smith-Waterman algorithm, Heuristic methods- BLAST, FASTA, Statistics of sequence alignment score-E-value and P-value. ***b) Multiple sequence alignments.*** Logic, Clustral omega, sequence profile.
11-13	**Phylogenetic tree.** study of evolution, Importance, reading phylogenetic trees, rooted and unrooted trees, tree construction-Neighbouring-Joining (NJ) method.
14-15	**Genome organization and evolution.** genomics and proteomics, map viewer, SNPs, Gene prediction.
1-15	**Class Test 1**
16-19	**Protein structure.** structural databases- PDB, Hierarchical databases, other structural databases.
20-28	**Structure prediction.** secondary structure prediction, accuracy of secondary structure prediction, predicting main physicochemical properties of protein, protein digestion, prediction of transmembrane and signal helices, prediction of disorder segments, prediction of tertiary, ligand- protein interaction, molecular docking, prediction of functional site of protein and drug designing.
29-32	**Analyzing a single DNA sequence.** verifying a restriction map, designing PCR primers, establishing the G+C content of a sequence, ORF finding in the DNA sequence, vector screening, assembling sequence with CAP3.
16-32	**Class Test 2**
33-39	**Metabolic pathways.** introduction to metabolic databases, BioCyc, Kegg, introduction to microarray technology, data analysis, application of microarray technology.
40-45	**PERL Programming Language.** programming for biologists, ease of PERL, writing PERL regular expression to manage biological data.
33-45	**Class Test 3**

Books Recommended

- Lesk, M. (2002): Introduction to Bioinformatics
- Rastogi, S.C., Namita Mendiratta, Parag Rastogi: Bioinformatics
- Campbell and Heyer: Discovering genomics, proteomics and bioinformatics
- Claverie and Notredame: Bioinformatics for Dummies
- Jin Xiong: Essential Bioinformatics

MBIO 407. Environmental Pollution and Bioremediation (3 Credits)

Rationale. The course has been designed to improve the understanding of the students about different pollution and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e. air, water and soil. The course will also be dealing about the sources of pollution in air, soil, water, solid-waste and noise and the impacts these sources on the environment and health.

Objectives of the Course.

- To assess air pollution: sources and effects
- To assess sources and classification of water pollutants
- To assess sources of soil contamination

Intended Learning Outcomes.

- Identify various types of environmental problems in mining industry;
- Know the methods of managing and controlling of various environmental problems in
- Mining and processing industries;
- Design some local machines/equipment for the containment of environmental problems

Lectures	Topics
1-3	**Environmental Pollution.** Types, sources and causes; impacts on health and ecosystem.
4-8	**Air, Water and Soil Quality.** Air quality and Air toxics, Physical, chemical and microbiological properties of water to determine water quality. Soil functions and degradation threats; Soil sustainability.
9-13	**Water Treatment Technologies.** Coagulation, Flocculation and Sedimentation, Filtration, Disinfection
14-17	**Sewage and Wastewater Treatment Technologies.** Origin, constituents and quality indicators of sewage or wastewater; Pre-treatment, primary, secondary and tertiary treatment of industrial and domestic wastewater; Sludge treatment and disposal.
18-20	**Treatment of Solid Waste and Management.** landfills and composting; Bio-waste treatments.

21-26 **Bioremediation.** Define, Types (*in situ* vs. ex situ; intrinsic vs. engineered; solid vs. slurry phase; bio-stimulation, bioventing, bio-sparging and bioaugmentation, Phytoremediation and Mycoremediation); Advantages and disadvantages.

27-32 **Biodeterioration *Vs.* Biodegradation.** Biodegradation of cellulose, hemicellulose and lignin, Role of microbes (aerobic or strictly anaerobic) in degradation or corrosion of metals; Types, mechanisms, and protection of metal corrosion, Microbes involved in degradation of natural (grain, oil-seed, wood, wool, fur, feather, leather, stone) and processed (pesticides and herbicides, detergents, fuel, lubricant, glass, paint) products, Physical, chemical and biological means of biodeterioration control.

33-41 **Biodegradable vs Recalcitrant Polymers.** Microbial degradation of biopolymers and recalcitrant polymeric substances (like PAH). Environmental impacts of microbial exopolymers; Aerobic and anaerobic degradation of aliphatic and aromatic compounds; Analysis of chemical features of recalcitrant compounds; Tools for recalcitrant biomass characterization; Structure-recalcitrance relationship; Catabolic genes involved in bioremediation.

42-45 **Viable but Non-culturable (VBNC) Microbes.** VBNC microbes in environment, food and water; Inducers of VBNC state; Emerging microbiological methods for detection of VBNC microbes.

Books Recommended

- Bioremediation: Principles and Applications. R.L. Crawford and D.L.Crawford.
- Ecological System and the Environment. T.C. Foin.
- Bio-treatment systems. D.L. Wise. Volume II
- Microbial Ecology: Fundamentals and applications. R.M. Atlas and R.Bartha. 4th edition.
- Microbial Ecology: A conceptual approach. J. M. Lynch and N.J. Poole
- Microbiology: Fundamentals and applications. R. M. Atlas. 2nd edition.
- Microbial Ecology: Organisms, habitats and activities. Heinz Stolp.
- Brock Biology of Microorganisms. M.T. Madigan, J.M. Martinko and J. Parker. 10th edition
- Current perspective in the Environment Ecology. M.J Klug and C.A. Reddy.

MBIO 408. Pharmaceutical Biotechnology (3 Credits)

Rationale. Pharmaceutical Biotechnology course is the collections of advanced thoughts of biotech pharmaceutical products and their ins and outs. The course is designed based on studies of various biopharmaceuticals, the present and future status, their development processes, and various important biological molecules/ compounds. The contents will help the students to understand the course in terms of research and industrial scopes.

Objectives. The objectives of the course are to help the students to advance their understanding and knowledge in:

- biopharmaceuticals, their history and their current and future status
- various types of drug development processes, product recovery and product analysis;
- general concepts of various types of biological products, for example, cytokines, growth factors, hormones, recombinant blood products and therapeutic enzymes, antibodies, vaccines, and adjuvants;
- nucleic acid and cell-based therapeutics and active antimicrobial agents from phyto-metabolites.

Intended Learning Outcomes.

The intended learning outcomes of the course can be described as follows:

- In industrial scales, these thoughts will help the students to learn the basic concepts of development of the drugs and they will learn the rules of regulatory authorities.
- The student will learn the production, purification, recovery and analysis of products in laboratory and industrial scales.
- The students will learns the detail study of various biologics which are therapeutically used against various types of disease, for example, their productions, their mode of actions, limitations etc.
- The students will be able to isolate and characterize the antimicrobial products from the sources. Their efficacy measurement can also be performed.

Lecture	Topics
01- 06	**Pharmaceuticals, biologics and biopharmaceuticals.** Introduction to pharmaceutical products, biopharmaceuticals and pharmaceutical biotechnology, history of the pharmaceutical industry, the age of biopharmaceuticals, biopharmaceuticals: current status and prospects.
07 – 13	**The Drug development process.** Discovery of biopharmaceuticals, the impact of genomics and related technologies upon drug discovery, gene chips, proteomics, structural genomics, pharmacogenetics, initial product characterization, patenting, delivery of pharmaceuticals, preclinical studies, pharmacokinetics and pharmacodynamics, toxicity studies, the role and remit of regulatory authorities.
14- 16	**Sources and upstream processing.** Sources of biopharmaceuticals, additional production system, upstream processing, Inoculum preparation and development of pharmaceutical products.

17- 21 **Downstream processing.** Initial product recovery, cell disruption, removal of nucleic acid, initial product concentration, chromatographic purification, HPLC of proteins, purification of recombinant proteins, final product formulation.

22 – 28 **Product analysis.** Protein based contaminants, removal of altered forms of the protein of interest, detection of protein-based product impurities, immunological approaches to detection of contaminants, endotoxin and other pyrogenic contaminants.

29 – 33 **The cytokines as biopharmaceuticals.** The interferons, interferon biotechnology, interleukins and tumor necrosis factors, interleukins and tumor necrosis factor biotechnology.

34 – 39 **Growth factors and therapeutic hormones.** Haematopoietic growth factors, growth factors and wound healing, insulin, glucagon, human growth hormones, gonadotrophins

40 – 43 **Recombinant blood products and therapeutic enzymes.** Haemostasis, anticoagulants, thrombolytic agents, enzymes of therapeutic value

44 – 49 **Antibodies, vaccines and adjuvants.** Traditional polyclonal antibody preparations, monoclonal antibodies, vaccine technology, adjuvant technology

50 – 55 **Nucleic acid and cell-based therapeutics.** Gene therapy, vectors used in gene therapy, gene therapy and genetic disease, gene therapy and cancer, gene therapy and AIDS, antisense technology, oligonucleotide pharmacokinetics and delivery, aptamers, cell and tissue-based therapies.

Books recommended.

- Pharmaceutical Biotechnology - Concepts and Applications; Gary Walsh
- Biopharmaceuticals – Biochemistry and Biotechnology; Gary Walsh
- Pharmaceutical Biotechnology- Vyas, S. P. and Dixit, V. K.
- Hugo and Russell's Pharmaceutical Microbiology; Edited by: Stephen P. Denyer, Norman A. Hodges and Sean P. Gorman; Seventh edition.
- British Pharmacopoeia- Vol. II.
- Protein Engineering in industrial Biotechnology- Alberghin, L.
- A text book of Biotechnology- Dubey, R. C

MBIO 409. Microbial Biotechnology (3 Credits)

Rationale. Microbial products such as antibiotics, microbial enzymes and bio-fuels contribute to global health and development. This course provides an overview of the diversity of microorganisms and their metabolic activities such as the microbial products of major social, economic and environmental importance.

Objectives of the Course. This course provides an overview of how microbes (e.g., bacteria, viruses and yeast) are manipulated to solve practical problems through biotechnology. Topics include basics in microbial life, ecology and metabolism, methods used in microbial technology, industrial microbiology, microbes in drug development, interactions between microbes, plants and animals; food microbiology, the gut microbiota, metagenomics and others.

Intended Learning Outcomes

- Demonstrate and apply theoretical and practical knowledge of large-scale production and applications of microbial metabolites, innovative approaches and strategies for discovering products of social economic and environment importance.
- Critically analyses data generated by isolating and testing microbial compounds to determine their beneficial and detrimental effect for large-scale application in regional and global environmental sustainability.
- Demonstrate advanced laboratory skills and biosafety adhering to ethical codes of conduct in data collection and analysis.

Lectures	Topics
1-4	**Introduction.** Historical development, scope and essential features of microbial biotechnology; Biotechnology of developed countries.
5-15	**Energy, environment and biotechnology.** Renewable biomass for energy; biogas production; conservation to fuel ethanol and methane fermentation; wastes as a renewable source of energy; sources of wastes; anaerobic treatment of wastes and waste water; biomass conversion (biological and non biological process); bioremediation; bioleaching of metals; biopolymers; biodegradation of materials.
16-24	**Agriculture and biotechnology.** Biofertilizer; bioinsecticides; vaccines for crops; transgenic plant development and microbes.
1-24	**Class Test 1**
25-32	**Food, drink and biotechnology.** Dairy products-cheese, yoghurt, butter and cultured milk; Bakery product-bread and baked goods, starch hydrolysate; Brewing-alcoholic beverage, cider, vinegar; Protein products- SCP, food additives and ingredients.
33-36	**Chemistry and biotechnology.** Current status, generation of chemicals from biomass using microbes
37-40	**Genetics and biotechnology.** Industrially important microorganisms: Yeast, molds, bacteria and Actinomycetes; screening and selection of microorganisms for useful products. Strain improvement, *in vivo* and *in vitro* genetic manipulation.

Lectures	Topics
41-45	**Chemical engineering and biotechnology.** Microbial factors and process engineering factors, their effects on process performance and economics, future development of industrial biotechnological process.
25-45	**Class Test 2**
46-47	**Biotransformation.** D-sorbitol to L-sorbose, Biotransformation of antibiotics and steroids.
48-50	**Fermentation processes.** Range of fermentation processes, chronological development of the fermentation industry, component parts of the fermentation process
51-54	**Fermenter and reactor Engineering.** Basic functions of fermenter, types, body construction, aeration and agitation, feed port, sensor ports, foam control devices, valves and stream traps.
55-58	**Enzyme biotechnology.** Screening and selection of microbes; methods of enzyme production; down Stream processing; principles, benefits and methods of immobilization of enzymes and cells; application of immobilized enzyme; biosensors and biochips.
59-62	**Biotechnology and biosafety.** ICGEB, hazards to environmental engineering, biosafe transproduction biomarkers for GMOs, biosafety guidelines and regulations, intellectual property right and protection, general agreements on tariffs and trade (GATT), trade related IPRs, patenting microbial live forms and the significance of patent in our countries.
46-62	**Class Test 3**

Books Recommended

- Biotechnology Principles – J.E. Smith.
- Prescon and Dinn's Industrial Microbiology – G. Reed.
- Comprehensive Biotechnology – Murray Moo – Young.
- Introduction to Biotechnology – C.M Brown I. Campell and F.G Priest.
- Biotechnology: Principles and applications – L.J. Higgin D.J. Best and Jones.
- Molecular Biotechnology – S.B. Primrose.
- Basic Biotechnology – J. Bu Lock.
- Fundamentals of Biotechnology – Purohit.
- Microbiology – R. Atlas.
- Biotechnology – Keshav Trehan

MBIO 410. Research Methodology (2 Credits)

Rationale. This course provides an understanding of how to develop research project and to define the mode of enquiry. It will give students a general introduction to research, its methodologies, its challenges and its organization. Students will be introduced to a range of research tools and will be equipped to plan and organize their research, as well as to communicate their findings

Objectives of the Course.

- understand some basic concepts of research and its methodologies to identify appropriate research topics
- select and define appropriate research problem and parameters
- prepare a project proposal (to undertake a project)
- organize and conduct research (advanced project) in a more appropriate manner
- write a research report, thesis and research proposal for grant application

Intended Learning Outcomes:

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

- plan and manage research projects
- make use of and evaluate a variety of research tools and methodologies
- address issues of copyright, confidentiality, data protection and other ethical issues
- articulate, reflect on and critically evaluate their chosen subject of research and its methods
- communicate with colleagues in the same and other disciplines about their research
- pursue specific research methods in detail.

Lectures	Topics
1-5	**Fundamentals of Research.** Principles, Characteristics, Types, Ethics, Plagiarism
6-13	**The Research Process.** Background/Introduction: Formulating the research problem; Reviewing the literature: Critical analysis of the selected literature; Formulating the objectives: Constructing concepts, hypotheses and specific objectives; Materials and methods: Sample design and collection, Experimental analysis sequentially according to the specific objectives; Results: Collecting and plotting the data as tabulated, graphical or illustrative fashion; Discussion: Qualitative and quantitative data analysis, Evaluating significance of the findings against research problem; Socio-economic importance; Future perspectives and recommendations; Conclusive remarks.
1-13	**Class Test 1**

Lectures	Topics
14-17	**Evaluation of Time Frame.** Project design, Reviewing the literature, and Formulations of objectives; Conduction of experiments; Data plotting and analysis; Writing research report/thesis/manuscript and submission.
17-25	**Writing a Research Proposal.** Essential Parts: Title, Background, Objectives, Materials and methods, expected results and impacts; Additional Parts: Time frame, Funding source, Experience and expertise related to proposed plan, Reference, Appendix.
14-25	**Class Test 2**
26-32	**Writing a research article for submitting in a journal.** Title page covering title, authors' names, authors' affiliations, corresponding author, running head, keywords, abbreviations, funding source, conflict of interests; Abstract; Introduction; Materials and methods; Results; Discussion; Acknowledgement; Reference (alphabetic/numeric order; Figure legend; Table comprising of caption and footnote; Appendix (if any); Figure as image; Forwarding letter to the journal editor.
33-35	**Writing a Review Article.** Characteristics, types and logical structures of review article; Rules for writing a review article.
36-37	**Writing a Training/Workshop/Conference Report:** Contents and considerations.
38-46	**Statistical data analysis:** Propose; Importance and pitfall of mean, standard. deviation, regression, sample size determination and hypothesis testing as statistical data analysis methods.
	Ethical Considerations and Plagiarism.
26-46	**Class Test 3**

Books Recommended.

- Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors,
- Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
- Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, Pearson Education.

MBIO 411. Microbiology Laboratory IV (3 Credits)

Rationale. In order for a complex organism to develop from a single egg cell, and then stay alive by staving off aging, cancer, and injury, cells must be able to carry out a variety of diverse functions related to pattern formation, regeneration, and homeostatic physiology. Some cells are designed to perform specialized functions such as movement or proliferation. At the same time, these cells still must maintain the right concentration of chemicals in their cytoplasm, ingest food and use it for energy, recycle molecules, expel wastes, construct proteins, and communicate with each other and the host organism. The field of Cell Biology focuses on examining cells and the behaviors they perform. This course will introduce students to the investigation of several laboratory problems using standard techniques of cell biology. Since there are numerous techniques employed by researchers in this exciting field, this semester there will be an emphasis on the following procedures/concepts: microscopy, polymerase chain reaction, cell-cell communication, signal transduction, regeneration, data analysis, hypothesis testing, and presentation of scientific results.

Objectives of the Course.

Students in this course will:

- Learn fundamental aspects of experimental design.
- Apply concepts and theory to a hands-on research project.
- Learn the purposes of the experimental methods they use.
- Learn to interpret and effectively communicate experimental results

Intended Learning Outcomes.

- identify and present relevant information from research publications dealing with issues of cell and molecular biology and assess and relate the information to the context of cell biology
- plan and carry out simple experiments on the basis of cell biology issues and established method descriptions, and summarize the laboratory results in writing similar to a scientific paper
- apply critical thinking and logical analysis in the assessment and evaluation of issues in cell biology

Topics

1. Study of primary cell culture of kidney/ liver cell of chicken
2. Enumeration of Bacteriophage from polluted water sample
3. Measurement of cytotoxicity of antigen by determining LD50 dose
4. Extraction and purification of plant secondary metabolites from local flora, and investigation of their antimicrobial potency
5. Isolation of lactic acid bacteria from milk and/or milk product, and investigation of their probiotic activity
6. Isolation of antibiotic producing actinomycetes from soil, and investigation of their antimicrobial potency

7. Biological Image Analysis
    i. Analysis of Cell Morphology
    ii. Counting of Fluorescent Particles
    iii. Analysis on Molecular Gels
    iv. Quantification of Bacterial Colonies on an Agar Plate
8. Pharmaceutical Biotechnology
    i. Determination of bacterial toxin.
    ii. Contamination test of pharmaceutical products: vaccinesand antibiotics
    iii. Serological identification of unknown organisms by agglutination test
9. Long term preservation of microorganism by freeze drying/lyophilization
10. Identification of malaria parasites in thin and thick blood films
11. Identification of intestinal parasites
    a. Helminths
    b. Protozoa- Amoebic trophozoites; Amooebic cysts; Flagellates; *Toxoplasma gondi*
12. Study of common parasites:
    Protozoa: *Plasmodium vivax, Giardia lamblia, Entamoebahistolytica*

MBIO 412. Molecular Biology Laboratory (3 Credits)

Rationale. This laboratory course will provide students with a hands-on understanding of how modern molecular biology techniques are used to study cell and molecular biology.

Objectives of the Course.

- Learn fundamental aspects of experimental design to apply concepts and theory to a hands-on research project
- Interpret and communicate experimental results

Intended Learning Outcomes.

- Resolve proteins from samples provided using SDS-PAGE and perform and analyze Western blot of specific proteins
- Analyze plasmids with and without restriction enzyme digestions by DNA gel electrophoresis and perform DNA engineering to generate expression plasmids for selected proteins involving PCR cloning
- Express recombinant proteins in bacteria and perform purification of fusion protein by affinity and size exclusion chromatography

Topics

1. Preparation of genomic DNA from bacteria
2. Phenol/chloroform extraction of DNA
3. Ethanol precipitation of DNA
4. Extraction and purification of plasmid DNA
5. Separation of chromosomal and plasmid DNA by agarose gel electrophoresis
6. Preparation *E. coli* competent cell
7. Transformation of *E. coli* by electroporation
8. Preparation of DNA fragment isolation from an agarose gel
9. Ligation of plasmid DNA to insert DNA
10. Transfection of Mammalian cells using lipofectamine
11. Southern blotting
12. Separation, purification and identification of protein by Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE)
13. Western blotting
14. Polymerase Chain Reaction (PCR)
15. Colony PCR
16. Real-Time PCR (PCR)
17. Restriction enzyme digestion of DNA
18. Pulsed Field Gel Electrophoresis (PFGE)
19. Immunostaining and Flow Cytometry
20. Separation of biomolecules by column chromatography.

MBIO 413. Environmental Microbiology Laboratory (2 Credits)

Rationale. This course has been designed to teach laboratory techniques with regard to sampling, handling, analyzing and identifying microbes from environmental sources.

Objectives of the Course.

- Identify various kinds of prokaryotic microbes and eukaryotic microbes from environmental sources.
- Understand sampling and analysis of microbes from water, air and solid matter.

Intended Learning Outcomes.

- Design and conduct experiments, as well as to analyze and interpret data
- Communicate effectively
- Apply the knowledge to solve and discuss contemporary issues

Topics

1. Isolation of dye degrading microorganisms
2. Isolation of crude oil degrading microorganisms
3. Isolation of pesticide degrading microorganisms
4. Determination of chemical oxygen demand (COD)
5. Determination of biological oxygen demand (BOD)
6. Determination of total dissolved solid (TDS)
7. Determination of total suspended solid (TSS)
8. Determination of chloride ion or chlorine concentration
9. Determination of phosphate ion or phosphorus concentration
10. Determination of nitrite ion-nitrogen concentration
11. Determination of heavy metals

MBIO 414. Bioinformatics Laboratory I (2 Credits)

Rationale. The advent of next-generation sequencing technology has revolutionized biology, enabling transformative breakthroughs in fields ranging from agriculture to conservation to medicine. New methods are enabling full genome sequencing of organisms ranging from microbes to humans, and through metagenomics scientists can analyze of millions of short sequences from microbial communities sampled directly from the environment. In this course, students will gain experience with the computational and bioinformatics tools needed to analyze "big data," including sequence searching and alignment, assembly, read mapping, gene calling and annotation. Students will learn to ask and answer their own scientific questions using sequence data, and to critically assess the conclusions of other genomics and bioinformatics studies

Objectives of the Course

- Obtain skills for the analysis of biological data, extraction of information from genomic and proteomic databases
- Identify fundamental concepts in the biological sciences, including the relationship between structure and function at all levels of biological organization, evolution and the role of natural selection in the process, ecological relationships between organisms and their environment.
- Describe and explain the mechanisms of heredity and the flow of genetic information.

Intended Learning Outcomes

- Apply knowledge in basic mathematics, chemistry, and physics to solve biological problems.
- Integrate biological, computational and quantitative skills to complete bioinformatics projects in a professional team-problem-solving context.

Topics

1. Introduction to Virtual Lab
2. Retrieving sequence data from NCBI
3. A virtual lab teaching method for identifying bacteria by their DNA
4. Locating the chromosome of a gene
5. Retrieve gene expression
6. Finding ORF of a given sequence
7. Retrieving structural data of a protein
8. Retrieving motif information of a protein
9. Designing a primer
10. Global alignment of two sequences
11. Local alignment of sequences
12. Pairwise sequence alignment using BLAST
13. Pairwise sequence alignment using FASTA
14. Aligning multiple sequences with CLUSTAL W
15. Construction of Cladogram
16. Phylogenetic
17. Genome annotation and multiple sequence alignment.
18. Visualizing the secondary structure of a protein
19. Calculating the distance between the ligand and a particular amino acid
20. Finding the active site pockets of a given protein molecule
21. Primary structure analysis of a protein
22. Secondary structure analysis of a protein
23. Protein- ligand interaction
24. Molecular Biology Virtual Lab
25. Retrieving sequence data from NCBI

MBIO 415. Viva-voce (2 Credits)

There will be viva-voce examination after the completion of theoretical and practical examinations.

MBIO 416. Sessional (4 Credits)

Practical Note Book (20) + Field Work (10) + Class Test (60) + Class Attendance (10)

Panel of Examiners

All teachers and scientists of the following institutions:

Department of Microbiology, University of Dhaka
Department of Microbiology, University of Chittagong
Department of Microbiology, Jahangirnagar University, Savar, Dhaka
Department of Microbiology and Hygiene, BAU.
Department of Genetic Engineering and Biotechnology, University of Chittagong.
Department of Mathematics, University of Chittagong.
Department of Microbiology and Biotechnology, Jagannath University, Dhaka-1100.
Department of Microbiology, Faculty of Medicine, USTC, Chittagong.
Department of Microbiology, Government Veterinary and Animal Science University, Ctg.
Department of Microbiology, Jessore Science and Technology University.
Department of Microbiology, Noakhali, Science and Technology University, Noakhali.
Department of Pharmacy, Jahangirnagar University, Savar, Dhaka.
Department of Pharmacy, University of Chittagong.
Department of Pharmacy, University of Dhaka.
Bangladesh Atomic Energy Commission
Bangladesh Forest Research Institute (FRI), Chittagong.
Chittagong Medical College, Chittagong.
Department of Applied Nutrition and Food Science, Islamic University, Kushtia.
Department of Biochemistry and Molecular Biology, Jahangirnagar University, Savar, Dhaka.
Department of Biochemistry and Molecular Biology, Rajshahi University.
Department of Biochemistry and Molecular Biology, University of Chittagong.
Department of Biochemistry and Molecular Biology, University of Dhaka.
Department of Biotechnology and Genetic Engineering, Dhaka University, Dhaka.
Department of Biotechnology, Khulna University, Khulna.
Department of Biotechnology, Shahajalal University of Science and Technology, Sylhet.
Department of Botany, Jahangirnagar University, Dhaka
Department of Botany, Rajshahi University
Department of Botany, University of Chittagong.
Department of Botany, University of Dhaka.
Department of Chemistry, University of Chittagong.
Department of Chemistry, University of Dhaka.
Department of Fisheries and Aquaculture, Rajshahi University
Department of Fisheries, Rajshahi University
Department of Soil Sciences, University of Chittagong.
Department of Statistics, University of Chittagong.
Department of Zoology, Rajshahi University
Department of Zoology, University of Chittagong.
Department of Zoology, University of Dhaka.
Faculty of Veterinary Science, Agricultural University, Bangladesh
Fish Inspection and Quality Control, Chittagong.
Fisheries Research Institute, Cox's Bazar, Chittagong
Fisheries Research Institute, Mymensingh.
Food and Microbiology, BCSIR, Chittagong
Food and Microbiology, BCSIR, Dhaka.

Food and Microbiology, BCSIR, Rajshahi
Institute of Forestry and Environmental Sciences, University of Chittagong.
Institute of Marine Sciences, University of Chittagong.
Institute of Nutrition and Food Sciences, University of Dhaka.
Medical Center, University of Chittagong.
Professor Dr. M. N. Anwar, Vice Chancellor, Port City International University, 7-14 Nikunja Housing Society, South Kulshi, Chittagong.