DAV UNIVERSITY, JALANDHAR
DEPARTMENT OF MICROBIOLOGY

Course Scheme & Syllabus
For
B.Sc. (Hons.) Microbiology
(Programme ID 6)
1st to 6th Semester
Examinations 2020–2021 Session Onwards

Course Scheme and Syllabus Applicable to Admissions in 2020-2021

Mission

To ignite and nurture the naive minds of students with the fundamental as well as applied concepts of microbiology and help them to bridge the gap between science and society. The program is designed to expand the arena of knowledge in microbiology through research efforts.

Programme Learning outcomes

After completing B.Sc (Hons.) Microbiology, students will be able to explain the theoretical basis of the tools, technologies and methods common to microbiology and apply the scientific method and hypothesis testing in the design and execution of experiments. They will be able to utilize microbiological concepts to summarize, analyze and synthesize scientific and microbiology related literature for future research in this field for mankind. Also this course will help them in securing jobs in pharmaceutical companies and other research oriented organizations and will open new avenues for life.

Scheme of Courses (Program ID 6)
B.Sc. (Hons.) Microbiology

Semester 1

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC111	Introduction to Microbiology	Core	4	0	0	4
2.	MIC112	Introduction to Microbiology Laboratory	Core	0	0	3	2
3.	BCH101	Biomolecules	Core	4	0	0	4
4.	BCH102	Biomolecules Laboratory	Core	0	0	3	2
5.	ENG151B	Basic Communications Skills	AECC1*	3	0	0	3
6.	ENG152A	Basic Communications Skills Laboratory	AECC1*	0	0	2	1
7.	Generic Elective I						4
8.	Generic Elective I Laboratory						2
Total							22

L: Lectures T: Tutorial P: Practical Cr: Credits

**Ability Enhancement Compulsory Course*

List of Generic Electives (Choose one and corresponding lab course)							
1.	ZOO154	Zoo Diversity	Generic Elective	4	0	0	4
2.	ZOO155	Zoo Diversity Laboratory	Generic Elective	0	0	3	2
3.	BOT131	Plant Diversity	Generic Elective	4	0	0	4
4.	BOT132	Plant Diversity Laboratory	Generic Elective	0	0	3	2
5.	BCH216	Membrane Biology and Bioenergetics	Generic Elective	4	0	0	4
6.	BCH217	Membrane Biology and Bioenergetics Laboratory	Generic Elective	0	0	3	2

Scheme of Courses
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Semester 2

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC113	Bacteriology	Core	4	0	0	4
2.	MIC114	Bacteriology Laboratory	Core	0	0	3	2
3.	BTY361	Bioanalytical Tools	Core	4	0	0	4
4.	BTY362	Bioanalytical Tools Laboratory	Core	0	0	3	2
5.	EVS100	Environmental Studies	AECC 2	4	0	0	4
6.	SGS107	General Knowledge and Human Values	AECC 3	4	0	0	4
7.	Generic Elective II						4
8.	Generic Elective II Laboratory						2
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Generic Electives (Choose one and corresponding lab course)							
1.	CHE157	General Chemistry – I	Generic Elective	4	0	0	4
2.	CHE158	General Chemistry – I Laboratory	Generic Elective	0	0	3	2
3.	PHY153	Optics and Lasers	Generic Elective	4	0	0	4
4.	PHY154	Optics Laboratory	Generic Elective	0	0	3	2
5.	CHE117A	Physical Chemistry –II	Generic Elective	4	0	0	4
6.	CHE118A	Physical Chemistry –II Laboratory	Generic Elective	0	0	3	2

Scheme of Courses B.Sc.
B.Sc. (Hons.) Microbiology
Semester 3

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	BTY393	Virology	Core	4	0	0	4
2.	BTY394	Virology Laboratory	Core	0	0	3	2
3.	MIC221A	Fundamentals of Microbial Physiology and metabolism	Core	4	0	0	4
4.	MIC222A	Fundamentals of Microbial Physiology and metabolism Laboratory	Core	0	0	3	2
5.	MIC331	Medical Microbiology	Core	4	0	0	4
6.	MIC332	Medical Microbiology Laboratory	Core	0	0	3	2
7.	Skill Enhancement Course 1						2
8.	Generic Elective III						4
9.	Generic Elective III Laboratory						2
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Skill Enhancement Courses (Choose one)							
1.	MIC265A	Microbiological Analysis of Air and Water	Skill Enhancement Course	1	0	2	2
2.	MIC262	Microbial Diagnosis in Health Clinics	Skill Enhancement Course	1	0	2	2

List of Generic Electives (Choose one and corresponding lab course)							
1.	BOT131	Plant Diversity	Generic Elective	4	0	0	4
2.	BOT132	Plant Diversity Laboratory	Generic Elective	0	0	3	2
3.	BOT241	Plant Physiology and Metabolism	Generic Elective	4	0	0	4
4.	BOT242	Plant Physiology and Metabolism Laboratory	Generic Elective	0	0	3	2

Scheme of Courses B.Sc.
B.Sc. (Hons.) Microbiology

Semester 4

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC225A	Fundamentals of Microbial Genetics	Core	4	0	0	4
2.	MIC226A	Fundamentals of Microbial Genetics Laboratory	Core	0	0	3	2
3.	BTY241	Molecular Biology	Core	4	0	0	4
4.	BTY242	Molecular Biology Laboratory	Core	0	0	3	2
5.	MIC227	Food and Dairy Microbiology	Core	4	0	0	4
6.	MIC 228	Food and Dairy Microbiology	Core	0	0	3	2
7.	Skill Enhancement Course II						2
8.	Generic Elective IV						4
9.	Generic Elective IV Laboratory						2
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Skill Enhancement Courses (Choose one)							
1.	MIC261	Management of Human Microbial Diseases	Skill Enhancement Course	1	0	2	2
2.	MIC264	Food Fermentation Techniques	Skill Enhancement Course	1	0	2	2

List of Generic Electives (Choose one and corresponding lab course)							
1.	CHE257	General Chemistry – II	Generic Elective	4	0	0	4
2.	CHE258	General Chemistry – II Laboratory	Generic Elective	0	0	3	2
3.	BTY243	Biotechnology and Human Welfare	Generic Elective	4	0	0	4
4.	BTY244	Biotechnology and Human Welfare Laboratory	Generic Elective	0	0	3	2
5.	BCH218	Proteins and Enzymes	Generic Elective	4	0	0	4
6.	BCH219	Proteins and Enzymes Laboratory	Generic Elective	0	0	3	2

Scheme of Courses B.Sc.
B.Sc. (Hons.) Microbiology

Semester 5

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	MIC223	Environmental Microbiology	Core	4	0	0	4
2.	MIC224	Environmental Microbiology Laboratory	Core	0	0	3	2
3.	MIC353	Soil Microbiology	Core	4	0	0	4
4.	MIC354	Soil Microbiology Laboratory	Core	0	0	3	2
5.	BTY395	Biostatistics and Bioinformatics	Core	4	0	0	4
6.	BTY396	Biostatistics and Bioinformatics Laboratory	Core	0	0	3	2
6.	Discipline Specific Elective I						4
7.	Discipline Specific Elective I Laboratory						2
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Discipline Specific Electives (Choose one and corresponding lab courses)							
1.	MIC345	Microbial Biotechnology	Discipline Specific Elective	4	0	0	4
2.	MIC346	Microbial Biotechnology Laboratory	Discipline Specific Elective	0	0	3	2
3.	MIC349	Recombinant DNA Technology	Discipline Specific Elective	4	0	0	4
4.	MIC350	Recombinant DNA Technology Laboratory	Discipline Specific Elective	0	0	3	2

Scheme of Courses B.Sc.
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Semester 6

S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1.	BTY121	Cell Biology	Core	4	0	0	4
2.	BTY122	Cell Biology Laboratory	Core	0	0	3	2
3.	MIC335A	Basics of Industrial Microbiology	Core	4	0	0	4
4.	MIC336A	Basics of Industrial Microbiology Laboratory	Core	0	0	3	2
5.	MIC351	Biosafety and IPR	Core	4	0	0	4
6.	MIC352	Biosafety and IPR Laboratory	Core	0	0	3	2
6.	Discipline Specific Elective II						4
7.	Discipline Specific Elective II Laboratory						2
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

List of Discipline Specific Electives (Choose one and corresponding lab courses)							
1.	MIC333A	Basics of Immunology	Discipline Specific Elective	4	0	0	4
2.	MIC334A	Basics of Immunology Laboratory	Discipline Specific Elective	0	0	3	2
3.	MIC347	Plant Pathology	Discipline Specific Elective	4	0	0	4
4.	MIC348	Plant Pathology Laboratory	Discipline Specific Elective	0	0	3	2
5	BTY363	Genomics and Proteomics	Discipline Specific Elective	4	0	0	4
6	BTY364	Genomics and Proteomics Laboratory	Discipline Specific Elective	0	0	3	2

CORE COURSES

Course Name: INTRODUCTION TO MICROBIOLOGY
Course Code: MIC111
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
The objective of this course is to provide an overview of the discipline of microbiology including the wide diversity of microorganisms. It will help the students to understand the scope of microbiology

Course Content:

UNIT 1 **Hours: 15**

Development of microbiology as a discipline. Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming
Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman , Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

UNIT 2 **Hours: 20**

Systems of classification-Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domain classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms
General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.
Algae- History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food. Protozoa-General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

UNIT 3 **Hours: 15**

Fungi- Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.
Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

UNIT 4 **Hours: 10**

Scope of Microbiology, Methods in Microbiology, Microbiology in the field of medicine, Microbiology in the field of environment, Microbiology in the field of agriculture, Microbiology in the field of food, Microbiology in fermentation industry.

Learning outcome: The students will be able to appreciate the vast array of microorganisms and their immense significance in our lives

Suggested Readings

1. Pelczar MJ, Chan ECS and Krieg NR. *Microbiology*: *Application based approach* 7th edition. McGraw Hill Book Company. 2009
2. Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print.
3. Tortora GJ, Funke BR,Case CL, Weber D, Bair. W. *Microbiology: An Introduction*. 13th edition. Pearson Education. 2018. Print
4. Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2017. Print
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. *General Microbiology*. 5th edition. McMillan. 2005. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015
2. https://microbiologyonline.org/
3. https://slideplayer.com/slide/4509199/

Other supportive material:

1. https://www.cengage.com/biology/discipline_content/animations/generation_alternation_m.swf
2. https://www.springer.com/cda/content/document/cda_downloaddocument/3001.swf
3. https://sites.fas.harvard.edu/~biotext/animations/viralinfection.html.

Course Name: INTRODUCTION TO MICROBIOLOGY LABORATORY
Course Code: MIC112
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:
1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
9. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.

Suggested Readings :

1. Aneja, KR Experiments in Microbiology, Plant pathology and Biotechnology, 4th edition, New Age International Publishers, 2003, Print
2. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print.
3. Kochar, GS, Practical Manual teachings in Microbiology, 1st edition, Narendra publishing house, Delhi, 2012. Print.

Course Name: BIOMOLECULES
Course Code: BCH101
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
The objective of this course is to provide an overview of the biomolecules involved in metablic pathways of living beings.. It will help the students understand the role of biomolecules in metabolism.

Course Content:

UNIT 1 **(15 hours)**

Water as a biological solvent. Weak acids and bases. pH and buffers. Henderson-Hasselbalch equation. Physiological buffers. Fitness of the aqueous environment for living organisms. Carbohydrates

Structure of monosaccharides. Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

UNIT 2 **(15 hours)**

Introduction to proteins. Classification based on solubility, shape, composition and functions. Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers. Classification and structures of standard amino acids as zwitterion in aqueous solutions. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids. Essential amino acids.

Structure of peptide bond. Solid-phase synthesis of peptides. Peptide sequencing. Chemical and enzymatic cleavage of polypeptide chains and separation of peptides. Levels of structure in protein architecture. denaturation and renaturation of proteins. Behaviour of proteins in solutions. Salting in and salting out of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins.

UNIT 3 **(15 hours)**

Nature of genetic material. Evidence that DNA is the genetic material. Composition of DNA and RNA. Generalized structural plan and Nomenclature of nucleic acids. DNA double helix. Structure and roles of different types of RNA. Size of DNA in prokaryotes and eukaryotes. Central dogma of molecular biology. Concepts of gene, genome and chromosome. Porphyrins

Porphyrin nucleus and classification of porphyrins. Important metalloporphyrins occurring in nature. Detection of porphyrins. Bile pigments – chemical nature and physiological significance.

UNIT 4 **(15 hours)**

Definition and classification of lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissel Number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens),

sphingomyelins, glycolipids – cerebrosides, gangliosides. Properties and functions of phospholipids, isoprenoids and sterols.

Learning outcome:
After studying this course, students will be able to get acquaintance with biological molecules and their role in metabolic system of organisms.

Suggested Readings:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, W.H. Freeman & Company, New York, 2008. Print.
2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.
3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

Course Name: BIOMOLECULES LABORATORY
Course Code: BCH102
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

1. Preparation of normal, molar and percent solutions.
2. Titration curve of Glycine.
3. Buffer preparation.
4. Qualitative tests for Carbohydrates, Lipids, Amino acids, Proteins, Nucleic acids
5. Preparation of casein from milk and determination of its isoelectric point.
6. Titrimetric analysis of Vitamin C.

Course Name: BASIC COMMUNICATIONS SKILLS
Course Code: ENG151B
Total Credits: 3
Credits components: (Theory, Practical, Tutorial): 3,0,0

Course Objectives:

To enhance students' vocabulary and comprehension skills through the prescribed texts, to hone students' reading and writing skills, to teach the rules of English grammar descriptively and to make students aware about the socio-cultural aspect of English.

UNIT – 1

1. **Applied Grammar (in Socio-Cultural Context)**
    - Tenses
    - Passives
    - Reported/Reporting Speech

UNIT – 2

1. **Reading (Communicative Approach to be Followed)**

 Nissim Ezekiel : The Patriot (Poem)

(Sub-topic: Basic Introduction to Indianisms and Difference between Indian English & Standard English)

2. **Writing**

    - Paragraph Writing : Topic Sentence, Inductive logic, and Deductive logic
    - Essays: Narrative, Descriptive, Expository, and Persuasive
    - Notice: Format, Characteristics, and 5 W's,

- Email: Structure, Characteristics of Effective Emails, and Advantages

UNIT – 3

1. **Applied Grammar (in Socio-Cultural Context)**

- Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, and Interjection
- Modals: Can, Could, May, Might, Will, Would, Shall, Should, and Must

UNIT – 4

1. **Reading (Communicative Approach to be Followed)**

Alleen Pace Nilsen: Sexism in English (Prose)

(Sub-topic: Relationship between Society & Language and Sexist Language)

2. **Writing**

Letter Writing: Formal and Informal

Learning Outcomes:
Students will have developed a wide vocabulary and be able to summarize ideas, be able to read and analyze texts and display competence in written communication, show a considerable understanding of English Grammar and demonstrate sensitivity to cultural differences while communicating.

Suggested Readings:

1. Eschholz, Paul and Rosa, Alfred (ed.), *Subject and Strategy*. NY: St. Martin's Press, 1978. Print.
2. Ezekiel, Nissim. *Collected Poems 1952-1988*. New Delhi: Oxford University Press, 1999. Print.
3. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.
4. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.
5. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.
6. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.
7. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.
8. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.

Course Name: BASIC COMMUNICATIONS SKILLS LABORATORY

Course Code: ENG152A
Total Credits: 1
Credits components: (Theory, Practical, Tutorial): 0,2,0

UNIT – A Speaking and Listening
IPA for Language Learning - Basic Phonetics
Movie-Clippings
Role Plays
Group Discussions
Mock Interviews

Project File: Each student will prepare a project file on any of the topics given by class teacher. Student should be able to justify the contents of his/her scrap file. The file must be handwritten, not typed. Students must acknowledge all the sources of information in his/her scrap file.

Testing: The end term lab. examination will be conducted as per the norm of the university. The distribution of marks in the end-term lab. examination is as follows:

Component	**Weightage**
Project File Marks will be given for originality, creativity and presentation. Student will receive credit	**30 %**

for his/her command of the language also.	
Lab. Activity It may include dialogue writing (Dialogue to Prose and Prose to Dialogue), writing about a picture/some object, writing a report, writing on a topic of general interest, listening exercise, English phonetic exercise, etc. It will be decided by examiner on the spot.	**30%**
Viva Voce Questions will be based on the project file. Examiner may ask other non-technical questions related to student's life and interests.	**40%**
Total	**100%**

For the final result, marks will be calculated as per the criterion laid down by the university:

Component	**Weightage**
Marks Obtained in the lab examination	**80%**
Continuous Assessment (Based on Student's Regularity & Class Performance)	**20%**
Total	**100%**

Programme: B.Sc. (Hons) Microbiology
Course Name: ZOO DIVERSITY
Course Code: ZOO154
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objectives: This course has been designed with the objective of making the students aware about zoological aspects like kingdom animalia and its phyla.

Course Content:

UNIT-1

- **Protozoa:** General characters of Protozoa; life cycle of *Plasmodium*
- **Porifera:** General characters of Porifera; canal system in Porifera.
- **Radiata:** General characters of Coelenterata; Polymorphism.

UNIT-2

- **Acoelomates:** General characters of Helminthes; Life cycle of *Taenia solium*
- **Pseudocoelomates:** General characters of Nemethehelminthes; Parasitic adaptations

UNIT-3

- **Coelomate Protostomes:** General characters of Annelida; Metamerism
- **Arthropoda:** General characters of Arthropoda; social life in insects
- **Mollusca:** General characters of Mollusca; Pearl formation
- **Coelomate Deuterostomes:** General characters of Echinodermata; Water vascular system in star fish

UNIT-4

- **Protochordata:** Salient features
- **Pisces:** Osoregulation. Migration of Fishes
- **Amphibia:** General characters, Adaptations for terrestrial life, Parental care in Amphibia
- **Reptilia:** Amniotes, origin of reptiles, terrestrial adaptations in reptiles
- **Aves:** The origin of birds; flight adaptations
- **Mammalia:** Early evolution of mammals; Primates; Dentition in mammals

Learning Outcomes:
After studying this course, the students will be able to explain about various organisms and their morphological and anatomical aspects.

Suggested Readings:

1. Kotpal, R.L., Modern Text Book of Zoology Invertebrates, 10th ed., Rastogi Publishers,
   Meerut, 2012.
2. Kotpal, R.L., Minor phyla, 5th ed., Rastogi Publishers, Meerut, 2006.
3. Dhami, P.S. and Dhami, J.K., Invertebrate Zoology, 5th ed., R. Chand & Co., New Delhi, 2004.

4. Parker, T.J. and Haswell, W.A., Text book of Zoology, Invertebrates, 7th ed., Vol. I (eds. A.J. Marshall & W.D. Williams), CBS Publishers & Distributors., Delhi, 1992.
5. Hyman L.H. The Invertebrates. Vol. I, II, III, IV and V. McGraw Hill Book Company. Inc., New York. London. Toronto, 1959.
6. Barnes, R.D. Invertebrate Zoology. Saunders College Pub. USA., 1992.
7. Ruppert, Fox and Barnes. Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole, 2006.

8. Campbell and Reece . Biology, Pearson Education, (Singapore) Pvt. Ltd, 2005
9. Kardong, K. V. Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi, 2002.
10. Raven, P. H. and Johnson, G. B. Biology, 6th edition, Tata McGraw Hill Publications. New Delhi, 2004.

Course Name: ZOO DIVERSITY LABORATORY
Course Code: ZOO155
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Study of following specimens with the help of charts/models/e-resources;

Non Chordates: *Euglena*, *Noctiluca*, *Paramecium*, *Sycon*, *Physalia*, *Tubipora*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, *Aphrodite*, Leech, *Peripatus*, *Limulus*, Hermitcrab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Dentalium*, Octopus, *Asterias*, and *Antedon*.

Chordates: *Balanoglossus*, *Amphioxus*, *Petromyzon*, *Pristis*, *Hippocampus*, *Labeo*, *Icthyophis/Uraeotyphlus*, *Salamander*, *Rhacophorus*, *Draco*, *Uromastix*, *Naja*, Viper, *Archaeopteryx*, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

2. Study of following through e-resources:

Cross section of *Sycon*, Sea anemone and *Ascaris* (male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva, Septal & pharyngeal nephridia of earthworm, Placoid, cycloid and ctenoid scales.

3. Study of the following through e-resources:

- Digestive and nervous system of Cockroach.
- Urinogenital system of Rat.

Programme: B.Sc. (Hons) Microbiology
Course Name: PLANT DIVERSITY
Course Code: BOT131
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objectives: This course has been designed with the objective of making the students aware about botanical aspects of plant species of kingdom plantae and its phyla.

UNIT 1 **(15 hours)**

Viruses: Discovery, general structure, replication (general account), DNA virus (T -phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

UNIT 2 **(15 hours)**

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus*, *Polysiphonia*. Economic importance of algae.

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi-General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

UNIT 3 **(15 hours)**

Introduction to Archegoniate: Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

UNIT 4 **(15 hours)**

Pteridophytes: General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit, stellar evolution.Ecological and economical importance of Pteridophytes.

Gymnosperms: General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. Ecological and economical importance.

Learning Outcomes:

After studying this course, the students will be able to explain about various plants and their morphological and anatomical aspects.

SUGGESTED READINGS:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi.2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7 Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8 Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Programme: B.Sc. (Hons) Microbiology
Course Name: PLANT DIVERSITY LABORATORY
Course Code: BOT132
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* Fucus - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).

14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Programme: B.Sc. (Hons) Microbiology
Course Name: Membrane Biology and Bioenergetics
Course Code: BCH216
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

UNIT 1 **(15 hours)**

Introduction to biomembranes

Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.

Membrane structures

Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

UNIT 2 **(15 hours)**

Membrane dynamics

Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Vesicular transport and membrane fusion

Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin. Membrane biogenesis

UNIT 3 **(15 hours)**

Introduction to bioenergetics

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Oxidative phosphorylation

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory
pathways in plants.

UNIT 4 **(15 hours)**

Photophosphorylation

General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and Halobacterium salinarum. Photophosphorylation in plants -structure of chloroplast, molecular architecture of Photosystem I and Photosystem II,Z-scheme of photosynthetic electron flow, oxygen evolving

complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

Suggested Readings:

1. Lehninger: Principles of Biochemistry (2013) 6th edition, Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 9781464109621.
2. Molecular Cell Biology (2013) 7th edition, Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN: 9781464109812.
3. Biochemistry (2010) 4th edition, Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN: 9780495114642.
4. Principles of Biochemistry (2008) 3rd edition, Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN: 9780470233962

Programme: B.Sc. (Hons) Microbiology
Course Name: Membrane Biology and Bioenergetics Laboratory
Course Code: BCH217
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:
1. Determination of CMC of detergents.
2. RBC ghost cell preparation and to study the effect of detergents on membranes.
3. Separation of photosynthetic pigments by TLC.
4. Isolation of mitochondria from liver and assay of marker enzyme SDH.
5. Study photosynthetic O2 evolution in hydrilla plant.
6. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.
7. Study of changes in erythrocyte membrane permeability under hypotonic and hypertonic consitions

Programme: B.Sc. (Hons) Microbiology
Course Name: BACTERIOLOGY
Course Code: MIC113
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective:
This course will allow the student to develop an understanding about bacteria, including their structural organization, reproduction and classification. This course will also expose the students to the commonly used techniques in the field of bacteriology.

Course Content:

UNIT 1 (**Hours: 25)**
Prokaryotic cell: Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.
Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids;
Microscopy: Principles and application of (Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope)

UNIT 2 **(Hours: 14)**
Nutritional requirements in bacteria and nutritional categories; Autotroph/Phototroph, heterotrophy,
Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph

Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media, Diauxic growth, Synchronous growth, Define Mixed culture, pure culture, Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.
Contamination. Sterilization, Disinfection, Disinfectant, Bacteriocidal, Bacteriostatic .
Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation
Chemical methods of microbial control: disinfectants, types and mode of action
Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate, Endospore: Structure, formation, stages of sporulation.

UNIT 3 (**Hours: 8)**
Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Overview of Bergey's manual, Differences between eubacteria and archaebacteria

UNIT 4 (**Hours: 16)**

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)] **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: ***Gram Negative:*** Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples ***Gram Positive:*** Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples. ***Cyanobacteria*****:** General characteristics.

Learning outcome: After studying this course, the students will be able to know about various aspects of bacteria, their morphology, habitat and antigenic behaviour.

SUGGESTED READINGS:

1. Atlas RM. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 1997. Print
2. Black JG. *Microbiology: Principles and Explorations*. 7th edition. Prentice Hall. 2008. Print
3. Madigan MT, and Martinko JM. *Brock Biology of Micro-organisms*. 14th edition. Parker J. Prentice Hall International, Inc. 2014. Print
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. *Microbiology*. 5th edition Tata McGraw Hill. 2004. Print
5. Srivastava S and Srivastava PS. *Understanding Bacteria*. Kluwer Academic Publishers, Dordrecht. 2003. Print
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. *General Microbiology*. 5th edition McMillan. 2005. Print
7. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition Pearson Education. 2008. Print
8. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print

Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print.

Programme: B.Sc. (Hons) Microbiology
Course Name: BACTERIOLOGY LABORATORY
Course Code: MIC114
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Simple staining
2. Negative staining
3. Gram's staining
4. Acid fast staining-permanent slide only.
5. Capsule staining
6. Endospore staining.
7. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

Programme: B.Sc. (Hons) Microbiology
Course Name: BIOANALYTICAL TOOLS
Course Code: BTY361
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course objective
To introduce the students to various bioanalytical tools available and their applications

UNIT 1 **(15 hours)**
Simple microscopy, phase contrast microscopy, florescence microscopy and Principles of electron microscopy, pH meter.

UNIT 2 **(15 hours)**
Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT 3 **(15 hours)**
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion-exchange chromatography, gas chromatography, HPLC.

UNIT 4 **(15 hours)**
Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and their applications.

SUGGESTED READINGS (text & reference books)
1. Wilson, K. and Walker, J. *Practical Biochemistry: Principles and Techniques*. 5th Edition. Cambridge University Press. 2005. Print.

2. Iserentant, D. M. *Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes*. 1st Edition. Springer-verlag Gmbh. 1997. Print.

3. Ho, P. S., Johnson, C. and van Holde, K. E. *Principles of Physical Biochemistry*. 2nd Edition. Pearson. 2005. Print.

4. Venn, R. F. *Principles and Practice of Bioanalysis*. 1st Edition. Taylor & Francis. 2000. Print.

5. Hoppert, M. *Microscopic Techniques in Biotechnology*. 1st Edition. John Wiley & Sons. 2001. Print.

Programme: B.Sc. (Hons) Microbiology
Course Name: BIOANALYTICAL TOOLS LABORATORY
Course Code: BTY362
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0
Experiments:

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Programme: B.Sc. (Hons) Microbiology
Course Name: ENVIRONMENTAL STUDIES
Course Code: EVS100
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The objective of this course is acquaint the students with holistic aspects of environment and its components, biodiversity and its conservation.

UNIT 1 **(15 hrs)**

Definition, scope and importance, Need for public awareness

Natural Resources: Renewable and non-renewable resources:
Natural resources and associated problems.
(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.
(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Ecosystem:
Concept of an ecosystem

- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

UNIT 2 (**15 Hours)**

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts

Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

Environmental Pollution

- Definition, causes, effects and control measures of:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear pollution

- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

UNIT 3 **(15 Hours)**

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

UNIT 4 **(15 Hours)**

- Population Growth and Variations among Nations
- Population Explosion
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

Field Work

- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

Learning outcomes: After studying this course, the students will have an insight about planet earth and well being of its biotic and abiotic components.

Suggested readings:

1. Odum, EP. *Basic Ecology*. Japan: Halt Saundurs, 1983.
2. Botkin, DB, and Kodler EA. *Environmental Studies: The Earth as a living planet.* New York: John Wiley and Sons Inc., 2000.
3. Singh, JS, Singh, SP, and Gupta SR. Ecology, *Environment and Resource Conservation.* New Delhi: Anamaya Publishers, 2006.
4. De, AK. *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990.
5. Sharma, PD. *Ecology and Environment*. Meerut Rastogi Publications, 2004.

Programme: B.Sc. (Hons) Microbiology

Course Name: GENERAL KNOWLEDGE & HUMAN VALUES
Course Code: SGS107
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course objective: The objective of this course is to inculcate moral values in generation next and to make them aware about general studies.

UNIT-1 **(15 Hrs)**

Human Values

1. **Concept of Human Values:** Meaning, Types and Importance of Values.
2. **Value Education :** Basic guidelines for value education
3. **Value crisis and its redressal**

Being Good and Responsible

1. Self Exploration and Self Evaluation
2. Acquiring Core Values for Self Development
3. Living in Harmony with Self, Family and Society
4. Values enshrined in the Constitution: Liberty, Equality Fraternity and Fundamental Duties.

UNIT-2 **(15 Hrs)**

Value – based living

1. Vedic values of life
2. *Karma Yoga* and *Jnana Yoga*
3. *Ashta Marga* and *Tri-Ratna*

Ethical Living:

1. Personal Ethics
2. Professional Ethics
3. Ethics in Education

UNIT-3 **(15 Hrs)**

World Geography

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

Indian Geography

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

General History

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

Glimpses of World History Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

Indian Polity: Constitution of India Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panachayati Raj System, RTI etc.

General Economy

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

UNIT-4 **(15 hrs)**

General Science 3 Hrs General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

Sports and Recreation

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours. Famous personalities, Festivals, Arts and Artists

Current Affairs

National and International Issues and Events in News, Governments Schemes and Policy Decisions

Miscellaneous Information

Who is who: Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports.

Learning outcome: After studying this course, the students will be aware about all aspects of current events and past events in all dimensions of life.

Suggested Readings:

1. Human Values, A N Tripathi, New Age International Publishers, New Delhi, Third Edition, 2009
2. Professional Ethics, R. Surbiramanian, Oxford University Press, New Delhi, 2013.
3. Human Values and Professional Ethics, Rishabh Anand, Satya Prakashan, New Delhi, 2012
4. Human Values and Professional Ethics, Sanjeev Bhalla, Satya Prakashan, New Delhi, 2012.
5. Human Values and Professional Ethics, Ritu Soryan Dhanpat Rai & Co. Pvt. Ltd., First Edition, 2010.
6. Human Values and Professional Ethics by Suresh Jayshree, Raghavan B S, S Chand & Co. Ltd. , 2007.
7. Human Values and Professional Ethics, Yogendra Singh, Ankur Garg, Aitbs publishers, 2011.
8. Human Values and Professional Ethics, Vrinder Kumar, Kalyani Publishers, Ludhiana, 2013.
9. Human Values and Professional Ethics, R R Gaur, R. Sangal, GP Bagaria, Excel Books, New Delhi 2010.
10. Values and Ethics, Dr. Bramwell Osula, Dr. Saroj Upadhyay, Asian Books Pvt. Ltd., 2011.
11. Indian Philosophy, S. Radhakrishnan, George Allen & Unwin Ltd., New York: Humanities Press INC, 1929.
12. Essentials of Hinduism, Jainism and Buddhism, A N Dwivedi, Books Today, New Delhi – 1979
13. Dayanand : His life and work, Suraj Bhan, DAVCMC, New Delhi – 2001.
14. Esence of Vedas, Kapil Dev Dwivedi, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
15. Vedic Concepts, Prof. B B Chaubey, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
16. Advance Objective General Knowledge, R. S. Aggarwal, S. Chand Publisher (2013)
17. Concise General Knowledge Manual 2013, S. Sen, Unique Publishers,2013
18. Encyclopedia of General Knowledge and General Awareness by R P Verma, Penguin Books Ltd (2010)
19. General Knowledge Manual 2013-14, Edgar Thorpe and Showick Thorpe, The Pearson, Delhi.
20. General Knowledge Manual 2013-14, Muktikanta Mohanty, Macmillan Publishers India Ltd., Delhi.

21. India 2013, Government of India (Ministry of Information Broadcasting), Publication Division, 2013.
22. Manorama Year Book 2013-14, Mammen Methew, Malayalam Manorama Publishers, Kottayam, 2013.
23. Spectrum's Handbook of General Studies – 2013-14, Spectrum Books (P) Ltd., New Delhi

CURRENT AFFAIRS

Magazines

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum. Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

Newspapers

The Hindu, Times of India, The Hindustan Times, The Tribune.

Programme: B.Sc. (Hons) Microbiology
Course Name: GENERAL CHEMISTRY- I
Course Code: CHE157
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course objective: The objective of this course is to acquaint students about basic concepts of chemistry as a whole.

Course content:

UNIT 1 **(15 Hours)**

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers *n, l* and *m.* Shapes of *s, p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT 2: **(15 Hours)**

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizabilty. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

UNIT 3 **(15 Hours)**

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

UNIT 4 **(15 Hours)**

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L *cis – trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$ ozonolysis and oxidation with hot alk. $KMnO_4$.

Learning outcome: After studying this course, the students will be aware about all fundamental aspects of chemistry.

Suggested readings:

• J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
• F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
• Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
• James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
• T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
• Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
• E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
• I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
• R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.

Programme: B.Sc. (Hons) Microbiology
Course Name: GENERAL CHEMISTRY – I LABORATORY
Course Code: CHE158
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ with internal indicator.

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given):

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Programme: B.Sc. (Hons) Microbiology
Course Name: OPTICS AND LASERS
Course Code: PHY153
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course objective: The objective of the course on Optics and Lasers for the students is to enable them to understand the different phenomenon exhibited by the light as well as the basics of the laser light so that they could perform microscopy with basic understanding of optics.

UNIT- 1 **(15 Hours)**

Young's double slit experiment, Coherent Source, Theory of interference fringes, Types of interference, Fresnel's biprism, thickness of thin transparent sheet, Interference in thin films, Newton's rings and their application, Michelson Interferometer, Application of thin film interference; Anti reflection coatings; dielectric mirrors; interference filters; Holography.

UNIT- 2

(15 Hours)

Difference between Fresnel and Franunhoffer diffraction, Franunhoffer diffraction at a single slit and its discussion, Fraunhoffer diffraction at double slit, missing orders in a double slit, Diffraction of N slits and its discussion, Diffraction grating, Missing orders, dispersive power, Rayleigh Criterion for resolving power, resolving power of a diffraction grating.

UNIT- 3 **(15 Hours)**

Polarised light and its production; polarisers and analyzers; anisotropic crystals; Polarization by transmission and reflection, Malus Law, Brewster's Law, Polarization by refraction, anisotropic crystals, Theory of double refraction, Elliptically and circularly polarized light, Quarter wave and half wave plates, Production and detection of polarized light, Optical activity, specific rotation. Half shade polarimeter; LCD's.

UNIT- 4

(15 Hours)

Attenuation of light in an optical medium; thermal equilibrium; interaction of light with matter; Einstein relations; light amplification; population inversion; active medium, pumping; metastable states; principle pumping schemes; optical resonant cavity; axial modes; gain curve and laser operating frequencies, transverse modes; types of lasers; Q-switching; laser beam characteristics and applications.

Learning outcome: After studying this course, the students will be aware about basic aspects of optics and its use in microscopy for better visualization of microorganisms.

Suggested Books:

1. Subramanayam, N., Lal,B.& Avadhamulu, M. N. Textbook of Optics. New Delhi: S. Chand &
Company, 2006.
2. Jenkins, F.A., White, H.E. Fundamentals of Optics.USA: McGraw Hill Publication, 1976.
3. Ghatak,A.,Optics. New Delhi: Tata McGraw Hill Publication, 2008.

Programme: B.Sc. (Hons) Microbiology
Course Name: OPTICS AND LASERS LABORATORY
Course Code: PHY154
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine the Dispersive Power of the Material of a given Prism using Mercury Light.
3. To determine the Resolving Power of a Prism.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the Thickness of a Thin Paper by measuring the Width of the Interference Fringes produced by a Wedge Shaped Film.
7. To determination Wavelength of Sodium Light using Michelson's Interferometer.
8. To determine the wavelength of Laser light using Diffraction of Single Slit.
9. To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
10. To determine the Dispersive Power of a Plane Diffraction Grating.
11. To determine the Resloving Power of a Plane Diffraction Grating.
12. To determine the (1) Wavelength and (2) Angular Spread of HeNe Laser using Plane Diffraction Grating.
13. To study the wavelength of spectral lines of sodium light using plane transmission grating.
14. To study the specific rotation of sugar solution Laurents half shade polarimeter method
15. To study the numerical aperture and propagation losses using He-Ne laser Optical fibre set up.
16. To compare the focal length of two lenses by Nodal slide method.

Programme: B.Sc. (Hons) Microbiology
Course Name: Physical Chemistry-II
Course Code: CHE117A
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objectives:
This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC CBCS guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth importance of academic and laboratory skills for the undergraduate students.

UNIT 1 **(36 Hours)**
Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Absolute temperature scale
First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Joule's law; Joule-Thomson coefficient and inversion temperature.
Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature; explosion temperature.
Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.
Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.
Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

UNIT 2 (**8 Hours)**
Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases; concept of fugacity and activity; method for determination of fugacity; variation of fugacity with temperature and pressure, fugacity of solids and liquids, Numerical.

UNIT 3 **(8 Hours)**
Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient; equilibrium constants and their quantitative dependence on temperature, pressure and concentration; Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants *Kp* , *Kc* and *Kx*. Le Chatelier's principle (quantitative treatment).

UNIT 4 **(8 Hours)**
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.
Thermodynamic derivation using chemical potential to derive relations between the four colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Course Outcome:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Physical chemistry. The students will be able to pursue their career objectives in advance education, scientific research and teaching.

Reference Books

1. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press, 2011.
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
3. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall, 2012.
4. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi, 2004.
5. Maron S.H., Pretton C.F. (1965) Principles of Physical Chemistry, 4thEdition, Mac Millan Publishing Company, New York.
6. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY, 2011.
7. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.
8. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

Programme: B.Sc. (Hons) Microbiology
Course Name: Physical Chemistry-II Laboratory
Course Code: CHE118A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Thermochemistry

(a) To determine the heat of solution of given salt.

(b) To Determine the Molecule Weight of given compound by Freezing Point Depression Method

(c) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(d) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(e) Calculation of the enthalpy of ionization of ethanoic acid.

(f) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(g) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(h) Determination of enthalpy of hydration of copper sulphate.

(i) Study of the solubility of benzoic acid in water and determination of *H*.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi, 2011.

2. Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi, 2001.

Programme: B.Sc. (Hons) Microbiology
Course Name: VIROLOGY
Course Code: BTY393
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: To give an introduction to the basics in virology. General information on morphology, architecture, transmission of plant and animal viruses and viruses infecting microbes and insects.

Course Content:

UNIT-1 **(15 hours)**
Introduction & History of Virology, Origin & Evolution of Viruses, Taxonomy. Defective Particles, Multiparticles, Viroids, Virusoids, Prions, Mycoviruses, Bacteriophage, Cynophage, Virophage, Baculoviruses.

UNIT-2 **(15 hours)**
Morphology, Architecture and methods for its study, Host range, Transmission, Movement, Symptomatology, Serology, methods for assay, detection and diagnosis, Virus purification.

UNIT-3 **(15 hours)**
Biochemistry of Viruses & Viral Pathogenesis, Organization & Expression of Viral genomes. Replication of RNA and DNA Viruses.

UNIT-4 **(15 hours)**
Management and control of viruses including development of virus disease resistant transgenics.

Learning outcome: After studying this course, the students will be aware about all aspects of viruses, their life cycle and pathogenesis.

Suggested Readings:

1. Hull, R. *Matthews Plant Virology.* 4th Edition. Academic Press. 2001. Print.
2. Knipe, D.M. and Howley, P.M. *Fields Virology*. 5th Edition. Lippincott Williams & Wilkins. 2006. Print.
3. Cann, A.J. *Principles of Molecular Virology.* 5th Edition. Academic Press. 2011. Print.
4. Carter, J. and Saunders, V. *Virology: Principles and Applications.* 2nd Edition. John Wiley & Sons Ltd. 2013. Print.

Course Name: VIROLOGY LABORATORY
Course Code: BTY394
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Virus diagnosis using ELISA
2. Virus diagnosis using PCR
3. Virus diagnosis using slot-blot hybridization
4. Study of symptoms of virus diseases through visit to local diseases fields and/or photographs
5. Collection and Processing of Viral Samples
6. Effect of virus infection on chloroplast number and cell size
7. Transmission of plant viruses
8. Collection and Identification of local insect vectors
9. Determination of disease progress curve.

Course Name: INTRODUCTORY MICROBIAL PHYSIOLOGY & METABOLISM
Course Code: MIC221A
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
The objective of this course is to introduce the students to the diversity of microbial life-styles including heterotrophy, chemolithotrophy, photolithotrophy, fermentation, aerobic and anaerobic respiration. This course will help the students understand about the microbial growth and various factors impacting it and about microbial nutrition.

Course Content:

UNIT 1 **(20 Hours)**
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve, Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.
Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.
Passive and facilitated diffusion , Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

UNIT 2 **(10 Hours)**
Concept of aerobic respiration, anaerobic respiration and fermentation
Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle , Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

UNIT 3 **(10 Hours)**
Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)
Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

UNIT 4 **(20 Hours)**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)
Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria, Autotrophy in photosynthetic bacteria
Introduction to biological nitrogen fixation, Symbiotic and non symbiotic nitrogen fixation , Nitrogenase enzyme complex azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction,assimilation of ammonia, nitrogen cycle. Nif genes and its regulation.
Learning outcomes: The students will be able to comprehend the vast array of metabolic diversity in microorganisms.

Suggested Readings:

1. Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print
2. Spector MP, Foster JW, Audia, JP, *Moat's Microbial Physiology*. 5th edition. John Wiley & Sons. 2014. Print
3. Gottschalk G. *Bacterial Metabolism*. 2nd edition. Springer Verlag. 1986. Print

4. Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2017. Print
5. Reddy SR and Reddy SM. *Microbial Physiology*. Scientific Publishers India. 2005. Print
6. Aneja, KR Experiments in Microbiology, Plant pathology and Biotechnology, 4th edition 2003
7. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print.

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015/module6/lec3/3.html
2. https://microbiologyonline.org/
3. https://www.accessscience.com/content/nitrogen-fixation/454100

Other supportive material:

1. https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=1
2. https://www.wiley.com/college/boyer/0470003790/animations/tca/tca.htm
3. https://www.wiley.com/college/boyer/0470003790/animations/membrane_transport/membrane_transport.htm

Course Name: INTRODUCTORY MICROBIAL PHYSIOLOGY & METABOLISM LABORATORY
Course Code: MIC222A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,0,3

Experiments:
1.Study and plot the growth curve of bacteria by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of bacteria
4. Effect of pH on growth of bacteria
5. Effect of carbon and nitrogen sources on growth of bacteria
6. Effect of salt on growth of bacteria
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of bacteria.
9. Determination of thermal death point of the given culture.
10. Effect of inhibitors on growth of bacteria.
11. Study of diauxic growth.
12. Bacterial endospore induction (by multiple methods).

Programme Name: B.Sc. (Hons) Microbiology
Course Name: MEDICAL MICROBIOLOGY
Course Code: MIC 331
Total Credits: 4
Credits components (Theory, Practical, Tutorial): 4,0,0
Course Learning Objective:

The objective of this course is to provide an overview about the significance of medical microbiology including cycle of disease establishment, some common diseases caused by bacteria, viruses, protozoa and fungi as well as their diagnosis procedures and anti-microbial agents and their mechanisms of action.

Course Content:

UNIT 1 **(13 Hours)**

Normal microflora of the human body(skin, throat, gastrointestinal tract, urogenital tract) & its importance:. Host pathogen interaction: Definitions of- Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, for medical application).

UNIT 2 **(15 Hours)**

List of diseases of various organ systems and their causative agents. The following diseases in detail with ymptoms, mode of transmission, prophylaxis and control. Respiratory Diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori*. Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficie*

UNIT 3 **(24 Hours)**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control:
Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis
Diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar
Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot), Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis

UNIT 4 **(8 Hours)**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine
Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

Learning outcomes: The students will be able to decode and adopt various strategies for prevention, diagnosis and control of different microbial diseases and future aspects for epidemiological studies.

Suggested Readings:

1. Ananthanarayan R. and Paniker C.K.J. *Textbook of Microbiology*. 10th edition, Universities Press Publication. 2017. Print

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. *Jawetz, Melnick and Adelberg's Medical Microbiology*. 26th edition. McGraw Hill Publication. 2013. Print

3. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott, Harley and Klein's Microbiology*. 10th edition. McGraw Hill Higher Education. 2017. Print

4. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 15th edition. Pearson International Edition. 2016. Print

5. Goering R., Dockrell H., Zuckerman M. and Wakelin D. *Mims' Medical Microbiology*. 6th edition. Elsevier. 2018. Print

Websites and Audio Video lectures:

https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm
https://nptel.ac.in/courses/102103015
https://microbiologyonline.org/

Programme Name: B.Sc. (Hons) Microbiology
Course Name: MEDICAL MICROBIOLOGY LABORATORY
Course Code: MIC 332
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 0,0,3

Experiments:

Identify bacteria using reference strains on the basis of

1. Cultural characteristics
2. Morphological characteristics
3. Biochemical characteristics
4. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
5. Study of bacterial flora of skin by swab method
6. Perform antibacterial sensitivity by Kirby-Bauer method
7. Determination of minimal inhibitory concentration (MIC) of an antibiotic
8. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
9. Study of various stages of malarial parasite in RBCs using permanent mounts.

Course Name: MICROBIOLOGICAL ANALYSIS OF AIR & WATER
Course Code: MIC265A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 1,2,0

Course Learning Objective:
This objective of the course is to help the students to understand about the microflora associated with air and water, various methods of their assessment and control.

UNIT 1 **(8 Hours)**
Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their impact, Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics; Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

UNIT 2 **(7 Hours)**
Water borne pathogens and diseases**,** Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests; Control Measures- Precipitation, chemical disinfection, filtration, high temperature, UV light.

Practical **(15 hours)**
1. Sample collection from various locations.
2. Water quality testing by presumptive test (MPN) & complete test.
3. Isolation of faecal coliforms from sewage sample.
4. Assessment of air quality by settle plate method.
5. Effect of chlorination on microorganisms in water sample.

Learning outcomes: The students will get an idea about the various techniques involved in microbiological quality control of air and water.

Suggested Readings
1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR. Microbiological Examination Methods of Food and Water: A Laboratory Manual.2nd edition CRC Press. 2018. Print
2. Atlas RM and Bartha R. Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print
3. Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print .
4. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Raina M. Maier. Environmental Microbiology. 2nd edition. Academic Press. 2011. Print
5. Hurst CJ, Crawford RL, Garland JL, Lipson DA. Manual of Environmental Microbiology, 3rd edition, ASM press. 2007. Print

Websites and Audio Video lectures:
1. https://www.cdc.gov/air/resources.htm
2. https://www.cdc.gov/healthywater/statistics/environmental/index.html
3 https://www.who.int/water_sanitation_health/publications/wqa/en/
4.https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-77-water-quality-control-spring-2006/lecture-notes/

Other supportive material:
1 https://bioisolutions.blogspot.com/2008/05/cholera-toxin-animation.html

2. https://quizlet.com/203127355/lab-quiz-microbiology-of-water-mpn-test-flash-cards/
3. https://www.pwcsa.org/what-we-do/water-treatment/wt-animation.

Programme Name: B.Sc. (Hons) Microbiology
Course Name: MICROBIAL DIAGNOSIS IN HEALTH CLINICS
Course Code: MIC 262
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 1,2,0

Course Learning Objective:

The objective of this course is to make the students to develop an understanding about the clinical microbiology especially about sample collection and various diagnostic approaches based on microscopic studies, cultural techniques, serological and molecular techniques to be used for microbial human diseases and to assess the antimicrobial resistance patterns of different pathogens for selective regimen designing.

Course Content:

UNIT 1 **(10 Hours)**

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage, Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria, Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

UNIT 2 **(5 Hours)**

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods -PCR, Nucleic acid probes Typhoid, Dengue, HIV and Swine flu detection kits

Practical

1. Preparation and staining of bacterial smear.
2. Z-N staining
3. Capsule staining
4. Preparation of differential media
5. Blood agglutination test

Learning outcomes: The students will be able to know about all the methodologies to be followed in a Microbiological diagnostic laboratory for diseases diagnosis like sample collection and microscopic, serological and molecular methods and their treatment using effective antimicrobial agents.

Suggested Readings:

1. Ananthanarayan R and Paniker CKJ. *Textbook of Microbiology*. 10th edition, Universities Press Private Ltd. 2017. Print.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. *Jawetz, Melnick and Adelberg's Medical Microbiology*. 26th edition. McGraw Hill Publication. 2013. Print

3. Randhawa, VS, Mehta G and Sharma KB. *Practicals and Viva in Medical Microbiology*. 2nd edition, Elsevier India Pvt Ltd. 2009. Print

4. Tille P. *Bailey's and Scott's Diagnostic Microbiology*. 14th edition, Mosby Publications. 2017. Print

5. Collee JG, Fraser, AG, Marmion, BP, Simmons A. *Mackie and Mccartney Practical Medical Microbiology*. 14th edition, Elsevier. 2007. Print.

Websites and Audio Video lectures:

https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm

https://nptel.ac.in/courses/102103015

https://microbiologyonline.org/

Other supportive material:

https://www.cengage.com/biology/discipline_content/animations/generation_alternation_m.swf

https://www.springer.com/cda/content/document/cda_downloaddocument/3001.swf

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Course Name: PLANT DIVERSITY
Course Code: BOT131
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:

The objective of this course is to provide an overview about the significance of plants, their diversity and life forms.

Course content:

UNIT 1 **(15 hours)**

Viruses: Discovery, general structure, replication (general account), DNA virus (T -phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

UNIT 2 **(15 hours)**

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria, Fucus*, *Polysiphonia*. Economic importance of algae.

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi-General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

UNIT 3 **(15 hours)**

Introduction to Archegoniate: Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

UNIT 4 **(15 hours)**

Pteridophytes: General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit, stellar evolution.Ecological and economical importance of Pteridophytes.

Gymnosperms: General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. Ecological and economical importance.

Learning outcome: The students will be able to decode and adopt various strategies for plant related studies and innovations.

SUGGESTED READINGS

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi.
Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

2. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

5. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

6. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

7. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Programme Name: B.Sc. (Hons) Microbiology
Course Name: PLANT DIVERSITY LABORATORY
Course Code: BOT132
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 0,3,0

Experiments:

EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
Gram staining
Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* Fucus - Specimen and permanent slides)
Rhizopus and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
Alternaria: Specimens/photographs and tease mounts.
Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).

Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Course Name: PLANT PHYSIOLOGY AND METABOLISM
Course Code: BOT241
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:

The objective of this course is to provide an overview about the significance of plants, their metabolic pathways and growth regulators.

Course content:

UNIT 1 **(15 hours)**

Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

UNIT 2 **(15 hours)**

Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

UNIT 3 **(15 hours)**

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

UNIT 4 **(15 hours)**

Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Learning outcome: The students will be able to decode and adopt various strategies for plant extracts related studies and their metabolites use.

SUGGESTED READINGS:

1. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Name: PLANT PHYSIOLOGY AND METABOLISM LABORATORY
Course Code:BOT242
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.

6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Course Name: FUNDAMENTALS OF MICROBIAL GENETICS
Course Code: MIC225A
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0
Course Learning Objective:
The objective of the course is to introduce the students to various aspects of microbial genetics including genome organization in bacteria and phages, plasmids. This course will make the students aware about the various means of introducing genetic variations in microbes like transformation, transformation, conjugation, mutation, transposition.

Course Content:

UNIT 1 (18 Hours)
Genome organization: *E. coli, Saccharomyces, Tetrahymena , Neurospora, Aspergillus nidulans*
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations
Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes,

UNIT 2 (10 Hours)
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids , importance of plasmids and their major uses in genetic engineering

UNIT 3 (12 Hours)
Transformation - Discovery, mechanism of natural competence
Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping
Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers, Recombination and genome mapping in viruses

UNIT 4 (20 Hours)
Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon
Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds), Uses of transposons and transposition.

Learning outcomes: The students will get an insight into the various mechanisms involved in the maintenance and creating variation in microbial genome.

Suggested Readings
1. Freifelder D, Cronan J, Maloy SR. Microbial Genetics. 2nd edition, Narosa Publishers, 2009. Print
2. Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 10th Edition. McGraw Hill International. 2016. Print .
3.Klug WS, Cummings MR, Spencer, C, Palladino, M. *Concepts of Genetics*, 10th Ed., Benjamin Cummings. 2011. Print
4. Krebs J, Goldstein E, Kilpatrick S. *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning. 2013. Print
5. Pierce BA. *Genetics: A Conceptual Approach*, 4th Ed., Macmillan Higher Education Learning. 2011. Print

6. Watson JD, Baker TA, Bell SP et al. *Molecular Biology of the Gene*, 6th Ed., Benjamin Cummings. 2008. Print
7. Gardner EJ, Simmons MJ, Snustad DP. *Principles of Genetics*. 8th Ed. Wiley-India. 2008. Print
8. Russell PJ. *i Genetics- A Molecular Approach*. 3rd Ed, Benjamin Cummings. 2009. Print
9. Sambrook J and Russell DW. *Molecular Cloning: A Laboratory Manual*. 4th Edition, Cold Spring Harbour Laboratory press. 2001. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102103015/33
2. https://freevideolectures.com/course/2919/microbial-genomics-and-genetics
3. http://faculty.collin.edu/mweis/Microbiology/Lecture/Micro%20Lecture%20Notes/micro_lecture_notes_genetics_BITC.htm

Other supportive material:

1. http://www.sumanasinc.com/webcontent/animations/content/replicaplating.html
2. https://highered.mheducation.com/sites/0072556781/student_view0/chapter13/animation_quiz_5.html
3. https://www.dnalc.org/resources/animations/transformation1.html

Course Name: FUNDAMENTALS OF MICROBIAL GENETICS LABORATORY
Course Code: MIC226A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,0,3

1. Principle & demonstration of Master and Replica Plates.
2. Demonstration of fluctuation test.
3. Study the effect of chemical (HNO_2) agent on bacterial cells
4. Study the effect of physical agent (UV) on bacterial cells.
5. Study killing curve of bacteria after exposure to ultraviolet (UV) light
6. Isolation of Plasmid DNA from *E.coli*
7. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
8. Demonstration of Bacterial Conjugation
9. Demonstration of bacterial transformation and transduction
10. Demonstration of AMES test

Course Name: MOLECULAR BIOLOGY
Course Code: BTY241
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The aim is to extend understanding of the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.

Course Content:

UNIT 1 **(15 hours)**
DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT 2 **(15 hours)**
DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

UNIT 3 **(15 hours)**
RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' capping, polyadenylation, splicing of mRNA, rRNA and tRNA.

UNIT 4 **(15 hours)**
Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Post translational modifications of proteins.

Learning outcome: After studying this course, the students will be able to get the basic and applied aspects of molecular biology in respect of central dogma of molecular biology.

Reference Books:
1. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1st Edition. Academic Press. 2001. Print.
2.Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1st Edition. Cambridge University Press. 1997. Print.
3. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd Edition. Oxford University Press. 2000. Print.
4. Friefelder, D. *Molecular Biology*. 2nd Edition. Narosa Book Distributors Pvt. Ltd. 2008. Print.
Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th Edition. Garland Science. 2007. Print.

Course Name: MOLECULAR LABORATORY
Course Code: BTY242
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Isolation of DNA from animal and plant tissue using classical methods
2. Isolation of RNA from animal and plant tissue using classical methods
3. Isolation of plasmid DNA from *E. coli* using boiling-prep and alkali lysis method
4. Restriction fragment length polymorphism
5. Agarose gel electrophoresis
6. Polyacrylamide gel electrophoresis
7. Elution of nucleic acids from agarose gel
8. Primer Designing
9. Polymerase Chain Reaction.

Course Name: FOOD AND DAIRY MICROBIOLOGY
Course Code: MIC227
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
To familiarise students about the basic principles of food spoilage, food preservation and food borne diseases. To make students understand some significant food fermentations.

Course Content:

UNIT 1 **(15 Hours)**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general-bacteria, yeasts, molds.
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

UNIT 2 **(15 Hours)**
Principles, Physical methods of food preservation: temperature, irradiation, high hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging,
Chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins, Concept of modified atmospheric packaging

UNIT 3 **(12 Hours)**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Concept of Probiotics and prebiotics, Health benefits, types of microorganisms used as probiotics, probiotic foods available in market.

UNIT 4 **(18 Hours)**
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;
Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*
, HACCP, Indices of food sanitary quality and sanitizers, Cultural and rapid detection methods of food borne pathogens in foods. National and International Agencies for Food Standards and Quality Control.

Learning outcomes:
Upon successful completion of the course, students would 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, explain why microbiological quality control programmes are necessary in food production. They will be able to understand the effects of fermentation in food production and how it influences the microbiological quality and status of the food product.

Suggested Readings:

1. Frazier WC and Westhoff DC (2008) *Food Microbiology*. 4th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. Print.
2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.
3. Adams MR and Moss MO. *Food Microbiology*. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. 2015. Print

4. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print
5. Jay JM, Loessner MJ and Golden DA. *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India. 2005. Print.
6. Davidson PM and Brannen AL. *Antimicrobials in Foods*. 3rd edition, Marcel Dekker, New York. 2005. Print.
7. Lund BM, Baird Parker AC, and Gould GW. *The Microbiological Safety and Quality of Foods*. Vol. 1-2, ASPEN Publication, Gaithersberg, MD. 2000. Print

Websites and Audio Video lectures:

- https://swayam.gov.in/courses/5147-food-microbiology-and-food-safety
- https://microbiologyonline.org/

Other supportive material:

- http://www.fda.gov/Food/ScienceResearch/ResearchAreas/SafePracticesforFoodProcesses/defa ult.htm
- CAC – Principles of microbiological risk analysis www.who.int/fsf/mbriskassess/pdf/draftpr.pdf

Course Name: FOOD AND DAIRY MICROBIOLOGY LABORATORY
Course Code: MIC228
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetablesfruits.
5. Isolation of spoilage microorganisms from spoiled dairy products.
6. Isolation of spoilage microorganisms from bread.
7. Isolation of lactic acid bacteria
8. Preparation of Sauerkraut
9. Preparation of Yogurt/Dahi.
10. Demonstration of food preservation techniques.

Programme Name: B.Sc. (Hons) Microbiology
Course Name: MANAGEMENT OF HUMAN MICROBIAL DISEASES
Course Code: MIC 261
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 1,2,0

Course Learning Objective:

This course is designed with the aim of providing an insight into the various aspects of some significant human diseases caused by microbes, their mechanism of establishment, diagnosis and therapeutic and prophylactic measures to be adopted including judicious regimen use.

Course Content:

UNIT 1 (**6 Hours)**

Infection, Infectious and non infectious diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

UNIT 2 (**9 Hours)**

Respiratory microbial diseases, gastrointestinal microbial diseases, urinary tract diseases, types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola/Coronavirus) – causes, spread and control. Treatment using antibiotics, Judicious use of antibiotics, importance of completing antibiotic regimen, emergence of antibiotic resistance.

Practical **(15 Hours)**

1. Effects of antibiotics on human pathogens.
2 Study of AMR and its prevalence.
3 Isolation of antibiotic producer microorganisms.
4 Isolation of microorganism from biological sample.
5 A visit to hospital/diagnostic laboratory.

Learning outcomes: The students will be able to know about all the preventive and therapeutic aspects to be followed for microbial diseases.

Suggested Readings:

1. Ananthanarayan R. and Paniker C.K.J. *Textbook of Microbiology*. 10th edition, University Press Publication. 2017. Print
2. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott, Harley and Klein's Microbiology*. 10th edition. McGraw Hill Higher Education. 2013. Print
3. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. *Jawetz, Melnick and Adelberg's Medical Microbiology*. 26th edition. McGraw Hill Publication. 2013. Print
4. Goering R., Dockrell H., Zuckerman M. and Wakelin D. *Mims' Medical Microbiology*. 6th edition. Elsevier. 2018. Print

5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2014. Print.
6. Patton K.T and Thibodeau G.A.*The Human Body in Health & Disease*. 6th edition. Mosby publications 2013. Print

Websites and Audio Video lectures:

https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm
https://nptel.ac.in/courses/102103015
https://microbiologyonline.org/

Other supportive material:

https://www.cengage.com/biology/discipline_content/animations/generation_alternation_m.swf

Course Name: FOOD FERMENTATION TECHNIQUES
Course Code: MIC264
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 1,2,0

Course Learning Objective:
The aim of this course is to provide an insight into the fundamentals of various types of food fermentation processes based on milk, vegetables, grains, meats and probiotics.

UNIT 1 **(9 Hours)**
Fermented food: Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process; Probiotics- Definition, types, microorganisms and health benefits

UNIT 2 **(6 Hours)**
Soy sauce, Bread, Idli and Dosa, Pickels, Saeurkraut: Microorganisms and production process

Practical
1. Isolation of microorganisms from traditional fermented food.
2. Preparation of yogurt/Dahi.
3. Study of fermentative microorganisms for their probiotic potential.
4. Preparation of Saeurkraut
5. A visit to food industry/food microbiological laboratory.

Learning Outcomes:
The students will came to know about important microbial food fermentations and imply their knowledge in various food fermentation industries.

Suggested Readings:

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS. *Handbook of food and fermentation technology*. CRC Press. 2004. Print
2. Holzapfel W. *Advances in Fermented Foods and Beverages*. Woodhead Publishing. 2014. Print
3. Yadav JS, Grover, S and Batish VK. *A comprehensive dairy microbiology*. Metropolitan. 1993. Print

Websites and Audio Video lectures:
- https://swayam.gov.in/courses/5147-food-microbiology-and-food-safety
- http://www.fda.gov/Food/ScienceResearch/ResearchAreas/SafePracticesforFoodProcesses/defa ult.htm

Programme Name: B.Sc. (Hons) Microbiology
Course Name: GENERAL CHEMISTRY-II
Course Code: CHE257
Total Credits: 4
Credits components (Theory, Practical, Tutorial): 4,0,0

Course objective: The aim of this course is to further stimulate and brush up the basic concepts of chemistry of students to make them more insightful for chemistry.

UNIT 1 *:* **(15 Hours)**

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between *G* and G^o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.

UNIT 2 **(15 Hours)**

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit 3 **(15 Hours)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 or NaNH2.

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

UNIT 4 **(15 Hours)**

Alcohols: *Preparation:* Preparation of primary, secondary and tertiary alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol cse) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann

Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Learning outcome: After studying this course, the students will be more thoughtful for chemistry and its processes.

Reference Books:

• T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
• Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
• I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
• R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
• Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.
• G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
• G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
• J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
• B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Programme Name: B.Sc. (Hons) Microbiology
Course Name: GENERAL CHEMISTRY-II LABORATORY
Course Code: CHE258
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 0,3,0

Experiments:
Thermochemistry
1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of H.

Ionic equilibria
pH measurements
a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide
Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.
(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2, 4 dinitrophenylhydrazone of aldehyde/ketone.

Programme Name: B.Sc. (Hons) Microbiology
Course Name: BIOTECHNOLOGY AND HUMAN WELFARE
Course Code: BTY243
Total Credits: 4
Credits components (Theory, Practical, Tutorial): 4,0,0

Course objective: The aim of this course is to make the students aware about welfare aspects of biotechnology and its applications for mankind.

Course content:

UNIT 1 **(15 hours)**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT 2 **(15 hours)**

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT 3 **(10 hours)**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT 4 **(20 hours)**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.
Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

Learning outcomes: After studying this course, the students will be able to follow the strategy of sustainable development and technology for welfare of mankind using biotechnological innovations,

Programme Name: B.Sc. (Hons) Microbiology
Course Name: BIOTECHNOLOGY AND HUMAN WELFARE LABORATORY
Course Code: BTY244
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 0,3,0

Course content:
1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

Programme Name: B.Sc. (Hons) Microbiology
Course Name: PROTEINS AND ENZYMES
Course Code: BCH218
Total Credits: 4
Credits components (Theory, Practical, Tutorial): 4,0,0

Unit 1 **(15 hours)**

Introduction to proteins Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Isolation and analysis of proteins

Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifeld method.

Unit 2 **(15 hours)**

Introduction to protein three-dimensional structures

Secondary structure: alpha-helices and beta-sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures.

Myoglobin and haemoglobin - structure and function

Oxygen binding curves, cooperativity models for haemoglobin.

Unit 3 **(15 hours)**

Introduction to enzyme catalysis

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Enzyme kinetics

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit 4 **(15 hours)**

Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

Enzymes in medicine and industry

Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

Recommended Books

1. Lehninger: Principles of Biochemistry (2013) 6th edition, Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 19781464109621.
2. Fundamentals of Enzymology (1999) 3rd edition, Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN: 9780198064398.
3. ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry (2008), 2nd edition, Palmer, T and Bonner P, East West Publishers. ISBN: 9788176710596

Programme Name: B.Sc. (Hons) Microbiology
Course Name: PROTEINS AND ENZYMES LABORATORY LABORATORY
Course Code: BCH219
Total Credits: 2
Credits components (Theory, Practical, Tutorial): 0,3,0

Experiments:
1. Protein estimation by UV absorbance and Biuret method.
2. Protein microassay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
5. Determination of Km and Vmax of enzyme enriched fraction.
6. Inhibition of acid phosphatase activity by inorganic phosphate.

Course Name: ENVIRONMENTAL MICROBIOLOGY
Course Code: MIC223
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
To familiarise students about microbial ecology, microbial interactions with each other and with higher organisms. The students will also be exposed to the role of microbes in the environment, waste management etc.

Course Content:

UNIT 1 **(20 hours)**

Structure and function of ecosystems, Terrestrial Environment:Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.
Microbial succession in decomposition of plant organic matter
Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
Microbe-Plant interaction: Symbiotic and non symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

UNIT 2 **(14hours)**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
Phosphorus cycle: Phosphate immobilization and solubilisation
Sulphur cycle: Microbes involved in sulphur cycle
Other elemental cycles: Iron and manganese

UNIT 3 **(10 hours)**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

UNIT 4 (1**6 hours)**
Bioremediation: basic concepts, in situ bioremediation, ex-situ bioremediation, Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants
Bioleaching and biomining- Introduction and advantages, methods of microbial mineral recovery-heap method, continuous method, recovery of copper, recovery of uranium

Learning outcomes:

The students will come to know about the different aspects of microorganisms about environment management. The program will prepare students for further education (microbiology, environmental science) or for careers in fields such as environmental monitoring and safety, characterization and control of pathogenic microorganisms, and bioremediation.

Suggested Readings:

1. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print
2. Maier RM, Pepper IL and Gerba CP. *Environmental Microbiology*. 2nd edition, Academic Press. 2009. Print
3. Okafor, N. *Environmental Microbiology of Aquatic & Waste systems*. 1st edition, Springer, New York. 2011. Print
4. Barton LL & Northup DE. *Microbial Ecology*. 1st edition, Wiley Blackwell, USA. 2011. Print
5. Martin A. *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London. 1977. Print
6. Madigan MT, Martinko JM and Parker J. *Brock Biology of Microorganisms*. 14th edition. Pearson/ Benjamin Cummings. 2014. Print.
7. Subba Rao NS. *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi. 1999. Print.
8. Lynch JM & Hobbie JE. *Microorganisms in Action: Concepts & Application in Microbial Ecology*. Blackwell Scientific Publication, U.K. 1988. Print

Websites and Audio Video lectures:
https://nptel.ac.in/courses/105107173/
https://asm.org/index.php/education

Other supportive material:
https://www.sciencedaily.com/news/plants_animals/microbiology/
https://www.microbes.info/news/index.php

Course Name: ENVIRONMENTAL MICROBIOLOGY LABORATORY
Course Code: MIC224
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water(Presumptive)
5. Assessment of microbiological quality of water(Complete)
6. Estimation of total dissolved solutes(TDS) in water.
7. Indoor air quality assessment by settle plate method.
8. Determination of BOD of waste water sample.
9. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
10. Isolation of *Rhizobium* from root nodules/soil.

Course Name: SOIL MICROBIOLOGY
Course Code: MIC353
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
The aim of this course is to provide an insight into the role and significance of microbes in soil including their role as mineralizing agents, biocontrol agents, biofertilizers. This course will also introduce the students to the utilization of genetically modified crops and their significance.

Course Content:

UNIT 1 (20hours)
History of Soil Microbiology, Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil, Soil microbial biomass, Soil enzymes and their functions
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus
Phosphate, nitrate, silicate & potassium solubilising microorganisms.

UNIT 2 (20 hours)
Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*),
Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae),
Consortium of microbes as biofertilizers, PGPRs
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against microbial plant pathogens, Insects, Weeds

UNIT 3 (10hours)
Microbial waste recycling: organic compost, vermicomposting, Biogas production, Biomanure, biofuels, microbial sewage treatment, waste water treatment by microbes Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

UNIT 4 (10 hours)
GM Crops: advantages, social and environmental aspects, Bt cotton, golden rice etc.

Learning outcomes:
Students will learn that the soil is an excellent habitat for multitude of microorganisms balancing the soil ecosystem. Students will learn about various beneficial effects of soil microorganisms on soil health, which is instrumental in the production of food and fiber. The knowledge acquired in Soil Microbiology will enhance the student's competency in the performance of their duties as future employees in the field of Agricultural Microbiology/Soil Science.

Assessment:
Mid Semester Examination, Written Quiz (Objective Type MCQs) and Assignment and Project Work/Seminar (evidence based), End Semester Examination.

Suggested Readings:
1. Alexander,M.1977. Introduction to soil microbiology. John Wiley and Sons. New York.

2. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print.
3. Altman A. *Agriculture Biotechnology*, 1st edition, Marcel decker Inc. 1998. Print.

4. Subba Rao NS. *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi. 1999. Print.
5. Coyne MS. *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning. 2001. Print.
6. Agrios GN. *Plant Pathology*. 5th edition. Academic press, San Diego. 2006. Print.
7. Maier RM, Pepper IL and Gerba CP. *Environmental Microbiology*. 2nd edition, Academic Press. 2009. Print.
8. Glick BR, Pasternak JJ, and Patten CL. *Molecular Biotechnology*. 4th edition, ASM Press. 2010. Print.
9. Mahendra K. Rai. *Hand Book of Microbial Biofertilizers*. The Haworth Press, Inc. New York. 2005. Print.

Websites and Audio Video lectures:

1. https://www.sare.org/learning-center/soil-microbiology
2. https://onlinecourses.nptel.ac.in/noc18_ce01/preview (soil and environmental)

Other supportive material:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-microbiology
2. https://www.omicsonline.org/scholarly/soil-microbiology-journals-articles-ppts-list.php
3. https://www.nature.com/subjects/soil-microbiology

Course Name: SOIL MICROBIOLOGY LABORATORY
Course Code: MIC354
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms
7. Isolation of P-solubilizing microorganisms from soil by using PVK agar medium
8. Isolation of siderophore producing microorganisms from soil by using CAS medium
9. Isolation of antifungal bacteria by using agar well diffusion method
10. Isolation of starch degrading bacteria from soil

Course Name: BIOSTATISTICS AND BIOINFORMATICS
Course Code: BTY395
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The course focuses on design, analysis, and interpretation of data for research studies. It also gives insight into the uses of computation to better understand biology which involves analysis of biological data, particularly DNA, RNA, and protein sequences.
Course Contents:

UNIT 1 **(15Hours)**
Types of data, collection of data; primary & secondary data, classification and graphical representation of statistical data. Measures of central tendency and dispersion. Measures of Skewness and Kurtosis. Probability classical & axiomatic definition of probability, theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT 2 **(15Hours)**
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA), correlation and regression. Emphasis on examples from biological sciences.

UNIT 3 **(15Hours)**
History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Searching Databases: SRS, Entrez, sequence similarity searches-BLAST, FASTA, Data submission. Genome annotation: Pattern and repeat finding, gene identification tools. Alignments: Pairwise and multiple sequence alignment, using it on the web, interpreting results, phylogenetic analysis

UNIT 4 **(15Hours)**
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of data generating techniques and bioinformatics problem posed by them-restriction digestion, chromatograms, blots, PCR, microarrays, mass Spectrometry.

Reference Books:
1. Banerjee, P.K. Introduction to Biostatistics. 4th Edition. S. Chand & Co. Ltd. 4th Edition. 2013. ISBN: 9788121923293

2. Sokal, R.R. and Rohlf, F.J. Introduction to Biostatistics. 2nd Edition. Dover Publications. 2009. ISBN: 978-0486469614

3. Pevzner, P. and Shamir, R. Bioinformatics for Biologists. 1st Edition. Cambridge University Press. 2011. ISBN: 978-1107648876

4. Lesk, A.M. Introduction to Bioinformatics. 3rd Edition. Oxford University Press. 2008. ISBN: 978-0199208043

5. Bourne, P.E. and Weissig, H. Structural Bioinformatics. 2nd Edition. John Wiley & Sons Ltd. 2009. ISBN: 0 471201995

Course Name: BIOSTATISTICS AND BIOINFORMATICS LABORATORY
Course Code: BTY396
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

EXPERIMENTS:

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square
5. Introduction to SPSS and MATLAB
6. Sequence information resource
7. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene
8. Protein information resource (PIR)
9. Understanding and using: PDB, Swissprot, TREMBL
10. Using various BLAST and interpretation of results.
11. Retrieval of information from nucleotide databases.
12. Sequence alignment using BLAST.
13. Multiple sequence alignment using Clustal W.

Programme: B.Sc. (Hons) Microbiology
Course Name: MICROBIAL BIOTECHNOLOGY
Course Code: MIC345
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The objective of this course is to expose the students to the various possible applications of the microbes in the field of medicine, environment and production of various industrially important products.

Course Content:

UNIT 1 (**Hours: 20)**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology
Use of prokaryotic and eukaryotic microorganisms in biotechnological applications
Genetically engineered microbes for industrial application: Bacteria and yeast
Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine), therapeutic live vaccines
Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors, Single cell protein

UNIT 2 **(Hours:15)**

Microbial based transformation of steroids and sterols
Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute
Microbial product purification: filtration, ion exchange & affinity chromatography techniques
Immobilization methods and their application: Whole cell immobilization

UNIT 3 (**Hours: 15)**

Biofuels: Commercial production of bio-ethanol, bio-diesel, biohydrogen, biogasproduction fromm waste biomass. Microorganisms in bioremediation: Degradation of xenobiotics, recovery and removal of heavy metals
RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

UNIT 4 (**Hours: 10)**

IPR in Biotechnology: Patents, Procedure of Patenting in India, Roles of patents in biotechnology, Copyrights, Trademarks, and Plant Breeder's Rights and Farmer's Variety Act

SUGGESTED READINGS:

1. Ratledge, C and Kristiansen, B. *Basic Biotechnology*.3rd Edition, Cambridge University Press. 2006. Print
2. Demain, A. L and Davies, J. E. *Manual of Industrial Microbiology and Biotechnology*. 3rd Edition, ASM Press. 2010. Print
3. Swartz, J. R. *Advances in Escherichia coli production of therapeutic proteins*. Current Opinion in Biotechnology, 12, 195–201. 2001. Print
4. Willey JM, Sherwood LM, Woolverton CJ. *Prescott, Harley and Klein's Microbiology*. 9th edition, Mc Graw Hill Publishers. 2014. Print
5. Gupta PK. *Elements of Biotechnology*. 2nd edition, Rastogi Publications. 2010. Print
6. Glazer AN and Nikaido H. *Microbial Biotechnology.* 2nd edition, Cambridge University Press. 2007. Print

7. Glick BR, Pasternak JJ, and Patten CL. *Molecular Biotechnology : Principles And Applications Of Recombinant Dna*. 5th edition,T&F. 2018. Print
8. Stanbury PF, Whitaker A, Hall SJ. *Principles of Fermentation Technology*. 3rd edition Butterworth-Heinemann.2016. Print

Programme: B.Sc. (Hons) Microbiology
Course Name: Microbial BIOTECHNOLOGY LABORATORY
Course Code: MIC346
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0
Experiments:

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase producing bacteria
5. Isolation of lipase producing bacteria
6. Study of algal Single Cell Proteins
7. Isolation of cellulolytic microbes from soil sample
8. Isolation of antibiotic producer microorganisms
9. Demonstration of antimicrobial resistance to antibiotics.
10. Isolation of dye degrading bacteria.

Programme: B.Sc. (Hons) Microbiology
Course Name: RECOMBINANT DNA TECHNOLOGY
Course Code: MIC349
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: Recombinant DNA technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn how the genes can be cut and pasted from one organism to another and what its implications are.

Course Content:

UNIT 1 **(15 hours)**

Molecular tools and applications - restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR

UNIT 2 **(15 hours)**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Applications of Genetic Engineering; Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

UNIT 3 **(15 hours)**

Random and site-directed mutagenesis: PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT 4 **(15 hours)**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

SUGGESTED READINGS (Text and reference books)

1. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes.* 3rd Edition. W.H. Freeman & Company. 2006. Print.
2. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics.*7th Edition. Oxford University Press. 2006. Print.
3. Lodge, J., Lund, P. and Minchin, S. *Gene Cloning: Principles and Applications*. 1st Edition. Taylor & Francis. 2006. Print.
5. Brown,T.A. *Gene cloning and DNA analysis: An introduction*.5thEdition. Wiley-Blackwell. 2010. Print.
6. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III.2nd Edition. Cold Spring Harbor Laboratory,1989. Print.

Programme: B.Sc. (Hons) Microbiology
Course Name: RECOMBINANT DNA TECHNOLOGY LABORATORY
Course Code: MIC350
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E. coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

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Programme: B.Sc. (Hons) Microbiology
Course Name: CELL BIOLOGY
Course Code: BTY121
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: To study in detail about the cell which encompasses the cell structure, structure and functions of organelles, locomotion, life cycle and division. To impart knowledge to students about the basics of stem cells and their applications as well as to introduce them to the world of cellular differentiation and cloning.

Course Content:

UNIT I: (18 hours)
Introduction: Cell as a basic UNIT of living system, Biochemical composition of cell, the cell theory, ultra structure of cell.
Cytoskeleton: The Nature of the Cytoskeleton and endomembrane system, intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins.
Cell membranes: Architecture and dynamics (models); Membrane composition, the lipid bilayer/membrane; A summary of membrane functions - simple diffusion, Facilitated transports, Active transport.

UNIT 2: (16 hours)
Structure and functions of the following cell organelles: endoplasmic reticulum, Golgi complex, lysosome, ribosome and mitochondria. Principles & applications of differential centrifugation in the fractionation of cellular organelles and Svedberg UNIT; endosymbiotic theories

UNIT 3: (10 hours)
Genome organization, structure and function of nucleus, nuclear envelope, structure of chromatin, nucleosome and chromosome, cell cycle, mitosis and meiosis.

UNIT 4: (16 hours)
The compartmentalization of higher cells, transport of molecules into and out of organelle membranes, the endoplasmic reticulum, transport from the ER through the Golgi Apparatus, transport from the trans Golgi network to lysosomes, transport from the plasma membrane via endosome: Endocytosis, molecular mechanisms of vesicular transport; introduction to transit peptide, signal peptide and translocons.

Learning outcome: After studying this course, the students will be able to know about various aspects of cell, its organelles and their functions.

Suggested Readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th Edition. Garland Science. 2007. Print.

2. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.

3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. *The World of the Cell.* 7th Edition. Benjamin Cummings. 2008. Print.

4. Powar, C.B. *Cell Biology*. Himalaya Publishing House. 2007. Print.

5. G Karp. Cell and molecular Biology. John wiley and sons 6th edition.

Cooper G.M. The *Cell .6th* edition

Programme: B.Sc. (Hons) Microbiology
Course Name: CELL BIOLOGY LABORATORY
Course Code: BTY122
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

1. Understanding principle, working and handling of light microscope and microtome.

2. Understanding microscope adjustments, light sources, microscopic measurements, calibration and types of microscopes available.

3. Observation of microorganisms under phase contrast microscope and dark-field microscope.

4. Preparation of different types of stains

5. Cytological preparations, Fixation, dehydration and staining

6. Squash preparation of meiotic and mitotic cells

7. Embedding and sectioning.

8. Examination of various stages of mitosis and meiosis.

Programme: B.Sc. (Hons) Microbiology
Course Name: BASICS OF INDUSTRIAL MICROBIOLOGY
Course Code: MIC335A
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The objective of this course is to provide knowledge to the students about the fundamentals of industrial microbiology and fermentation technology like isolation of industrially important microbes, types of fermenters, downstream processing etc.

Course Content:

UNIT 1 **(12 Hours)**

Brief history and developments in industrial microbiology

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

UNIT 2 **(18 Hours)**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations

Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Principle, methodology, instrumentation an applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, lyophilization and spray drying.

UNIT 3 **(18 Hours)**

Process outline and producer organism for industrial production of Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase, xylanases, cellulases) Wine, beer, Bread, single cell protein.

UNIT 4 **(4 Hours)**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

SUGGESTED READINGS:

1. Patel A.H. *Industrial Microbiology*. 1st edition, Macmillan India Limited. 1996. Print
2. Okafor N. *Modern Industrial Microbiology and Biotechnology*. 1st edition. Bios Scientific Publishers Limited. USA 2007. Print
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. *Industrial Microbiology: An Introduction.* 1st edition. Wiley – Blackwell. 2001. Print
4. Glaze A.N. and Nikaido H. *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 1st edition. W.H. Freeman and Company. 1995. Print
5. Casida LE. *Industrial Microbiology*. 1st edition. Wiley Eastern Limited. 1991. Print
6. Crueger W and Crueger A. *Biotechnology: A textbook of Industrial Microbiology*. 2nd edition. Panima Publishing Co. New Delhi. 2000. Print
7. Stanbury PF, Whitaker A and Hall SJ. *Principles of Fermentation Technology*. 2nd edition, Elsevier Science Ltd. 2006. Print

Programme: B.Sc. (Hons) Microbiology
Course Name: BASICS OF INDUSTRIAL MICROBIOLOGY LABORATORY
Course Code: MIC336A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Study different parts of fermenter.
2. Isolation and quantification of microbial amylase
3. Isolation and quantification of microbial Protease
4. Isolation and quantification of microbial Cellulase
5. Production and quantification of amino acid: Glutamic acid
6. Production and quantification of Organic acid: Citric acid
7. Production and quantification of Alcohol: Ethanol
8. Production of beer/wine.
9. Demonstration of antibiotic producer from soil.
10. Demonstration & application of TLC in industrial microbiology.
11. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

Programme: B.Sc. (Hons) Microbiology
Course Name: Biosafety & Intellectual Property Rights
Course Code: MIC351
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course objective: This course will familiarize the students with the concepts of biosafety, intellectual property and its management.

Course Content:

UNIT 1 (24 Hours)

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms
Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

UNIT 2 (12 Hours)

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR –patentable and non patentables – patenting life – legal protection of biotechnological inventions –world intellectual property rights organization (WIPO).

UNIT 3 (12 Hours)

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

UNIT 4 (12 Hours)

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

SUGGESTED READINGS:

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Implications,Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Programme: B.Sc. (Hons) Microbiology
Course Name: BIOSAFETY & IPR LABORATORY
Course Code: MIC352
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:
1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

Programme Name: B.Sc. (Hons) Microbiology
Course Name: BASICS OF IMMUNOLOGY
Course Code: MIC 333A
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:

The course will expose the students to the basic concepts of immune system including important cells and organs on immune system, antigens and antibodies, generation of immune response, and experimental immunological techniques.

Course Content:

UNIT 1 (11 Hours)

Concept of Innate and Adaptive immunityy; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa. Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs– Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT 2 (19 Hours)

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants,
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies. Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).
Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

UNIT 3 (17 Hours)

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Tolerance,, Autoimmunity and Hypersensitivity Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD.

UNIT 4 (13 Hours)

Techniques in immunology: Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Cancer immunology, Cancer vaccines,New approaches for delivery of immunotherapies into tumors.

Learning outcomes: The students will be able to understand the components and working of immune system in response to variety of antigens or pathogens and mode of action of immunotherapeutic agents.

Suggested Readings:

1. Delves P, Martin S, Burton D, Roitt IM. *Roitt's Essential Immunology*. 13th edition Wiley-Blackwell Scientific Publication, Oxford. 2017. Print

2. Goldsby RA, Kindt TJ, Osborne BA. *Kuby's Immunology*. 8th edition W.H. Freeman and Company, New York. 2019. Print

3. Abbas AK, Lichtman AH, Pillai S. *Cellular and Molecular Immunology*. 9th edition Saunders Publication, Philadelphia. 2017. Print

4. Murphy K, Travers P, Walport M. *Janeway's Immunobiology*. 9th edition Garland Science Publishers, New York. 2017. Print

5. Peakman M, and Vergani D. *Basic and Clinical Immunology*. 2nd edition Churchill Livingstone Publishers, Edinberg. 2009. Print

6. Parham P.*The Immune System.* 4th edition, W. W. Norton & Company,Garland Science.2015.

Websites and Audio Video lectures:

https://www.atsu.edu/faculty/chamberlain/Website/Lects/Content1.htm

https://nptel.ac.in/courses/102103015

Programme Name: B.Sc. (Hons) Microbiology
Course Name: BASICS OF IMMUNOLOGY LABORATORY
Course Code: MIC 334A
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,0,3

Experiments:

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Demonstration of serum preparation from the blood sample
5. Demonstration of plasma separation from blood sample.
6. Perform immunodiffusion by Ouchterlony method.
7. Demonstration of ELISA.
8. Demonstration of WIDAL test.
9. Perform DOT ELISA.
10. Perform immunoelectrophoresis.

Programme: B.Sc. (Hons) Microbiology
Course Name: PLANT PATHOLOGY
Course Code: MIC347
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Learning Objective:
The students will come to know about the basic aspects of plant disease development, control of plant diseases and some significant diseases of plants caused by fungi, bacteria and viruses.

Course Content:

UNIT 1 (**10 Hours)**
Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman,
H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

UNIT 2 **(10 Hours)**
Stages in development of a disease:Infection, invasion, colonization, dissemination of pathogens and perennation.
Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

UNIT 3 **(20 Hours)**
A. *Microbial Pathogenicity*
Virulence factors of pathogens, Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).
B. *Genetics of Plant Diseases*
Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.
C. *Defense Mechanisms in Plants*
Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins.

UNIT 4 **(20 Hours)**
Principles & practices involved in the management of plant diseases by different methods, *viz.*
Regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material
Cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches
Chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.
Biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants
Genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes
Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control: A. Important diseases caused by fungi**;** White rust of crucifers - *Albugo candida***,** Late blight of potato - *Phytophthora infestans***,** Black stem rust of wheat -

Puccinia graminis tritici Loose smut of wheat - *Ustilago nuda***,** Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici***,** Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial cankers of citrus

D. Important diseases caused by viruses and viroids: tomato yellow leaf curl, Potato spindle tuber.

Learning outcomes:

The students will learn to understand the importance of plant diseases in plant production systems. They will learn to recognize the various signs and symptoms of diseases in plants 3) understand the principals of disease diagnosis and be able to apply this knowledge to practical situations 4) understand the principals of diseases management in plant production systems

Suggested readings:

1. Agrios GN. *Plant Pathology*. 5th edition. Academic press, San Diego. 2006. Print

2. Rangaswami G. *Diseases of Crop Plants in India*. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi. 2005. Print.

3. P.D. Sharma

Programme: B.Sc. (Hons) Microbiology
Course Name: PLANT PATHOLOGY LABORATORY
Course Code: MIC348
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

Experiments:

1. Demonstration of Koch's postulates in fungal pathogen
2. Demonstration of Koch's postulates in bacterial pathogen
3. Study of important fungal diseases of crop plants by cutting sections of infected plants.
4. Isolation of antagonistic bacteria
5. Demonstration of infection cycle of *Phytopthora infestans*
6. Demonstration of infection cycle of *Alternaria solani*
7. Demonstration of infection cycle of TMV
8. Study of characteristic symptoms of plants infected with various pathogens.

Programme: B.Sc. (Hons) Microbiology
Course Name: GENOMICS AND PROTEOMICS
Course Code: MIC355
Total Credits: 4
Credits components: (Theory, Practical, Tutorial): 4,0,0

Course Objective: The course helps in developing a detailed understanding of eukaryotic genome complexity and organization. The students will be familiarised with the techniques in Genomics and Proteomics.

Course Contents:

UNIT 1 **(15 Hours)**

The origin of genomes. Acquisition of new genes. The origins of introns. Basic principles of protein structure.

UNIT 2 **(15 Hours)**

Restriction mapping, DNA & RNA finger printing, DNA sequencing-chemical and enzymatic methods, the human genome.

UNIT 3 **(15 Hours)**

Phylogeny, SAGE, ESTs, AFLP & RFLP analysis. 2D– gel electrophoresis and mass spectroscopy for proteome analysis. Protein – protein interactions: Yeast- two hybrid method, GFP tags, proteome- wide interaction maps.

UNIT 4 **(15 Hours)**

Modelling of three-dimensional structure of a protein from amino acid sequence. Modeling mutants. Designing proteins. Analysis of nucleic acid / protein sequence and structure data, genome and proteome data using web-based tools.

Reference Books:

1. Brown, T.A. Genomes III. 3rd Edition. Garland Science. 2006. ISBN: 978-0815341383

2. Lengauer, T., Mannhold, R., Kubinyi, H. and Timmerman, H. Bioinformatics: From Genomes to Drugs. 1st Edition. John Wiley and Sons Ltd. 2001. ISBN: 978-3527299881

3. Mount, D. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press. 2013. ISBN: 978-0879697129

4. Schena, M. DNA Microarrays: A Practical Approach. 1st Edition. Oxford University Press. 1999. ISBN: 9780199637768

5. Gibson, G. and Muse, S.V. A Primer of Genome Science. 3rd Edition. Sinauer Associates, Inc. 2009. ISBN: 978-0878932368

6. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. Recombinant DNA: Genes and Genomes. 3rd Edition. W.H. Freeman & Company. 2006. ISBN: 978-0716728665

7. Xiong, J. Essential Bioinformatics. 1st Edition. Cambridge University Press. 2006. ISBN: 9780521600828

8. Twyman, R. Principles of Proteomics. 2nd Edition. Garland Science. 2013. ISBN: 9780815344728

Programme: B.Sc. (Hons) Microbiology
Course Name: GENOMICS AND PROTEOMICS LABORATORY
Course Code: MIC356
Total Credits: 2
Credits components: (Theory, Practical, Tutorial): 0,3,0

EXPERIMENTS

1. Electrophoretic separation of plasmid DNA.

2. Restriction, digestion & ligation of DNA.

3. Native PAGE

4. SDS PAGE

5. Gene finding tools and genome annotation- Gen Scan, Net Gene, Hmm gene.

6. Use of SNP databases at NCBI and other sites

7. Detection of Open Reading Frames using ORF Finder

8. Proteomics 2D PAGE database

9. Comparison of two given genomes- Mummer.

10. Homology modelling of 3-D structure from amino acid sequence: SWISS- MODELLER

11. Graphics tools: SWISS- PDB Viewer.

Assessment

For Theory Courses:
Mid Semester Examination (MSE)- 25 Marks,
Written Quiz (Objective Type MCQs)- 10 Marks
Assignment/ Project Work/Seminar (evidence based) -10 Marks
End Semester Examination (ESE)- 50 Marks
Attendance- 5 Marks

For Practical Courses:
End Semester Practical Exam- 80 Marks
Continuous Assessment – 20 Marks

Question paper formats for mid semester exam (MSE) and end semester exam (ESE)

DAV University, Jalandhar.

Term-

MSE

Name: ……. **Regd. No.: ……**

Course Code: MIC000 **Roll No.: …….**

Time: 1 Hour30 Minutes

Maximum Marks: 25

Course Name: ……

Section – A **(Maximum Marks: 1 x 5 = 5)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

Section – B **(Maximum Marks: 4 x 3 = 12)**

Attempt any **3 Questions out of 5 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Section – C **(Maximum Marks: 8 x 1 = 8)**

Attempt **1 Question out of 2 Questions** and each question should be answered in maximum 4 pages.

Q.7

Q.8

DAV University, Jalandhar.

ESE

Name: …….

Regd. No.: …….

Course Code: MIC000

Time: 3 Hours

Maximum Marks: 50

Course Name: …….

Section – A **(Maximum Marks: 1 x 10 = 10)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

vi.

vii.

viii.

ix.

x.

Section – B **(Maximum Marks: 4 x 6 = 24)**

Short Answer Type: Attempt any **6 Questions out of 8 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Q.7

Q.8

Q.9

Section – C **(Maximum Marks: 8 x 2 = 16)**

Long Answer Type: Attempt **2 Questions out of 4 Questions** and each question should be answered in maximum 4 pages.

Q.10

Q.11

Q.12

Q.13