Guru Jambheshwar University of Science and Technology
Hisar-125001, Haryana
('A+' NAAC Accredited State Govt. University)

Scheme of Examination for Integrated Five Years Program
[UG Three Years Program (Multidisciplinary) + PG Two Year Program)

Name of the Program: Integrated B.Sc. (Life Sciences)-M.Sc. Botany/Zoology/Microbiology/Biotechnology/Chemistry
According to National Education Policy 2020

FIRST YEAR

SEMESTER-I

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0101T	Chemistry-I	3	3	20	50	70	2.5
	24CHE0101P	Chemistry-I Lab	1	2	10	20	30	3
	24BOT0101T	Plant Diversity	3	3	20	50	70	2.5
	24BOT0101P	Plant Diversity Lab	1	2	10	20	30	3
	24ZOO0101T	Animal Diversity-I	3	3	20	50	70	2.5
	24ZOO0101P	Animal Diversity-I Lab	1	2	10	20	30	3
Minor Course		To be opted by the student from the pool of MIC	2	2	15	35	50	2
Multidisciplinary Course		To be opted by the student from the pool of MDC	3	3	25	50	75	2.5
Ability Enhancement Course	24AEC0101T	English for effective communication-I	2	2	15	35	50	2
Skill Enhancement Course		To be opted by the student from the pool of SEC	2	2	15	35	50	2
			1	2	10	15	25	3
Value Added Course		Environmental Studies-I	2	2	15	35	50	2
			24	**28**	**185**	**415**	**600**	

SEMESTER-II

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0201T	Chemistry-II	3	3	20	50	70	2.5
	24CHE0201P	Chemistry-II Lab	1	2	10	20	30	3
	24BOT0201T	Plant Anatomy and Physiology	3	3	20	50	70	2.5
	24BOT0201P	Plant Anatomy and Physiology Lab	1	2	10	20	30	3
	24ZOO0201T	Animal Diversity-II	3	3	20	50	70	2.5
	24ZOO0201P	Animal Diversity-II Lab	1	2	10	20	30	3
Minor Course		To be opted by the student from the pool of MIC	2	2	15	35	50	2
Multidisciplinary Course		To be opted by the student from the pool of MDC	3	3	25	50	75	2.5
Ability Enhancement Course	24AEC0102T	हिंदी भाषा का व्याकरणिक ज्ञान	2	2	15	35	50	2
Skill Enhancement Course		To be opted by the student from the pool of SEC	2	2	15	35	50	2
			1	2	10	15	25	3
Value Added Course		To be opted by the student from the pool of VAC	2	2	15	35	50	2
			24	**28**	**185**	**415**	**600**	

Note: The student opting for exit after the first year must complete an internship of 4 credits (120 Hrs) to get a UG Certificate.

SECOND YEAR

SEMESTER -III

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0301T	Chemistry-III	3	3	20	50	70	2.5
	24CHE0301P	Chemistry-III Lab	1	2	10	20	30	3
	24BOT0301T	Cell Biology	3	3	20	50	70	2.5
	24BOT0301P	Cell Biology Lab	1	2	10	20	30	3
	24ZOO0301T	Human Physiology	3	3	20	50	70	2.5
	24ZOO0301P	Human Physiology Lab	1	2	10	20	30	3
Minor Course		To be opted by the student from the pool of MIC	4	4	30	70	100	3
Multidisciplinary Course		To be opted by the student from the pool of MDC	3	3	25	50	75	2.5
Ability Enhancement Course	24AEC0301T	English for effective communication-II	2	2	15	35	50	2
Skill Enhancement Course		To be opted by the student from the pool of SEC	2	2	15	35	50	2
			1	2	10	15	25	3
			24	**28**	**185**	**415**	**600**	

SEMESTER -IV

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0401T	Chemistry-IV	3	3	20	50	70	2.5
	24CHE0401P	Chemistry-IV Lab	1	2	10	20	30	3
	24BOT0401T	Genetics	3	3	20	50	70	2.5
	24BOT0401P	Genetics Lab	1	2	10	20	30	3
	24ZOO0401T	Basics of Biochemistry	3	3	20	50	70	2.5
	24ZOO0401P	Basics of Biochemistry Lab	1	2	10	20	30	3

Vocational Course		To be opted by the student from the pool of Vocational course	2	2	15	35	50	2
			2	4	15	35	50	3
Ability Enhancement Course	24AEC0302T	संचार कौशल	2	2	15	35	50	2
Value Added Course		To be opted by the student from the pool of VAC	2	2	15	35	50	2
			20	**25**	**150**	**350**	**500**	

Note: The student opting for exit after second year must complete internship of 4 credits (120 Hrs) to get UG Diploma.

THIRD YEAR

SEMESTER – V

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0501T	Chemistry-V	3	3	20	50	70	2.5
	24CHE0501P	Chemistry-V Lab	1	2	10	20	30	3
	24BOT0501T	Plant Taxonomy and Embryology	3	3	20	50	70	2.5
	24BOT0501P	Plant Taxonomy and Embryology Lab	1	2	10	20	30	3
	24ZOO0501T	Developmental Biology	3	3	20	50	70	2.5
	24ZOO0501P	Developmental Biology Lab	1	2	10	20	30	3
Vocational Course		To be opted by the student from the pool of Vocational course	2	2	15	35	50	2
			2	4	15	35	50	3
Internship	24BLS0501I	**Internship (4 weeks)**	4	4	100	0	100	0
			20	**25**	**220**	**280**	**500**	

SEMESTER -VI

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)
Discipline Specific Course	24CHE0601T	Chemistry-VI	3	3	20	50	70	2.5
	24CHE0601P	Chemistry-VI Lab	1	2	10	20	30	3
	24BOT0601T	Plant Pathology	3	3	20	50	70	2.5
	24BOT0601P	Plant Pathology Lab	1	2	10	20	30	3
	24ZOO0601T	Molecular Biology	3	3	20	50	70	2.5
	24ZOO0601P	Molecular Biology Lab	1	2	10	20	30	3
Minor Course		To be opted by the student from the pool of MIC	4	4	30	70	100	3
Vocational Course		To be opted by the student from the pool of Vocational courses	2	2	15	35	50	2
			2	2	15	35	50	2
			20	**25**	**150**	**350**	**500**	

List of Value-Added Courses (VAC)

Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
1.	24VAC0113T	Biofertilizers	2	2	15	35	50	2	I & II
2.	24VAC0313T	Vermiculture and Vermicomposting	2	2	15	35	50	2	III
3.	24VAC0413T	Medical Diagnostics	2	2	15	35	50	2	IV

List of Skill Enhancement Courses (SEC)

Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
1.	24SEC0104T	Lifestyle Disorders	2	2	15	35	50	2	I
2.	24SEC0104P	Lifestyle Disorders Lab	1	2	10	15	25	3	I
3.	24SEC0204T	Mushroom Technology	2	2	15	35	50	2	II
4.	24SEC0204P	Mushroom Technology Lab	1	2	10	15	25	3	II
5.	24SEC0304T	Herbal Technology	2	2	15	35	50	2	III
6.	24SEC0304P	Herbal Technology Lab	1	2	10	15	25	3	III

List of courses to be offered as Minor Courses (MIC)

Course Title	Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
For Biotechnology	1	24MIC0118T	Landmark Discoveries in Biotechnology	2	2	15	35	50	2	I
	2	24MIC0218T	Introductory Biotechnology	2	2	15	35	50	2	II
	3	24MIC0318T	Bioanalytical Tools	4	4	30	70	100	3	III
	4	24MIC0618T	Recombinant DNA Technology	4	4	30	70	100	3	VI
For Microbiology	1	24MIC0127T	Landmark Discoveries in Microbiology	2	2	15	35	50	2	I
	2	24MIC0227T	Introductory Microbiology	2	2	15	35	50	2	II
	3	24MIC0327T	Techniques in Microbiology	4	4	30	70	100	3	III
	4	24MIC0627T	Food Microbiology	4	4	30	70	100	3	VI

List of courses to be offered as Vocational Courses (VOC)

Course Title	Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
For Biotechnology	1	24VOC0418T	Basic Concepts of Immunology	2	2	15	35	50	2	IV
	2	24VOC0418P	Basic Concepts of Immunology Lab	2	4	15	35	50	3	IV
	3	24VOC0518T	Fundamentals of Bioinformatics	2	2	15	35	50	2	V
	4	24VOC0518P	Fundamentals of Bioinformatics Lab	2	4	15	35	50	3	V
	5	24VOC0618T	Industrial Biotechnology	2	2	15	35	50	2	VI
	6	24VOC0618P	Industrial Biotechnology Lab	2	4	15	35	50	3	VI
For Microbiology	1	24VOC0427T	Fundamentals of Immunology	2	2	15	35	50	2	IV
	2	24VOC0427P	Fundamentals of Immunology Lab	2	4	15	35	50	3	IV
	3	24VOC0527T	Basic Concepts of Bioinformatics	2	2	15	35	50	2	V
	4	24VOC0527P	Basic Concepts of Bioinformatics Lab	2	4	15	35	50	3	V
	5	24VOC0627T	Industrial Microbiology	2	2	15	35	50	2	VI
	6	24VOC0627P	Industrial Microbiology Lab	2	4	15	35	50	3	VI

List of Multi-Disciplinary Courses (MDC)

Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
1	24MDC0104T	Fundamentals of Biology	3	3	25	50	75	2.5	I
2	24MDC0204T	Cytology	3	3	25	50	75	2.5	II
3	24MDC0304T	Introduction to Biotechnology	3	3	25	50	75	2.5	III
4		MOOC through SWAYAM							
5		Online courses offered by GJUST							

Minor Courses (MIN) for Scheme C (UTD)

Sr. No.	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hr)	To be offered in
1.	24MIN0127T	Landmark Discoveries in Microbiology	4	4	30	70	100	3	I
2.	24MIN0227T	Introductory Microbiology	4	4	30	70	100	3	II

SEMESTER I

Discipline Specific Course	
24CHE0101T: CHEMISTRY-I	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
This paper deals with the concepts of chemical bonding and molecular structure, basics of organic reactions, spatial arrangement of molecules and chemical thermodynamics	***After successful completion of this course, students should be able to: -*** • ***At the end of the course, the students would be able to:*** • ***Understand the atomic structure and bonding concepts.*** • ***Acquaint with the mechanistic approach for chemical reactions.*** • ***Understand the spatial arrangement and orientation of atoms in the molecules.*** • ***Get the knowledge of Kinetic theory of gases (Real & Ideal) and Maxwell distribution law***

UNIT-I **[15 Lectures]**

Chemical Bonding and Molecular Structure

Introduction to 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-Lande equation for calculation of lattice energy, polarizing power and polarizability

Introduction to Covalent bonding: 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.

Ionic Solids: Factors affecting the formation of ionic solids, concept of close packing, radius ratio rule and coordination number. Calculation of limiting radius ratio for tetrahedral and octahedral sites. Structures of some common ionic solids NaCl, ZnS (zinc blende and wurtzite).

UNIT-II **[15 Lectures]**

Basics of Organic Chemistry-I

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.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Stereochemistry: Conformations of cyclohexane. Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds.

UNIT-III **[15 Lectures]**

Chemical Thermodynamics

Introduction, Objectives and limitations of Chemical Thermodynamics, state functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy. First Law of Thermodynamics: First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas. Irreversible isothermal and adiabatic expansion. Enthalpy change and its measurement, standard heats of formation and absolute enthalpies.

Second and Third Law of thermodynamics.

Entropy changes with change in P, V, and T for an ideal gas. Free energy and work functions. Gibbs-Helmholtz Equation, Criteria of spontaneity in terms of changes in free energy. Introduction to Third law of thermodynamics.

Recommended Textbooks and References:

1. *Cotton F.A. and Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, 6th Ed., John Wiley & Sons. Inc., 1999.*
2. *Lee J.D., Concise Inorganic Chemistry, 4th Ed., ELBS, 1991.*
3. *Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; 4th Edition, Pubs: Harper Collins, 1993.*
4. *Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.*
5. *Finar, I. L., Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.*
6. *Finar, I. L., Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 5th Ed., 2002.*
7. *Kalsi, P. S., Stereochemistry Conformation and Mechanism, New Age International, 11th Ed., 2022.*
8. *Eliel, E. L. &Wilen, S. H., Stereochemistry of Organic Compounds, Wiley: London, 1994.*
9. *Puri B.R., Sharma L. R. and Pathania M. S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.*
10. *Atkins, P.W. & Paula J., Physical Chemistry, 10th Ed., Oxford University Press, 2014.*
11. *Castellan, G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.*
12. *Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed. 2020*
13. *Vogel, A.I., Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Longman Scientific & Technical, 1989.*
14. *Vogel, A.I., Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Longman Scientific & Technical, 1989*
15. *Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Thomson Books/Cole,2005.*
16. *Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 2016.*

Discipline Specific Course	
24CHE0101P: CHEMISTRY-I Lab	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
The objectives of this course are: - ***Hands on practice on preparation of solutions, titration experiments, determination of melting and boiling points, viscosity determination, preparation of organic and inorganic compounds***	***After successful completion of this course, students should be able to understand the: -*** • ***At the end of the course, the students would be able to:*** • ***Understand the atomic structure and bonding concepts.*** • ***Acquaint with the mechanistic approach for chemical reactions.*** • ***Understand the spatial arrangement and orientation of atoms in the molecules.*** • ***Get the knowledge of Kinetic theory of gases (Real & Ideal) and Maxwell distribution law***

List of Experiments:

1. Preparation of standard solutions.
2. Acid/Base titration: Determination of strength of acid/base.
3. Determination of melting point organic solids and boiling point of organic solvents.
4. Determination of the viscosity of at least two liquids using Ostwald's viscometer (excluding organic solvents)
5. Preparation (One step)
   (i) Preparation of *m*-Dinitrobenzene from Nitrobenzene.
   (ii) Preparation of Prussian blue.

Recommended Textbooks and References:

1. *Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Thomson Books/Cole,2005.*
2. *Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 2016.*

Discipline Specific Course

24BOT0101T: PLANT DIVERSITY	Credits: 3+0

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - ***To make students aware about the diversity of plants and microbes present on the planet and how are they possibly related to each other in light of evolution***	***After successful completion of this course, students should be able to understand the: -*** • ***The diversity of plants and microbes*** • ***Their general characteristics*** • ***Various groups of plants and their evolutionary relationships***

UNIT-I **[18 Lectures]**

Origin of life- Bacteria, Viruses and Fungi

Principles and concepts of evolution, Tree of Life, and classification (up to six kingdoms) Bacteria- General characteristic features, cell structure, asexual reproduction and modes of gene transfer (conjugation, transformation and transduction), brief introduction to Archaebacteria.

Viruses- General characteristic features, replication, RNA virus (structure of TMV), DNA virus (structure of T-phage), Lytic and Lysogenic life cycle (Lambda phage).

Fungi- General characteristic features, reproduction and broad classification. Myxomycetes and their similarities with fungi, plants and animals, Brief account of Rhizopus, Agaricus. Introduction to lichens.

UNIT - II **[12 Lectures]**

Algae, Bryophytes & Pteridophytes

Algae-General characteristic features, cell structure, range of thallus, methods of reproduction and evolutionary classification (only up to groups). Brief account of Spirogyra, Sargassum.

Bryophytes-General characteristic features and reproduction, adaptation to land habit, broad classification, evolutionary trends in Bryophytes. Brief account of Marchantia, Funaria.

Pteridophytes- General characteristic features and reproduction, broad classification, evolutionary trends in Pteridophytes, affinities with Bryophytes. Brief account of Adiantum, Selaginella

UNIT -III **[15 Lectures]**

Gymnosperms & Angiosperms

Gymnosperms- General characteristic features and reproduction, broad classification, evolutionary trends in gymnosperms, affinities with Pteridophytes. Brief account of Gnetum, Ephedra.

Angiosperms- General characteristic features and reproduction, Concept of natural, artificial and phylogenetic system of classification. Affinities with Gymnosperms.

Recommended Textbooks and References:

1. *Campbell, N.A., Reece, J.B.(2008.)Biology,8th edition, Pearson Benjamin Cummings, San Francisco.*
2. *Evert, R F., Eichhorn, S.E.(2012).Raven Biology of Plants,8th edition, New York, NY:W.H. Freeman and Company.*
3. *Bhatnagar, S. P., Moitra, A. (1996). Gymnosperms. New Delhi, Delhi: New Age International(P). Ltd. Publishers.*
4. *Kumar, H.D. (1999). Introductory Phycology,2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.*
5. *Pelczar, M.J. (2001). Microbiology,5th edition. NewDelhi, Delhi: Tata McGraw-HillCo.*
6. *Puri, P. (1985). Bryophytes. New Delhi, Delhi, Atma Ram and Sons.*

7. *Sethi, I.K and Walia, S.K.(2018).Textbook of Fungi and their Allies.(2nd Edition), Med tech Publishers, Delhi.*
8. *Tortora, G.J., Funke, B. R., Case. C.L. (2007) Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.*
9. *Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. New Delhi, Delhi: S.Chand & Co Ltd*

Discipline Specific Course	
24BOT0101P: PLANT DIVERSITY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - ***To make students aware about the diversity of plants.***	***After successful completion of this course, students should be able to understand the: -*** • ***The diversity of plants.*** • ***Their general characteristics***

List of Experiments:

1. Morphological study of representative member of Algae
2. Morphological study of representative member of fungi
3. Identification of fungal cultures: Rhizopus, Mucor, Aspergillus, Penicillium etc.
4. Study of morphological and internal structures of representative genera of fruticose, foliose, and crustose lichen.
5. Morphological study of representative member of Bryophytes and Pteridophytes.
6. Study of the living gymnosperms in the botanical garden of the university.
7. Study of important fossil gymnosperms from prepared slides and specimens.
8. Monographic study of the living Gymnosperms.
9. Description of a specimen from representative, locally available families.
10. Micro preparations of plant materials

Recommended Textbooks and References:

1. *Campbell, N.A., Reece, J. B. (2008.) Biology,8th edition, Pearson Benjamin Cummings, San Francisco.*
2. *Kumar, H. D. (1999). Introductory Phycology,2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.*
3. *Carlile MJ & Watkinson SC 2000, The Fungi, Academic Press, London.*
4. *Alexopoulos C.J., Mims, C.W. and Blakwell, M. 1996. Introducting Mycology 4th ed. John Wiley, N.Y*

Discipline Specific Course	
24ZOO0101T: ANIMAL DIVERSITY-I	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***The course would provide an insight to the learner about the existence of different life forms on the earth*** • ***To understand the features of non-chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.*** • ***The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals***	***After successful completion of this course, students should be able to: -*** • ***Learn about the importance of systematics, taxonomy, and structural organization of non-chordates.*** • ***Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.*** • ***Recognize the life functions and the ecological roles of the animals belonging to different phyla.***

UNIT-I [18 Lectures]

Principles of taxonomy and relationship with systematic. General characters and criteria for classification of invertebrates. An outline classification of non-chordates. Classification of Protozoans. Type study of *Paramecium caudatum* and Plasmodium vivax. Locomotion and reproduction in Protozoa. Organization of metazoan including symmetry, metamerism and body cavity or coelom. Theories of origin of metazoan. General characters and classification of phylum Porifera. Canal system and skeleton in Sponges.

UNIT - II [12 Lectures]

General characters and classification of Coelenterates. Type study of Aurelia. Polymorphism, corals and coral reefs. General characters and classification of phylum Platyhelminthes. General characters and classification of nematodes. Type study of Ascaris lumbricoides. Nematodes and human diseases. *Caenorhabditis elegans* and its application in research. Phylum – Annelida: General characters and classification up to class level, Type study of Earthworm (*Pheretima posthuma*).

UNIT -III [15 Lectures]

General characteristics and classification of Arthropods. Mouth parts of insects. Vision in arthropods. Metamorphosis in insects. Larval forms of Crustaceans. Social insects and their life cycle. Economic importance of insects. Lac culture, Sericulture, Apiculture and Prawn culture. General characters and classification of phylum Mollusca. Type study of Pila globosa. Torsion and detorsion in gastropods. General characters and classification of phylum Echinodermata. Water vascular system in star fish, Larval form in Echinoderm, Structure and affinities of Balanoglossus.

Recommended Textbooks and References:

1. *Ruppert, E. E. and Barnes, R. D., Invertebrate Zoology, Saunders College Publishing.*
2. *Parker, T. J. and Haswell, W. A., Textbook of Zoology, Vol. 1 (Invertebrates), Low Price Publications.*
3. *Kotpal, R. L., Modern Textbook of Zoology: Invertebrates, Rastogi Publications.*
4. *Jordan, E. L. and Verma, P. S., Invertebrate Zoology, S. Chand & Co.*
5. *Anderson, D. T., Invertebrate Zoology, Oxford University Press, India*

Discipline Specific Course	
24ZOO0101P: ANIMAL DIVERSITY-I LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course is: - ***To make students aware about the economic importance of important species of various orders of non-chordates***	***After successful completion of this course, students should be able to understand the: -*** ***Important ecological characteristics, morphological characteristics of various non-chordates***

List of Experiments:

Classification up to orders with ecological note and economic importance of the following animals:

1. Protozoa: Lamination of cultures of Amoeba, Euglena and Paramecium; permanent prepared slides: Amoeba, Euglena, Trypanosoma, Noctiluca, Paramecium (binary fission and conjugation), Opalina, Vorticella, Balantidium.
2. Parazoa (Porifera): Sycon, Grantia, Euplectella, Hyalonema, Spongilla, Euspongia
3. Coelenterata: Porpita, Valella, Physalia, Aurelia, Rhizostoma, Metridium, Millipora, Alcyonium, Tubipora, Madrepora, Favia, Fungia, and Astrea. Permanent prepared slides: Hydra (W.M.), Hydra with buds, Obelia (colony and medusa), Sertularia, Plumularia, Tubularia, Bougainvillea, Aurelia.
4. Playhelminthes: Dugesia, Fasciola, Taenia, Echinocoecus. Permanent prepared slides: Miracidium, Sporocyst, Redia, Cercaria, Scolex and Proglotttids of Taenia (mature and gravid).
5. Aschelminthes: Ascaris (male and female), Trichinella, Ancylostoma, Meloidogyne
6. Annelida: Pheretima, Polynoe, Aphrodite, Chaetopterus, Tubifex.
7. Arthropoda: Peripatus, Palaemon (Prawn), Lobster, Cancer (crab), Lepas, ,Cyclops, Lepisma, Periplaneta (cockroach), Poecilocerus (ak hopper), Gryllus (cricket), Mantis (praying mantis), Forticula (earwig), Dragon fly, termite queen, bug, moth, beetle, Polistes (wasp), Apis (honey bee), Bombyx (silk moth), Cimex (beg bug), Pediculus (body louse), Millipede, Scolopendra (centipede), Palamnaeus (scorpion), Aranea (spider), Limulus (king crab)
8. Mollusca: Mytilus, Ostrea, Pholas, Solen (razor/Fish), Pecten, Patella, Aplysia, Doris, Limax, Loligo, Sepia, Octopus.
9. Echinodermata: Asterias, Echinus, Cucumaia, Ophiothrix, Antedon and Asterophyton
10. Study of slides of non-chordates phyla; Staining of Obelia and Sertularia

Recommended Textbooks and References:

1. *Ayyar, E.K and T. Ananthakrishnan. 1992. Manual of Zoology Vol.1 Invertebrates Part I and II, S.Viswanathan Printers and Publishers Pvt. Ltd. Madras.*
2. *Lal S.S. (2019) Practical Zoology Invertebrates. Rastogi Publications, Meerut*

SEMESTER II

Discipline Specific Course	
24CHE0201T: CHEMISTRY-II	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - ***This paper deals with the concepts of coordination chemistry, nomenclature and spatial arrangement of coordination compounds, basics of organic chemistry, aromatic hydrocarbons and electrochemistry.***	• ***Understand the chemistry of coordination compounds including various theories and their stereochemistry.*** • ***Acquainted with the basics of organic chemistry, aromaticity and reactions of aromatic hydrocarbons.*** • ***Understand the basics and applications of electrochemistry.*** • ***Get practical knowledge of water analysis.*** • ***Perform experiments of surface chemistry.*** • ***Get practical knowledge of purification techniques like distillation and recrystallization.*** • ***Apply the concepts of Chemistry in the preparation of inorganic and organic compounds.*** • ***Perform experiments, evaluate the results and defend viva-voce.***

UNIT-I [15 Lectures]

Coordination Chemistry

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes- Thermodynamic & Kinetic stability.

UNIT - II [15 Lectures]

Basics of Organic Chemistry-II and **Aromatic Hydrocarbons**

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties of Organic Compounds.

Dipole moment; Organic acids and bases; their relative strength, Nucleophilicity and basicity.

Aromatic Hydrocarbons:

Aromatic, Anti-aromatic and non-aromatic compounds, *Huckel's* rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic

substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

UNIT -III [15 Lectures]

Electrochemistry

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities. Applications of conductance to measure degree of dissociation of weak electrolytes.

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. Nernst equation. Standard electrode (reduction) potential.

Recommended Textbooks and References:

1. Cotton F.A. and Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, 6th Ed., John Wiley & Sons. Inc., 1999.

2. Lee J.D., Concise Inorganic Chemistry, 4th Ed., ELBS, 1991.

3. Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; 4th Edition, Pubs: Harper Collins, 1993.

4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.

5. Finar, I. L., Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.

6. Finar, I. L., Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 5th Ed., 2002.

7. Samuel Glasstone, An Introduction to Electrochemistry, East West Press Pvt. Ltd. 2006.

8. Puri B.R., Sharma L. R. and Pathania M. S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.

9. Atkins, P.W. & Paula, J., Physical Chemistry, 10th Ed., Oxford University Press, 2014.

10. Castellan, G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.

11. Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed. 2020

Discipline Specific Course	
24CHE0201P: CHEMISTRY-II LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Hands on practice on hardness and softness of water, determination of surface tension, purification techniques, preparation of organic and inorganic compounds.***	***After successful completion of this course, students should be able to: -*** • ***Understand the chemistry of coordination compounds including various theories and their stereochemistry.*** • ***Acquainted with the basics of organic chemistry, aromaticity and reactions of aromatic hydrocarbons.*** • ***Understand the basics and applications of electrochemistry.*** • ***Get practical knowledge of water analysis.*** • ***Perform experiments of surface chemistry.*** • ***Get practical knowledge of purification techniques like distillation and recrystallization.*** • ***Apply the concepts of Chemistry in the preparation of inorganic and organic compounds.*** • ***Perform experiments, evaluate the results and defend viva-voce.***

List of Experiments:

1. Determination of hardness of water samples.
2. To determine the surface tension of at least two liquids using stalagmometer by drop no. and drop weight methods (Excluding organic solvents).
3. Purification techniques
   (i) Distillation (Simple and fractional distillation).
   (ii) Crystallization
4. Preparations:
   (i) Preparation of tetraamine copper (II) sulphate monohydrate.
   (ii) Preparation of dibenzalacetone.

Recommended Textbooks and References:

1. *Vogel, A.I., Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Longman Scientific & Technical, 1989.*
2. *Vogel, A.I., Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Longman Scientific & Technical, 1989*
3. *Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Thomson Books/Cole, 2005.*
4. *Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 2016.*

Discipline Specific Course	
24BOT0201T: PLANT ANATOMY AND PHYSIOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***The objective of this course is to familiarize the students with the fundamental concepts of plant anatomy.*** • ***This course will also give an insight into basic physiology and metabolism of plants.***	***After successful completion of this course, students should be able to: -*** • ***Understand Structural organization of plant tissues.*** • ***Understand the anatomical features of leaves, stems, and roots as well as flowers and fruits.*** • ***Understand the role of growth hormones and water relation of plants with respect to various physiological processes.*** • ***Learn the significance of carbon and nitrogen metabolism***

UNIT-I **[15 Lectures]**

Anatomy: The shoot and root apical meristem and its histological organization, Simple and complex permanent tissues, Primary structure of shoot and root, Secondary growth, Growth rings, Leaf anatomy (dorsi-ventral and isobilateral leaf).

Plant Water Relations: Importance of water to plant life, Diffusion, Osmosis, Plasmolysis, Imbibition, Guttation, Transpiration, Stomata and their mechanism of opening and closing.

UNIT - II **[15 Lectures]**

Carbon Metabolism: Photosynthesis- Photosynthesis pigments, Concept of two photosystems, photophosphorylation, Calvin cycle, CAM plants, Photorespiration, Compensation point. Nitrogen metabolism: Nitrogen fixation, Inorganic and molecular nitrogen fixation, Nitrate reduction and ammonium assimilation in plants

UNIT -III **[15 Lectures]**

Growth and Development: Definitions, Phases of growth, Growth curve, Growth hormones (auxins, gibberellins, cytokines, abscisic acid, ethylene) Physiological role and mode of action, Seed dormancy and seed germination, Concept of photoperiodic and vernalization.

Recommended Textbooks and References:

1. *Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.*
2. *Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.*
3. *Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.*
4. *Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.*
5. *Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.*
6. *Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4thedition, W.H. Freeman and Company, New York, USA.*
7. *Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.*
8. *Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MAss*

Discipline Specific Course

24BOT0201P: PLANT ANATOMY AND PHYSIOLOGY LAB	Credits: 0+1

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To learn the concept of how to conduct experiments in plant physiology for studying membrane permeability, ascent of sap*** • ***To learn the concept of seed germination, transpiration, photosynthesis etc.***	***After successful completion of this course, students should be able to: -*** • ***Understand Structural organization of plant tissues.*** • ***Understand the anatomical features of leaves, stems, and roots as well as flowers and fruits.*** • ***Understand the effect of various growth hormones on plant growth and metabolism.*** • ***Understand the water relation of plants with respect to various physiological processes***

List of Experiments:

1. To study the permeability of plasma membrane using different concentrations of organic solvents.
2. To study the effect of temperature on permeability of plasma membrane.
3. Determining the water potential of any tuber (Potato tuber).
4. To demonstrate the ascent of sap using a dye.
5. Comparison of loss of water from two surfaces of leaf by CoCl2 method/ four leaf method.
6. Determination of rate of respiration in germinating seeds under aerobic and anaerobic conditions.
7. Effect of phytohormones on plant growth
8. Separation of chloroplast pigments by chromatography
9. To demonstrate the process of ‘anaerobic’ respiration.
10. To demonstrate the process of phototropism.

Recommended Textbooks and References:

1. *General and Comparative physiology - Hoar, W.S. Prentice Hall of India, New Delhi. 1975*
2. *Practical in Plant Physiology and Biochemistry – Manju Bala, Sunita Gupta, N K Gupta.2012*
3. *Practical text book of Plant Physiology- Daniel Trembly Macdouga.2018*
4. *Akhtar Inam. A Laboratory Manual of Plant, Physiology, Biochemistry and Ecology. Agriobios. Publication. 2012*
5. *Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.2006*
6. *Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition. John Wiley sons, Inc.2006.*

Discipline Specific Course	
24ZOO0201T: ANIMAL DIVERSITY-II	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - ***To make students aware about the diversity of animal and microbes present on the planet and how are they possibly related to each other in light of evolution etc.***	***After successful completion of this course, students should be able to understand the: -*** • ***The diversity of animal and microbes*** • ***Their general characteristics*** • ***Various groups of animals and their evolutionary relationship Basic principles and concepts of evolution that contribute to animal diversity***

UNIT-I [18 Lectures]

Chordates & Superclass Pisces

General Characters, origin and ancestry of Chordates. A brief classification of phylum Chordata. Diversity of chordates and comparison with non-chordates. General characters and classification of subphylum Urochordata. Characteristics and affinities of Herdmania. General characters and classification of subphylum Cephalochordate. Characters and structure of Branchiostoma.
Superclass Pisces -General characters and classification of superclass Pisces. Type study of Class Cyclostomata: Petromyzon. Scales of fishes. Air or swim bladder and accessory respiratory organs. Migration and parental care in fishes. Pisciculture. Dipnoi, Freshwater and Brackish water fisheries in India.

UNIT - II [12 Lectures]

Class Amphibia and Reptilia

General characters, origin and classification of Amphibians. Parental care in class Amphibia. Origin, general characters and classification of Reptiles. Identification of snakes. Poisonous and non-poisonous snakes biting mechanism in snakes. Venom and anti-venom. Extinct reptiles (Dinosaurs), Evolution and adaptive radiation of reptiles.

UNIT -III [15 Lectures]

Class Aves and Mammalia

General characteristics and classification of class Aves. Affinities, origin and ancestry of birds. Mechanism and modes of flight adaptations. Type of beaks in birds. Flight adaptation in birds. Migration in birds. Economic importance of birds. General characters and classification of class Mammalia. Origin and ancestry of mammals. Dentition in mammals, Prototheria and Metatheria.

Recommended Textbooks and References:

1. *Young J Z (2004) The life of vertebrates III edition, Oxford university press*
2. *Kent GC & Karr RK (2000) Comparative anatomy of Vertebrates, 9th Edition, The Mcgraw – hill companies*
3. *Kardong KV (2005) Vertebrates comparative anatomy, function and evolution 4th edition. The McGraw – hill higher Education*
4. *RL Kotpal (2016) Modern textbook of zoology-vertebrates*

Discipline Specific Course	
24ZOO0201P: ANIMAL DIVERSITY-II LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To make students aware about the economic importance of important species of various orders of chordates***	***After successful completion of this course, students should be able to understand the: -*** • ***Important ecological characteristics, morphological characteristics of various chordates***

List of Experiments:

1. Classification up to orders, habit, habitats, external characters and economic importance (if any): Protochordata: Pyrosoma, Doliolum, Olikopleura, and Amphioxus.
2. Cyclostomata: Myxine, Petromyzon and Ammocoetus larva.
3. Chondrichthyes: Zygaena, Pristis, Narcine (electric ray), Trygon, Rhinobatus, Raja and Chimaera.
4. Osteichthyes: Mystus, Catla, Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Ostracion, Tetradon, Echinus, Lophius, Solea and Polypterus.
5. Amphibia: Necturus, Proteus, Amphiuma, Salamandra, Ambystoma, Axolotl larva, Alytes, Bufo, Rana.
6. Reptilia: Hemidactylus, Calotes, Draco, Varanus, Chamaeleon, Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Viper, Crocodilus, Gavialis, Chelone (Turtle) and Testudo (Tortoise).
7. Aves: Casuarius, Arden, Anas, Milvus, Pavo, Eudynamis, Tyto, Alcedo, Halcyon
8. Mammalia: Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaque, Hystrix, Funambulus, Felix, Panthera, Canis, Herpestes, Capra, Pteropus.
9. Study of the skeleton of Scoliodon, Labeo, Rana (Frog), Varanus, Pigeon and rat.
10. Study of the following permanent slides: Tornaria larva. Oikopleura, Histology of rat (compound tissues), different types of scales.

Recommended Textbooks and References:

1. *R.L.Kotpal. Modern Textbook of Zoology*
2. *E.L. Jordan and Verma. Chordate Zoology.*
3. *Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinbourgh.*
4. *Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.*
5. *Kent, C.G. Comparative anatomy of vertebrates.*
6. *S.S. Lal. Practical Zoology Vertebrate*

SEMESTER III

Discipline Specific Course	
24CHE0301T: CHEMISTRY-III	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
This paper deals with the chemistry of s and p block elements, noble gases, chemistry of C-C π-bond containing compounds (alkenes and alkynes), and liquid and gaseous states of matter.	***At the end of the course, the students would be able to:*** • ***CO1. Understand the chemistry of s and p block elements.*** • ***CO2. Get familiar with the chemistry of noble gases.*** • ***CO3. Acquaint with the chemistry of Carbon-Carbon π-bond containing compounds viz. alkenes and alkynes and mechanistic approach for chemical reactions related them.*** • ***CO4. Be aquinted with liquid and gaseous states of matter including kinetic molecular model of a gas, Maxwell distribution, and real gases.*** • ***CO5. Apply the concepts of chemical analysis techniques for determination of acid and basic radicals in inorganicsalts.*** • ***CO6. Get practice in preparation of organic compounds by conventional method and using green approach.*** • ***CO7. Determine molecular weight of the volatile liquids, and viscosity and surface tension of liquids.*** • ***CO8. Perform experiments, evaluate the results and defend viva-voce.***

UNIT-I [15 Lectures]

Chemistry of *s* and *p* Block Elements

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Inert pair effect. Complex formation tendency of *s* and *p* block elements**.** Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, pseudohalogens and basic properties of halogens.

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

UNIT - II [15 Lectures]

Carbon-Carbon π-bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions and their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn/ and *anti*-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes, and Diels-Alder reaction; Allylic and benzylic bromination and mechanism *e.g.* propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT -III [15 Lectures]

Liquid state

Qualitative treatment of the structure of the liquid state, physical properties of liquids' vapour pressure, surface tension and coefficient of viscosity, and their determination. Factors effecting surface tension and viscosity.

Gaseous state

Kinetic molecular model of a gas: derivation of the kinetic gas equation; collision frequency and diameter; mean free path and viscosity of gases, temperature and pressure dependence, relation between mean free path and coefficient of viscosity.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, and its variation with pressure. Van der Waals equation of state and application in explaining real gas behaviour. Isotherms of real gases and their comparison with Van der Waals isotherms.

Recommended Textbooks and References:

1. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., *Advanced Inorg. Chemistry*, John Wiley & Sons. Inc., 6th Ed., 1999.
2. Lee J.D., *Concise Inorganic Chemistry*, ELBS, 4th Ed., 1991.
3. Huheey J.E., Keiter E.A., Keiter R.L., *Inorganic Chemistry: Principles of Structures and Reactivity*; Pubs: Harper Collins, 4th Ed., 1993.
4. Douglas B.E, Mc Daniel D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry*, John Wiley Sons, N.Y. 3rd Ed., 1994.
5. Greenwood N.N., Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
6. Rodger G.E., *Inorganic and Solid-State Chemistry*, Cengage Learning India, 1st Ed, 2008.
6. Miessler G.L., Donald A. Tarr., *Inorganic Chemistry*, Pearson, 4th Ed., 2010.
7. Shriver & Atkins' Inorganic Chemistry, Oxford University Press 5th Ed, 2010.
8. Morrison R.N., Boyd, R.N., *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.
9. Finar I.L., *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.
10. Finar I.L., *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),* Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 5th Ed., 2002.
11. Ball D.W., Physical Chemistry Thomson Press, India, 2nd Ed., 2017.
12. Castellan G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.
13. Mortimer R.G., Physical Chemistry, Elsevier: NOIDA, UP, 3rd Ed., 2009.
14. Engel T., Reid P., Physical Chemistry, Pearson, 3rd Ed., 2013.
15. Puri B.R., Sharma L.R., Pathania M.S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.
16. Atkins P.W., Paula J., *Physical Chemistry,* Oxford University Press, 10th Ed., 2014.

17.. Mendham J., A. I. Vogel’s Quantitative Chemical Analysis, Pearson, 6th Ed., 2009.
18.. Vogel’s Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 2000.
19. Marr G., Rockett B.W. , Practical Inorganic Chemistry, Van Nostrand Reinhold Company, 1st Ed., 1972.
20. Mann F.G., Saunders B.C., Practical Organic Chemistry, Pearson Education India, 4th Ed., 2009.
21. Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed., 2020.
22. Ahluwalia V.K., Aggarwal R., Ahluwalia V.K., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Sangam Books Ltd., 2001.
23. Ahluwalia V.K., Dhingra S., Comprehensive Practical Organic Chemistry: QualitativeAnalysis, University Press, 2000.
24. Vogel A.I., Vogel's Textbook of Practical Organic Chemistry, Longman Scientific & Technical, 5th Ed., 1989.
25. Vogel A.I., Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific & Technical, 6th Ed., 1989
26. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, Thomson Books/Cole, 3rd Edn., 2005.
27. Furniss B.S., Hannaford A.J., Smith P.W.G., Tatchell A.R., Practical OrganicChemistry, Pearson, 5th Ed., 2012.
28. Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 36th Ed., 2016.

Discipline Specific Course	
24CHE0301P: CHEMISTRY-III	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
Hands on practice on chemical analysis of inorganic substances, preparation of organic compounds by conventional method and using green approach, molecular weight of the volatile liquids, and determination of viscosity and surface tension of liquids.	***At the end of the course, the students would be able to:*** • ***CO1. Understand the chemistry of s and p block elements.*** • ***CO2. Get familiar with the chemistry of noble gases.*** • ***CO3. Acquaint with the chemistry of Carbon-Carbon π-bond containing compounds viz. alkenes and alkynes and mechanistic approach for chemical reactions related them.*** • ***CO4. Be acquainted with liquid and gaseous states of matter including kinetic molecular model of a gas, Maxwell distribution, and real gases.*** • ***CO5. Apply the concepts of chemical analysis techniques for determination of acid and basic radicals in inorganic salts.*** • ***CO6. Get practice in preparation of organic compounds by conventional method and using green approach.*** • ***CO7. Determine molecular weight of the volatile liquids, and viscosity and surface tension of liquids.*** • ***CO8. Perform experiments, evaluate the results and defend viva-voce.***

List of Experiments:

1. Analysis of mixtures containing one anion and one cation. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, PO_4^{3-}, NH_4^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}.
2. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) by any one method:

(a) Using conventional method.

(b). Using green approach

3. Determination of molecular weight of the volatile liquid (chloroform, acetone, methanol) by Victor Meyer's method.
4. Determination of viscosity and surface tension of liquid samples.

Note: **The examiner will allot one practical at the time of end term examination. Candidates are required to obtain minimum passing marks separately in practical component and theory as per the University rules.**

Recommended Textbooks and References:

1. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., *Advanced Inorg. Chemistry*, John Wiley & Sons. Inc., 6th Ed.,

1999.
2. Lee J.D., *Concise Inorganic Chemistry*, ELBS, 4th Ed., 1991.
3. Huheey J.E., Keiter E.A., Keiter R.L., *Inorganic Chemistry: Principles of Structures and Reactivity*; Pubs: Harper Collins, 4th Ed., 1993.
4. Douglas B.E, Mc Daniel D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry*, John Wiley Sons, N.Y. 3rd Ed., 1994.
5. Greenwood N.N., Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
6. Rodger G.E., *Inorganic and Solid-State Chemistry*, Cengage Learning India, 1st Ed, 2008.
6. Miessler G.L., Donald A. Tarr., *Inorganic Chemistry*, Pearson, 4th Ed., 2010.
7. Shriver & Atkins' Inorganic Chemistry, Oxford University Press 5th Ed, 2010.
8. Morrison R.N., Boyd, R.N., *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.
9. Finar I.L., *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.
10. Finar I.L., *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 5th Ed., 2002.
11. Ball D.W., *Physical Chemistry* Thomson Press, India, 2nd Ed., 2017.
12. Castellan G.W., *Physical Chemistry*, Narosa Publishers, 3rd Ed., 2004.
13. Mortimer R.G., *Physical Chemistry*, Elsevier: NOIDA, UP, 3rd Ed., 2009.
14. Engel T., Reid P., *Physical Chemistry*, Pearson, 3rd Ed., 2013.
15. Puri B.R., Sharma L.R., Pathania M.S., *Principles of Physical Chemistry*, Vishal Publishing Company, 49th Ed., 2020.
16. Atkins P.W., Paula J., *Physical Chemistry*, Oxford University Press, 10th Ed., 2014.
17.. Mendham J., A. I. Vogel's Quantitative Chemical Analysis, Pearson, 6th Ed., 2009.
18.. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 2000.
19. Marr G., Rockett B.W. , Practical Inorganic Chemistry, Van Nostrand Reinhold Company, 1st Ed., 1972.
20. Mann F.G., Saunders B.C., Practical Organic Chemistry, Pearson Education India, 4th Ed., 2009.
21. Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed., 2020.
22. Ahluwalia V.K., Aggarwal R., Ahluwalia V.K., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Sangam Books Ltd., 2001.
23. Ahluwalia V.K., Dhingra S., Comprehensive Practical Organic Chemistry: QualitativeAnalysis, University Press, 2000.
24. Vogel A.I., Vogel's Textbook of Practical Organic Chemistry, Longman Scientific & Technical, 5th Ed., 1989.
25. Vogel A.I., Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific & Technical, 6th Ed., 1989
26. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, Thomson Books/Cole, 3rd Edn., 2005.
27. Furniss B.S., Hannaford A.J., Smith P.W.G., Tatchell A.R., Practical OrganicChemistry, Pearson, 5th Ed., 2012.
28. Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 36th Ed., 2016.

Discipline Specific Course	
24BOT0301T: CELL BIOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Structure and function of various cellular compartment and organelles Fundamentals of transport of biomolecule inside the cell and its cytoskeleton.*** • ***Cell growth, cell-division and cell-cycle control mechanisms.*** • ***Cell to cell communication and participation of signal transduction pathways, in driving cell response mechanics.***	***After successful completion of this course, students should be able to: -*** • ***Understand cell evolution and the basic types of cells.*** • ***Explore cell membrane structure, models, and transport mechanisms.*** • ***Learn the structure, function, and protein sorting of cellular organelles.*** • ***Recognize cell communication, junctions, and their roles in connectivity.*** • ***Grasp cytoskeleton functions, cell shape maintenance, and signaling pathways.***

UNIT-I [15 Lectures]

Cell Organelle: Structure and functions of Endoplasmic reticulum, SRP based targeting of proteins to ER, folding and disulfide bond formation, mechanism of vesicle transport, Mitochondria (DNA & pathways), lysosomes and their role in degradation, Golgi apparatus (post translational modifications of proteins and lipid synthesis).

UNIT - II [15 Lectures]

Cytoskeleton, Nucleus organization and cell cycle: Structure and organization of actin, myosin, muscle contraction system and intermediate filaments, microtubules and their role. Cell Shape, Mitotic Spindle, 9+2 Array, Filipodia Structure.

Structure and Function of Nucleus. Nuclear Membrane and Transport, Nuclear Pore complex, chromosomal structure and positioning. Potentiated genes, Cell cycle: controls and checkpoints.

UNIT -III [15 Lectures]

Membrane Transport and Cell signaling: Lipid bilayer and membrane proteins, Ionic channels, Ion pumps, membrane transport (Simple, Facilitated, Active and Voltage gated). Signaling molecules and their receptors (GPCR, Tyrosine, Kinase based) , Role of protein kinase , functions, intracellular signal transduction pathways (selected pathways), signaling networks and cross talk.

Recommended Textbooks and References:

1. *Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072*
2. *Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2016). 9th Edition. The world of the cell. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13:978-0321934925.*
3. *Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: WileyPublishers.ISBN-978—1-119-59816-9*

Discipline Specific Course	
24BOT0301P: CELL BIOLOGY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To develop an understanding about structural aspects of prokaryotic and eukaryotic cell and its inner components.*** • ***It will also insight into the anatomy of stem, leaf and root.***	***After successful completion of this course, students should be able to: -*** • ***Perform fixation, staining and visualize various stages of cell division*** • ***To analyze the anatomy of stem, root and leaf*** • ***To understand the structure of eukaryotic and prokaryotic cell***

List of Experiments:

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Measurement of cell size by cytometry
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides within cells/tissues from permanent slides.
7. To study of plasmolysis and de-plasmolysis of Rhoeo leaf.
8. To study prokaryotic cells, Bacteria/fungi and eukaryotic cells.
9. To prepare squash from root tip of Allium cepa and study various stages of mitosis.
10. To prepare the slide and study for various stages of meiosis.
11. To identify the blood cell types in human blood smear.
12. To prepare Buccal smear for Identification of Barr Body.
13. To prepare microscope slide for dicot leaf section.
14. To prepare permanent slide of plant stem/root/leaf.
15. Preparation of nuclear, mitochondrial & cytoplasmic fractions

Recommended Textbooks and References:

1. *Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072*
2. *Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2016). 9th Edition. The world of the cell. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13:978-0321934925.*
3. *Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: WileyPublishers.ISBN-978—1-119-59816-9*

Discipline Specific Course	
24ZOO0301T: HUMAN PHYSIOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To provide an insight into the physiology of different systems of the body.*** • ***To give an account of the mechanism of digestion, breathing blood circulation and nervous system***	***After successful completion of this course, students should be able to: -*** • ***Understand the physiology at cellular and system levels.*** • ***Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.*** • ***Understand the process of digestion and excretion.*** • ***Understand the organization of nervous system and process of nerve conduction.*** • ***Understand different physiological parameters as well as mechanism of action of different hormones, which will help in identifying outliers.***

UNIT-I [15 Lectures]

Digestion, Respiration and Excretion: Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT - II [15 Lectures]

Circulation and Muscle Physiology: Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.

Muscle Physiology : Structure of cardiac, smooth and skeletal muscle, threshold stimulus, All or None Rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical and electrical events of mechanism of muscle contraction.

UNIT -III [15 Lectures]

Nervous and Endocrine Coordination: Mechanism of generation and propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids) Different endocrine glands– hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo and hyper-secretions

Recommended Textbooks and References:

1. *Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.*

2. *Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons, Inc.*
3. *Marieb, E.N. & Hoehn, K.N. (2016). Human Anatomy and Physiology (10th Ed.) Pearson.*

Discipline Specific Course	
24ZOO0301P: HUMAN PHYSIOLOGY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To familiarize the students with an overview of prokaryotic and eukaryotic cell and its inner components.*** • ***To provide knowledge of processes of cell transport across membrane, protein synthesis, processing, trafficking and cell signaling***	***After successful completion of this course, students should be able to: -*** • ***Think critically to understand common research techniques used in animal physiology.*** • ***Design and execute an experiment of animal physiology***

List of Experiments:

1. Collection of blood sample, isolation of serum and plasma
2. Estimation of Differential Leucocyte Count (DLC).
3. Estimation of haemoglobin in the given blood sample.
4. Determination of ABO types.
5. Qualitative estimation of proteins in the given sample.
6. Qualitative estimation of carbohydrates in the samples provided.
7. Qualitative estimation of nitrogenous wastes viz. Ammonia, Urea and Uric acid,
8. Quantitative estimation of ammonia and urea in the given sample.

Recommended Textbooks and References:

1. *Comparative animal physiology - Professor C.L. and Brown, F.A W.B. Sounders, Philadelphia.*
2. *Animal physiology Cambridge university press. Cambridge - Schmidt – Nielsen K.*
3. *A handbook of Animal physiology - Pantelouris. EMA; W.B. Sounders Co. Philadelphia.*
4. *An Introduction to general and comparative animal physiology - Floray, E. W.B. Sounders Co., Philadelphia*

SEMESTER IV

Discipline Specific Course	
24CHE0401T: Chemistry-IV	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to this, six more questions (each question may be of 2-3 parts) will be set consisting of two questions from each unit. The student/candidate is required to attempt four questions in all, selecting one from each unit and the compulsory Question No.1. All questions carry equal marks

Course Objectives	Learning Outcomes
The objectives of this course are: - ***This paper deals with the transition elements, chemistry of organic compounds containg alhohols, phenols, ethers, epoxides and carboxylic acids, and solid-state chemistry and chemical kinetics.***	***At the end of the course, the students would be able to:*** ***CO1. Understand the chemistry of transition elements, lanthanides and actinides.*** ***CO2. Get the knowledge of organic compounds viz. alcohols, phenols, ethers and epoxides nd their chemical properties.*** ***CO3. Get acquainted with solid state chemistry.*** ***CO4. Familiar with chemical kinetics of reactions.*** ***CO5. Practical knowledge of strategies of inorganic preparations and gravimetric estimations of metal ions.*** ***CO6. Analyze unknown organic compounds Qualitatively alongwith preparation of their derivatives.*** ***CO7. Get practical knowledge of chemical kinetics of reactions.*** ***CO8. Develop the skill of performing experiments, compilation of experimental information, evaluation of results presentation of the findings in the form of lab record and defend viva-voce.***

UNIT-I [15 Lectures]

Chemistry of Transition Elements

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states, Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanides and Actinides

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide and actinide contraction, separation of lanthanides (ion-exchange method only).

UNIT - II [15 Lectures]

Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation and properties; Acidity and factors effecting, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Carboxylic Acid Derivatives

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group- Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

UNIT -III [15 Lectures]

Solid state

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics

Rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Recommended Textbooks and References:

1. *Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, John Wiley & Sons. Inc., 6th Ed., 1999.*
2. *Lee J.D., Concise Inorganic Chemistry, ELBS, 4th Ed., 1991.*
3. *Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; Pubs: Harper Collins, 4th Ed., 1993.*
4. *Douglas B.E, Mc Daniel D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry, John Wiley Sons, N.Y. 3rd Ed., 1994.*
5. *Greenwood N.N., Earnshaw, Chemistry of the Elements, Butterworth-Heinemann, Butterworth-Heinemann Oxford, 2nd Edition, 1997.*
6. *Rodger G.E., Inorganic and Solid-State Chemistry, Cengage Learning India, 1st Ed, 2008.*
6. *Miessler G.L., Donald A. Tarr., Inorganic Chemistry, Pearson, 4th Ed., 2010.*
7. *Shriver & Atkins' Inorganic Chemistry, Oxford University Press 5th Ed, 2010.*
8. *Morrison R.N., Boyd, R.N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.*
9. *Finar I.L., Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.*
10. *Finar I.L., Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 5th Ed., 2002.*
11. *Ball D.W., Physical Chemistry Thomson Press, India,* 2nd Ed., *2017.*
12. *Castellan G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.*
13. *Mortimer R.G., Physical Chemistry, Elsevier: Noida, UP, 3rd Ed., 2009.*
14. *Engel T., Reid P., Physical Chemistry, Pearson, 3rd Ed., 2013.*
15. *Puri B.R., Sharma L.R., Pathania M.S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.*
16. Atkins P.W., Paula J., Physical Chemistry, Oxford University Press, 10th Ed., 2014.
17. *Mendham J., A. I. Vogel's Quantitative Chemical Analysis, Pearson, 6th Ed., 2009.*
18. *Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 7th Edition, 2009.*
19. *Marr G., Rockett B.W. , Practical Inorganic Chemistry, Van Nostrand Reinhold Company, 1st Ed., 1972.*

20. *Mann F.G., Saunders B.C., Practical Organic Chemistry, Pearson Education India, 4th Ed., 2009.*
21. *Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed., 2020.*
22. *Ahluwalia V.K., Aggarwal R., Ahluwalia V.K., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Sangam Books Ltd., 2001.*
23. *Ahluwalia V.K., Dhingra S., Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press, 2000.*
24. *Vogel A.I., Vogel's Textbook of Practical Organic Chemistry, Longman Scientific & Technical, 5th Ed., 1989.*
25. *Vogel A.I., Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific & Technical, 6th Ed., 1989.*
26. *Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, Thomson Books/Cole, 3rd Ed., 2005.*
27. *Furniss B.S., Hannaford A.J., Smith P.W.G., Tatchell A.R., Practical Organic Chemistry, Pearson, 5th Ed., 2012.*
28. *Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 36th Ed., 2016.*

Discipline Specific Course	
24CHE0401P: Chemistry-IV LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Hands on practice on inorganic preparations, qualitative analysis of unknown organic compounds and preparation of their solid derivatives, and study of kinetics of reactions***	***At the end of the course, the students would be able to:*** ***CO1. Understand the chemistry of transition elements, lanthanides and actinides.*** ***CO2. Get the knowledge of organic compounds viz. alcohols, phenols, ethers and epoxides nd their chemical properties.*** ***CO3. Get acquainted with solid state chemistry.*** ***CO4. Familiar with chemical kinetics of reactions.*** ***CO5. Practical knowledge of strategies of inorganic preparations and gravimetric estimations of metal ions.*** ***CO6. Analyze unknown organic compounds Qualitatively alongwith preparation of their derivatives.*** ***CO7. Get practical knowledge of chemical kinetics of reactions.*** ***CO8. Develop the skill of performing experiments, compilation of experimental information, evaluation of results presentation of the findings in the form of lab record and defend viva-voce.***

List of Experiments:

1. Inorganic preparation and gravimetric estimations
(a). Cuprous chloride, Cu_2Cl_2
(b). Estimation of nickel (II) using Dimethylglyoxime (DMG).
(c). Estimation of copper as CuSCN
2. Qualitative analysis of unknown organic compounds containing following functional groups: alcohol, phenol, ester, carboxylic acid, carbonyl, and carbohydrate groups. Preparation of solid derivatives of the compounds analysed.
3. Initial rate method: Iodide-persulphate reaction
4. Integrated rate method: Saponification of ethyl acetate.
5. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.

Recommended Textbooks and References:

1. *Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, John Wiley & Sons. Inc., 6^{th} Ed., 1999.*

2. Lee J.D., Concise Inorganic Chemistry, ELBS, 4th Ed., 1991.
3. Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; Pubs: Harper Collins, 4th Ed., 1993.
4. Douglas B.E, Mc Daniel D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry, John Wiley Sons, N.Y. 3rd Ed., 1994.
5. Greenwood N.N., Earnshaw, Chemistry of the Elements, Butterworth-Heinemann, Butterworth-Heinemann Oxford, 2nd Edition, 1997.
6. Rodger G.E., Inorganic and Solid-State Chemistry, Cengage Learning India, 1st Ed, 2008.
6. Miessler G.L., Donald A. Tarr., Inorganic Chemistry, Pearson, 4th Ed., 2010.
7. Shriver & Atkins' Inorganic Chemistry, Oxford University Press 5th Ed, 2010.
8. Morrison R.N., Boyd, R.N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.
9. Finar I.L., Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.
10. Finar I.L., Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 5th Ed., 2002.
11. Ball D.W., Physical Chemistry Thomson Press, India, 2nd Ed., *2017.*
12. Castellan G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.
13. Mortimer R.G., Physical Chemistry, Elsevier: Noida, UP, 3rd Ed., 2009.
14. Engel T., Reid P., Physical Chemistry, Pearson, 3rd Ed., 2013.
15. Puri B.R., Sharma L.R., Pathania M.S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.
16. Atkins P.W., Paula J., Physical Chemistry, Oxford University Press, 10th Ed., 2014.
17. Mendham J., A. I. Vogel's Quantitative Chemical Analysis, Pearson, 6th Ed., 2009.
18. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 7th Edition, 2009.
19. Marr G., Rockett B.W. , Practical Inorganic Chemistry, Van Nostrand Reinhold Company, 1st Ed., 1972.
20. Mann F.G., Saunders B.C., Practical Organic Chemistry, Pearson Education India, 4th Ed., 2009.
21. *Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed., 2020.*
22. Ahluwalia V.K., Aggarwal R., Ahluwalia V.K., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Sangam Books Ltd., 2001.
23. Ahluwalia V.K., Dhingra S., Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press, 2000.
24. Vogel A.I., Vogel's Textbook of Practical Organic Chemistry, Longman Scientific & Technical, 5th Ed., 1989.
25. Vogel A.I., Vogel's Textbook of Quantitative Chemical Analysis, Longman Scientific & Technical, 6th Ed., 1989.
26. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, Thomson Books/Cole, 3rd Ed., 2005.
27. Furniss B.S., Hannaford A.J., Smith P.W.G., Tatchell A.R., Practical Organic Chemistry, Pearson, 5th Ed., 2012.
28. Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 36th Ed., 2016.

Discipline Specific Course	
24BOT0401T: GENETICS	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***The objective of this course is to provide students with an understanding of both classical and modern concepts in genetics.***	***After successful completion of this course, students should be able to: -*** • ***Develop good understanding of fundamentals of genetics.*** • ***Gain basic knowledge of mendelian and non-mendelian traits.*** • ***Understand genome organisation in prokaryotes and chromosome structure in eukaryotes.***

UNIT-I [15 Lectures]

Basic Genetics: Historical developments in the field of genetics, Organisms suitable for genetic experimentation and their genetic significance.

Mendelian laws of inheritance, Chromosome Theory of Heredity (Sutton- Boveri), Extra mendelian Inheritance patterns- incomplete dominance, co-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance and expressivity. Inheritance patterns in Human (Sex linked, Sex limited and Sex influenced), Non allelic interactions: supplementary genes, complementary genes and epistasis (dominant & recessive), Extra Chromosomal Inheritance

UNIT - II [15 Lectures]

Chromosome and Genomic Organization: Genetic organization of prokaryotic and eukaryotic genome, chromosome morphology, concept of euchromatin and heterochromatin. Packaging of DNA molecule into chromosomes, Specialized chromosomes, Transposons, Karyotyping,

Genetic Linkage, Crossing Over and Chromosome Mapping: Linkage and Recombination of genes in a chromosome, Cytological basis of crossing over, Molecular mechanism of crossing over, Genetic mapping.

UNIT -III [15 Lectures]

Gene Mutations: Definition and types of mutations, Causes of mutations, Ames test for mutagenic agents, , Variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), Chromosomal aberrations in human beings, Abnormalities – Aneuploidy and Euploidy

Genetic Disorders: Down, Turner and Klinefelter syndromes, chronic myeloid leukemia, cri-du-chat syndrome, cystic fibrosis

Recommended Textbooks and References:

1. *Hartl, D.L. & Jones, E.W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett. 1998.*
2. *Pierce, B.A. Genetics: a Conceptual Approach. New York: W.H. Freeman. 2005.*

3. *Tamarin, R.H. & Leavitt, R.W. Principles of Genetics. Dubuque, IA: Wm. C. Brown. 1991*
4. *Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. & Killian, D. Concepts of Genetics (12th Ed.). Pearson Education Limited: London. 2019.*

Discipline Specific Course	
24BOT0401P: GENETICS LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To develop skills in the graduates that understand fundamental genetic principles, and to enable them to develop practical skills in the field of biology integrating concepts from genetics.*** • ***To give them the opportunity to combine background knowledge and independent research to interpret experimental results and solve problems.***	***After successful completion of this course, students should be able to: -*** • ***Demonstrate a basic understanding of developmental terms and mechanisms.*** • ***Utilize laboratory techniques to design and carry-out experimental studies.*** • ***Demonstrate proficiency in quantitative reasoning and analytical skills*** • ***Display a broad understanding of core molecular genetics***

List of Experiments:

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Numericals on Mendelian deviations in dihybrid crosses.
4. Demonstration of - Barr Body-Rhoeotranslocation.
5. Demonstration of chromosomal (structural and numerical) aberrations
6. Study of polytene chromosomes (lamp brush chromosomes and giant chromosomes).
7. Karyotyping with the help of photographs.
8. Effect of colchicine on chromosomes
9. Demonstration of Mendelian laws using colour marbles or beads
10. Evaluation of segregation and random assortment using Chi square test or test of fitness.
11. Construction of genetic maps based on Problems in two and three factor crosses
12. Pedigree charts of some common characters like blood group, colour blindness and PTC tasting
13. Study of polyploidy in onion root tip by colchicine treatment

Recommended Textbooks and References:

1. *Hartl, D.L. & Jones, E.W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett. 1998.*
2. *Pierce, B.A. Genetics: a Conceptual Approach. New York: W.H. Freeman. 2005.*
3. *Tamarin, R.H. & Leavitt, R.W. Principles of Genetics. Dubuque, IA: Wm. C. Brown. 1991.*
4. *Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. & Killian, D. Concepts of Genetics (12th Ed.). Pearson Education Limited: London. 2019.*

Discipline Specific Course	
24ZOO0401T: BASICS OF BIOCHEMISTRY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To provide fundamental knowledge about the structure, function and properties of major biomolecules.*** • ***To introduce students to metabolic pathway of selected biomolecules.***	***After successful completion of this course, students should be able to: -*** • ***Describe the relationship between the structure and function of biomolecules*** • ***Classify the enzymes and explain mechanism of action and structure of enzyme*** • ***Comprehend metabolic pathways of selected biomolecules*** • ***Get a good grasp of the structure and biochemical role of vitamins and co-enzymes***

UNIT-I [15 Lectures]

Introduction to Biochemistry: A historical prospective, Concept of bio-molecules - Building blocks of life, Small molecules and macromolecules.

Carbohydrates: Structure, function and properties of monosaccharides, Stereo isomerism of monosaccharides, Furanose and pyranose forms, Haworth projection formulae, Disaccharides and polysaccharides. Homo & hetero polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions. Carbohydrates Metabolism-Glycolysis & TCA Cycle

Amino acids & Proteins: Amino acids- Structure, classification and properties of amino acids. Proteins: Types of proteins and their classification, Forces stabilizing protein structure and shape. Primary, secondary, tertiary and quaternary structures, Denaturation and renaturation of proteins. Fibrous and globular proteins

UNIT - II [15 Lectures]

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, prostaglandins, cholesterol. Lipids: Definition and major classes of storage and structural lipids. ß-oxidation of fatty acids.

Nucleic acids: Structure and functions: Physical & chemical properties of nucleic acids, nucleosides & nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, Denaturation and renaturation of DNA

UNIT -III [15 Lectures]

Enzymes: Nomenclature and classification of enzymes. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, Activation energy and transition state, Enzyme activity, Specific activity, Common features of active sites, Enzyme specificity: types & theories- Lock and key hypothesis, and Induced Fit hypothesis.,

Biocatalysts from extreme thermophilic and hyper thermophilic archaea and bacteria. Effect of pH and temperature on enzyme activity. Enzyme inhibition,

Vitamins: Role of NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallssssic ions

Recommended Textbooks and References:

1. *Berg, J.M., Tymoczko, J.L., Gatto, G.J., & Stryer, L. Biochemistry. (9th Ed.) New York: W.H. Freeman. 2019.*
2. *Nelson, D.L. & Cox, M.M. Lehninger, A. L. Lehninger Principles of Biochemistry (7th Ed.). New York, NY: W H Freeman & Co. 2017.*
3. *Voet, D. & Voet, J. G. Biochemistry (5th Ed.). Hoboken, NJ: J. Wiley & Sons. 2016.*
4. *Dobson, C. M. Protein Folding and Misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261. 2003.*
5. *Richards, F. M. The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54. 1991.*

Discipline Specific Course	
24ZOO0401P: BASICS OF BIOCHEMISTRY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To develop skills in the graduates that understand fundamental knowledge about the structure, function and properties of major biomolecules.*** • ***To make students to understand various qualitative and quantitative tests***	***After successful completion of this course, students should be able to: -*** • ***Describe the relationship between the structure and function of biomolecules*** • ***Get a good grasp of the basic tests and latest techniques applicable in Biochemistry*** • ***Demonstrate proficiency in quantitative reasoning and analytical skills***

List of Experiments:

1. Measure the rate of a reaction catalyzed by an enzyme (e.g., amylase or catalase).
2. Quantify the protein concentration in a solution by Bradford Assay.
3. Extract and identify lipids from seeds (e.g., sunflower or soybean).
4. Measure the concentration of Vitamin C in different fruit juices by titration with iodine solution
5. Measure the pH of various biological fluids (e.g., saliva, urine).
6. Determine which carbohydrates can be fermented by yeast or bacteria.
7. Convert fats or oils into soap (Saponification of Fats).
8. Separate and identify amino acids in a mixture by paper or thin-layer chromatography
9. Study the effect of inhibitors on enzyme activity.
10. Detect the presence of proteins in a sample by Biuret test.
11. Measure glucose concentration in biological fluids.
12. Measure the concentration of urea in urine.
13. Measure total cholesterol in serum.
14. Measure the rate of oxygen consumption by respiring cells by a respirometer.
15. Separate DNA fragments based on size by gel electrophoresis.

Recommended Textbooks and References:

1. *Berg, J.M., Tymoczko, J.L., Gatto, G.J., & Stryer, L. Biochemistry. (9th Ed.) New York: W.H. Freeman. 2019.*
2. *Nelson, D.L. & Cox, M.M. Lehninger, A. L. Lehninger Principles of Biochemistry (7th Ed.). New York, NY: W H Freeman & Co. 2017.*
3. *Voet, D. & Voet, J. G. Biochemistry (5th Ed.). Hoboken, NJ: J. Wiley & Sons. 2016.*
4. *Dobson, C. M. Protein Folding and Misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261. 2003.*
5. *Richards, F. M. The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54. 1991.*

SEMESTER V

Discipline Specific Course	
24CHE0501T: CHEMISTRY-V	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
This paper deals with the organometallic compounds, chemistry of organic compounds containg carbonyl and nitrogen containing compounds, chemical equilibrium, solutions and colligative properties.	***At the end of the course, the students would be able to:*** • ***CO1. Get knowledge of organometallic compounds and their applications.*** • ***CO2. Understand the chemistry of carbonyl compounds and related name reactions and their mechanistic details, and chemistry of active methylene compounds.*** • ***CO3. Acquaint with the chemistry of nitrogen containing fuctional groups and their synthetic applications.*** • ***CO4. Get familiar with chemical equilibrium and relations between various equilibrium constants.*** • ***CO5. Understand the thermodynamics of solutions and acquaint with colligative properties.*** • ***CO6. Perform experiments on synthesis of organometallic and organic compounds.*** • ***CO7. Perform experiments for determination of excess thermodynamic functions, experiments based on colligative properties such as determination of elivation in boiling point, depression of freezing point, and relative and absolute viscosity.*** • ***CO8. Develop the skill of performing experiments, compilation of experimental information, presentation of the findings in the form of lab record and defend viva-voce.***

UNIT-I [15 Lectures]

Organometallic Compounds-I

Definition and classification of organometallic compounds on the basis of bond type.

Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation) of mono and binuclear carbonyls of 3d series. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Role of triethylaluminium in polymerisation of ethene (Ziegler - Natta Catalyst). Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation).

UNIT-II [15 Lectures]

Carbonyl Compounds

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, Haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Nitrogen Containing Functional Groups

Preparation and important reactions of nitro compounds, nitriles and isonitriles

Amines: Effect of substituents and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

UNIT-III **[15 Lectures]**

Chemical Equilibrium

Criteria of thermodynamic equilibrium, Concept of chemical equilibria. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Thermodynamic derivation of relations between the various equilibrium constants *Kp, Kc* and *Kx. Le* Chatelier principle (quantitative treatment).

Solutions and Colligative Properties

Dilute solutions, 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.

Recommended Textbooks and References:

1. *Cotton F.A. and Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, 6th Ed., John Wiley & Sons. Inc., 1999.*
2. *Lee J.D., Concise Inorganic Chemistry, 4th Ed., ELBS, 1991.*
3. *Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; 4th Edition, Pubs: Harper Collins, 1993.*
4. *Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Ed., 2010.*
5. *Finar, I. L., Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 6th Ed., 2002.*
6. *Finar, I. L., Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 5th Ed., 2002.*
7. *Kalsi, P. S., Stereochemistry Conformation and Mechanism, New Age International, 11th Ed., 2022.*
8. *Eliel, E. L. &Wilen, S. H., Stereochemistry of Organic Compounds, Wiley: London, 1994.*
9. *Puri B.R., Sharma L. R. and Pathania M. S., Principles of Physical Chemistry, Vishal Publishing Company, 49th Ed., 2020.*
10. *Atkins, P.W. & Paula J., Physical Chemistry, 10th Ed., Oxford University Press, 2014.*
11. *Castellan, G.W., Physical Chemistry, Narosa Publishers, 3rd Ed., 2004.*
12. *Kapoor, K. L., A Text Book of Physical Chemistry, McGraw Hill Publication, 6th Ed. 2020*
13. *Vogel, A.I., Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Longman Scientific & Technical, 1989.*
14. *Vogel, A.I., Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Longman Scientific & Technical, 1989*
15. *Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Thomson Books/Cole,2005.*
16. *Yadav J. B., Advanced Practical Physical Chemistry, Krishna Prakashan Media, 2016.*

Discipline Specific Course	
24CHE0501P: CHEMISTRY-I Lab	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3H**

Course Objectives	Learning Outcomes
Hands on practice on inorganic and preparations, and studies of colligative properties.	***After successful completion of this course, students should be able to understand the: -*** • ***Understand the atomic structure and bonding concepts.*** • ***Acquaint with the mechanistic approach for chemical reactions.*** • ***Understand the spatial arrangement and orientation of atoms in the molecules.*** • ***Get the knowledge of Kinetic theory of gases (Real & Ideal) and Maxwell distribution law***

List of Experiments:

1. Preparation of the following organometallic compunds
(i) $VO(acac)_2$
(ii) $NH_4[Cr(NH_3)_2(CNS)_4]$
(iii) $Na_3[Co(NO_2)_6]$
2. Photoreduction of benzophenone to benzopinacol in the presence of sunlight
3. Nitration of salicylic acid using calcium nitrate
4. Determination of excess thermodynamic functions of different liquid mixtures.
5. To determine elivation of boiling point for a given solution.
6. To determine depression of freezing point for a given solution.
7. Detemination of relative and absolute viscosity of benzene.

Note: **The examiner will allot one practical at the time of end term examination. Candidates are required to obtain minimum passing marks separately in practical component and theory as per the University rules.**

Recommended Textbooks and References:

1. Cotton F.A., Wilkinson G., Gaus P.L. *Basic Inorganic Chemistry Wiley* India, 3rd Ed., 2007.
2. Huheey J.E., Keiter E.A., Keiter R.L., *Inorganic Chemistry, Principles of Structure and Reactivity,* Pearson, 4th Ed., 2006.
3. Powell P., *Principles of Organometallic Chemistry,* Chapman and Hall, 2nd Ed., 1988.
4. Shriver D.D., Atkins P., *Inorganic Chemistry,* Oxford University Press, 2nd Ed., 1994.
5. Basolo F. & Pearson, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution* John Wiley & Sons Inc. NY 2nd Ed.,
6. Collman J. P. *et al. Principles and Applications of Organotransition Metal Chemistry.* Mill Valley, CA, University Science Books, 2nd Ed., 1987.
7. Crabtree R. H. *The Organometallic Chemistry of the Transition Metals.* New York, NY, John Wiley, 6th Ed.,2000.
8. Morrison R. T., Boyd R. N., Bhattacharjee S. K. *Organic Chemistry,* Pearson Education, 6th Ed., 2018.
9. Finar I. L. *Organic Chemistry (Volume* 1), Pearson Education, 6th Ed., 2002.
10. Graham Solomons T.W., Fryhle C. B., Snyder S. A., *Organic Chemistry Global Edition,* John Wiley & Sons, Inc., 12th Ed. 2017.
11. McMurry J.E. *Fundamentals of Organic Chemistry,* Cengage Learning India Edition, 7th Ed., 2013.
12. Carey F. A., Sundberg R. J. *Advanced Prganic Chemistry, Part A: Structure and Mechanism,* Springer, 5th Ed.

2007.

13. Carey F. A., Sundberg R. J. *Advanced Organic Chemistry, Part B: Reactions and Synthesis,* Springer, 5th Ed. 2007.

14. Peter A., Paula, J. de. *Physical Chemistry* Oxford University Press,10th Ed., 2014.
15. Castellan G. W. *Physical Chemistry* Narosa, 4th Ed., 2004.
16. Engel T., Reid, P. *Physical Chemistry* Prentice-Hall, 3rd Ed., 2012.

Discipline Specific Course	
24BOT0501T: PLANT TAXONOMY AND EMBRYOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To make students aware about Taxonomy, including the rules of Nomenclature, other essential aspects and diversity of families.*** • ***Understanding conceptual knowledge about various aspects of Plant Embryology***	***After successful completion of this course, students should be able to understand the: -*** • ***The dynamic mechanism of plant pollination, fertilization and development.*** • ***Plant embryology make them understand how reproduction play significant role in defining population structure, natural diversity and sustainability of ecosystem in a better way.***

UNIT-I [18 Lectures]

Taxonomy and Types of classification: Artificial, Natural and Phylogenetic, Bentham & Hooker classification, its Merits and Demerits. Engler & Prantle's system of classification-merits and demerits , Phylogeny – origin and evolution of Angiosperms Botanical Nomenclature, International Code for Botanical Nomenclature (ICBN), Taxonomic Keys.

Herbarium: Preparation steps and types, Type concept, Botanical Gardens, Introduction to Botanical Survey of India. Flower and Its Parts (semi technical description), Types of Inflorescence, Simple and Compound Leaves, Phyllotaxy.

UNIT - II [12 Lectures]

Systematic taxonomy: Systematic study and economic importance of the following families: Annonaceae, Brassicaceae, Rutaceae, Curcurbitaceae, and Apiaceae.

Systematic study and economic importance of plants belonging to the following families: Asteraceae, Asclepiadaceae, Lamiaceae, Ephorbiaceae, Arecaceae,and Poaceae

UNIT -III [15 Lectures]

Structure of Anther and Pollen Grain, Structure and Types of Ovule, Placentation - Types. Structure and Types of Embryo sac, Pollination mechanism and adaptations, Double Fertilization.

Endosperm: Endosperm types, Structure and functions, Dicot and Monocot Embryo, Embryo-endosperm relationship. Seed Structure (Dicot & Monocot), Polyembryony and Apomixis: Definition, types and practical applications

Recommended Textbooks and References:

1. *Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.*
2. *Gangulee, Das and Datta (2011). College Botany (Volume I/II), New Central Book Agency*
3. *Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand. Delhi, India.*
4. *Singh, G. (2021). Plant Systematics: An Integrated Approach, CRC Press.*
5. *Sharma, O.P. (2017). Plant Taxonomy, Mc Graw Hill Publication.*

6. *Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.*

Discipline Specific Course	
24BOT0501P: PLANT TAXONOMY AND EMBRYOLOGY-LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Students should draw Figures or diagrams and write related descriptions/ notes in their practical note books.*** • ***Report on excursion tours with photographs, collection, preservation (if any).***	***After successful completion of this course, students should be able to understand the:*** • ***Significance of order, family, genus and species.*** • ***Students will understand the process of plant classification.*** • ***Students will have hands-on training on section cutting, preparation of slides study of pollen and ovules.***

List of Experiments:

1. Study of vegetative and floral characters of the locally available members (one/two) of following families (Description, V.S. flower, T.S. of ovary, Floral diagram, Floral formula and systematic position (Bentham & Hooker's system of classification):
   Malvaceae, Solanaceae, Lamiaceae, Asteraceae, Fabaceae, Poaceae.
2. To study about different types of inflorescences (model/chart/photographs).
3. Mounting of a collected, properly dried and pressed specimen of wild plants with herbarium label.
4. Excursion/Field Visit: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Angiosperms.

Recommended Textbooks and References:

1. Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Gangulee, Das and Datta (2011). College Botany (Volume I/II), New Central Book Agency
3. Pandey, B.P. (2001).A Textbook of Botany-Angiosperms, S. Chand. Delhi, India.
4. Singh, G. (2021). Plant Systematics: An Integrated Approach, CRC Press.
5. Sharma, O.P. (2017). Plant Taxonomy, Mc Graw Hill Publication.
6. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.

Discipline Specific Course	
24ZOO0501T: DEVELOPMENTAL BIOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To provide the students a comprehensive understanding of the concepts of early animal development.*** • ***To familiarize the students with the events that led up to and comprise the process of fertilization, cleavage, blastulation, gastrulation, cell commitment and determination and development of different body structure.***	***After successful completion of this course, students should be able to: -*** • ***List the types of characteristics that make an organism ideal for the study of developmental biology.*** • ***Compare and contrast spermatogenesis and oogenesis and fertilization process in mammals.*** • ***Describe the organogenesis in different animals and the fate of the embryo.*** • ***Conclusively explain the development of the life starting from the first day to the formation of different organs and cellular and genetic control of the development.***

UNIT- I [15 Lectures]

Gametogenesis and Fertilization: Definition, scope and historical perspective of developmental biology; Gametogenesis: spermatogenesis, oogenesis, Generalized structure of mammalian ovum and sperm; Fertilization: Definition, mechanism and types of fertilization; Different types of eggs on the basis of yolk.

UNIT- II [15 Lectures]

Early Embryonic Development: Definition, types, patterns & mechanism; Blastulation: Process, types & mechanism; Morphogenetic movements- epiboly, emboly, extension, invagination, convergence, delamination; Formation & differentiation of primary germ layers; Fate Maps in early embryos. Early development of mammals up to gastrulation.

UNIT- III [15 Lectures]

Embryonic Differentiation and Organogenesis: Cell commitment and determination- the epigenetic landscape: a modelof determination and differentiation, control of differentiation at the level of genome, transcriptionand post-translation level; Concept of embryonic induction.
Organogenesis: Neurulation, Notogenesis, Development of vertebrate eye. Extra embryonic membranes, Placentation in Mammals:Definition, types and functions of placenta

Recommended Textbooks and References:

1. *Gilbert, S.F. Developmental Biology (8th Ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. 2010.*
2. *Balinsky, B.I. An introduction to Embryology. International Thomson Computer Press. 2008.*
3. *Kalthoff, K. Analysis of Biological Development (2nd Ed.). McGraw-Hill Professional. 2000.*
4. *Slack, J.M.W. Essential of Developmental Biology (3rd Ed.). Blackwell Publishing. 2012.*

Discipline Specific Course	
24ZOO0501P: DEVELOPMENTAL BIOLOGY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To develop comprehensive understanding of concept of early animal development and apply key models and techniques used to study animal and plant development; to enable them to develop practical skills in the field of biology*** • ***To give them the opportunity to combine background knowledge and independent research to interpret experimental results and solve problems.***	***After successful completion of this course, students should be able to understand the: -*** • ***Demonstrate a basic understanding of developmental terms and mechanisms.*** • ***Utilize laboratory techniques to design and carry-out experimental studies.*** • ***Demonstrate proficiency in quantitative reasoning and analytical skills*** • ***Display a broad understanding of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution***

List of Experiments:

1 Identification of developmental stages of chick and frog embryo using permanent mounts.
2 Preparation of a temporary stained mount of chick embryo.
3 Study of developmental stages of Anopheles.
4 Study of the developmental stages of Drosophila from stock culture/ photographs.
5 Study of different types of placenta

Recommended Textbooks and References:

1. *Gilbert, S.F. Developmental Biology (8th Ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. 2010.*
2. *Balinsky, B.I. An introduction to Embryology. International Thomson Computer Press. 2008.*
3. *Kalthoff, K. Analysis of Biological Development (2nd Ed.). McGraw-Hill Professional. 2000.*
4. *Slack, J.M.W. Essential of Developmental Biology (3rd Ed.). Blackwell Publishing. 2012*

SEMESTER VI

Discipline Specific Course	
24CHE0601T: CHEMISTRY-VI	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - ***This paper deals with the concepts of molecular and organic spectroscopic methods and their applications.***	***After successful completion of this course, students should be able to: -*** • ***CO1. Explain the interaction of electromagnetic radiation with matter*** • ***CO2. Describe the rotational and vibrational motions in molecules, and Rotation and Vibrational spectroscopy.*** • ***CO3. Explain the origin of UV-visible bands, electronic transitions, Fieser-Woodward rules and photophysical properties of organic molecules.*** • ***CO4. Explain the basic principle and instrumentation of IR spectroscopy, characteristic vibrational frequencies oforganic molecules.*** • ***CO5. Explain the basic principle of NMR spectroscopy, chemical shift, spin-spin interactions and simplification of complex spectra of different compounds.*** • ***CO6. Apply the knowledge of UV, IR, NMR and Mass spectrometry for structural elucidation of organic compounds.*** • ***CO7. Prove Beer-Lambert's relationship and determine the concentrations of unknown aquous solutions.*** • ***CO8. Determine the strength of Cu (II), Fe (III) and Ni spectrophotometrically.*** • ***CO9. Determine the concentration of a dye spectrophotometrically.*** • ***CO10. Develop the skill of performing experiments, analysing data and compile experimental information in the form of lab record, and defend viva-voce.***

UNIT-I [15 Lectures]

Molecular Spectroscopy-I **15 Hrs**

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic

molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

UNIT - II [15 Lectures]

Organic Spectroscopy-I **15 Hrs**

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: *α, β*- unsaturated aldehydes and ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between *cis*- and *trans*- isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

UNIT -III [15 Lectures]

Organic Spectroscopy-II **15 Hrs**

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin-Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.

Applications of IR, UV and NMR for identification of simple organic molecules (Problems solving with examples)

Recommended Textbooks and References:

1. Banwell C. N., *Fundamental of molecular spectroscopy*, McGraw-Hill Education (India), 4th Ed., 2017.
2. Clayden J., Greeves, N., Warren S., Wothers P., *Organic Chemistry*, Oxford University Press.
3. Kemp W., *Organic Spectroscopy*, John Wiley.
4. Lampman G.M., Pavia D.L., Kriz G.S., Vyvyan, J.M., *Introduction to spectroscopy*, Cengage Learning.
5. Jag Mohan, *Organic Spectroscopy*, Narosa Publishers, New
6. Silverstein, R., Webster F.X., Kiemle D.J., Bryce D.L., Spectrometric identification of organic compounds, John Wiley
7. Abraham R.J., Fisher J., Loftus P., *Introduction to NMR Spectroscopy*, Wiley
8. Dyer J.R., *Application of Spectroscopy of Organic Compounds*, Prentice Hall.
9. Williams D.H., Fleming I., *Spectroscopic Methods in Organic Chemistry*, Tata McGraw-Hill.
10. Jolly W.L., *Synthesis and Characterization of Inorganic Compounds*. Prentice Hall.
11. Bell C.F., *Synthesis and Physical studies of Inorganic compounds*, Pergamon Press.
12. Vogel A.I., *A Textbook of Quantitative Analysis,* ELBS.

Discipline Specific Course	
24CHE0601P: CHEMISTRY-VI LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Hands on practice on hardness and softness of water, determination of surface tension, purification techniques, preparation of organic and inorganic compounds.***	***After successful completion of this course, students should be able to: -*** ***After successful completion of this course, students should be able to: -*** • ***CO1. Explain the interaction of electromagnetic radiation with matter*** • ***CO2. Describe the rotational and vibrational motions in molecules, and Rotation and Vibrational spectroscopy.*** • ***CO3. Explain the origin of UV-visible bands, electronic transitions, Fieser-Woodward rules and photophysical properties of organic molecules.*** • ***CO4. Explain the basic principle and instrumentation of IR spectroscopy, characteristic vibrational frequencies oforganic molecules.*** • ***CO5. Explain the basic principle of NMR spectroscopy, chemical shift, spin-spin interactions and simplification of complex spectra of different compounds.*** • ***CO6. Apply the knowledge of UV, IR, NMR and Mass spectrometry for structural elucidation of organic compounds.*** • ***CO7. Prove Beer-Lambert's relationship and determine the concentrations of unknown aquous solutions.*** • ***CO8. Determine the strength of Cu (II), Fe (III) and Ni spectrophotometrically.*** • ***CO9. Determine the concentration of a dye spectrophotometrically.*** • ***CO10. Develop the skill of performing experiments, analysing data and compile experimental information in the form of lab record, and defend viva-voce.***

List of Experiments:

1. To determine the strength of Cu (II) using EDTA spectrophotometrically.
2. To determine the strength of Fe (III) using EDTA spectrophotometrically.
3. To determine the concentration of nickel in given solution spectrophotometrically.
4. To determine dye concentration using UV-Visible Spectrophotometer.
5. To apply Beer-Lambert's relationship to an aqueous solution containing an absorbing substance and thus, determine its respective concentrations.
6. To identify a compound by an investigation of its Infra Red spectrum.
7. To identify a compound by an investigation of NMR Spectrum.

Note: **The examiner will allot one practical at the time of end term examination. Candidates are required to obtain minimum passing marks separately in practical component and theory as per the University rules.**

Recommended Textbooks and References:

1. Banwell C. N., *Fundamental of molecular spectroscopy*, McGraw-Hill Education (India), 4th Ed., 2017.
2. Clayden J., Greeves, N., Warren S., Wothers P., *Organic Chemistry*, Oxford University Press.
3. Kemp W., *Organic Spectroscopy*, John Wiley.
4. Lampman G.M., Pavia D.L., Kriz G.S., Vyvyan, J.M., *Introduction to spectroscopy*, Cengage Learning.
5. Jag Mohan, *Organic Spectroscopy*, Narosa Publishers, New
6. Silverstein, R., Webster F.X., Kiemle D.J., Bryce D.L., Spectrometric identification of organic compounds, John Wiley
7. Abraham R.J., Fisher J., Loftus P., *Introduction to NMR Spectroscopy*, Wiley
8. Dyer J.R., *Application of Spectroscopy of Organic Compounds*, Prentice Hall.
9. Williams D.H., Fleming I., *Spectroscopic Methods in Organic Chemistry*, Tata McGraw-Hill.
10. Jolly W.L., *Synthesis and Characterization of Inorganic Compounds*. Prentice Hall.
11. Bell C.F., *Synthesis and Physical studies of Inorganic compounds,* Pergamon Press.
12. Vogel A.I., *A Textbook of Quantitative Analysis,* ELBS.

Discipline Specific Course	
24BOT0601T: PLANT PATHOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To give the essential knowledge pertaining to various aspects of Plant Pathology like Symptomatology, Defence mechanisms, Host Parasite interactions, Role of enzymes and toxins in pathogenesis.*** • ***To study the Etiology, Epidemiology and Control of different plant diseases caused by Fungi and other micro-organisms***	***After successful completion of this course, students should be able to: -*** • ***Understand the interaction between plant and pathogen in relation to the overall Environment*** • ***Demonstrate an understanding of the principles of plant pathology and the application of these principles for the control of plant disease.***

UNIT-I [15 Lectures]

Milestones in phytopathology, major epidemics, and their social impact. Historical developments of chemical, legislative, cultural, and biological disease control measures. Antagonistic microorganisms in soil, rhizosphere, and phyllosphere; biocontrol strategies. Koch's postulates, pathogen survival, dispersal, and factors influencing infection.

UNIT-II [15 Lectures]

Plant quarantine, exotic pathogens, and WTO regulations (TRIPS, PRA). Genetic basis of disease resistance and pathogenicity: gene-for-gene hypothesis, breeding for disease resistance. Disease-free seed production, certification, and sanitation practices. Fungicides, antibiotics, resistance issues, and environmental impact. Cultural practices, integrated disease management, and forecasting techniques.

UNIT-III [15 Lectures]

Plant metabolic alterations under biotic and abiotic stress, molecular mechanisms of pathogenesis. Structural and biochemical defense mechanisms: R-genes, phytoalexins, Phytoanticipins, PR proteins, Hydroxyproline rich glycoproteins (HRGP). Antiviral proteins. SAR and ISR. HR and active oxygen radicals. Genetic engineering in disease management: RNA interference, plantibodies, and cross-protection. Biotechnology applications in pathogen control, biosafety, and bioethics.

Recommended Textbooks and References:

1. *Agrios, G.N., (2005), Plant Pathology, Acad. Press, Inc. California.*
2. *Bilgrami, K.S. and Dube, H.C., (1990), A Text Book of Modern Plant Pathology, VikasPublishing House, New Delhi.*
3. *Mehrotra, R.S. and Aggarwal, A., (2013), Fundamentals of Plant Pathology, Tata McGraw Hill Publ. Ltd., New Delhi.*
4. *Mehrotra, R.S. and Ashok Aggarwal (2017): Plant Pathology, Tata Mc Graw Hill Publ.Ltd., New Delhi.*
5. *Singh, R.S., (2018), Plant Disease, 9th Edition, Oxford, IBH Publ., New Delhi.*
6. *Singh, R.S., (2017), Principles of Plant Pathology, 5th Edition, Medtech.*
7. *Recent and important review articles from scientific journals.*

Discipline Specific Course	
24BOT0601P: PLANT PATHOLOGY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To give the students essential practical knowledge pertaining to Plant Pathology.***	***After successful completion of this course, students should be able to: -*** • ***Get practical knowledge of plant diseases.*** • ***Study the symptoms and diagnostic features of casual organisms of various plant diseases.***

List of Experiments:

1. Demonstration of working of microscopes.
2. Microscopic examination of Living microorganisms
3. Isolation of pathogenic microorganisms from soil
4. Isolation of fungal pathogen from infected plant leaves/stem.
5. Isolation of bacterial pathogen from infected plant tissues.
6. Study of different types of media preparation for microbial culturing
7. Methods of obtaining pure culture of plant pathogens
8. Counting of cells/spores of pathogens by plate count or serial dilution technique
9. Study of Bacterial population by the use of spectrophotometer
10. The effect of fungal growth on seed health
11. Demonstration of Koch's Postulates for a fungal pathogens
12. Demonstration of Koch's Postulates for a bacterial pathogens

Recommended Textbooks and References:

1. *Gurr, S. J., McPherson, M. J., & Bowles, D. J. (Eds.). (1992). Molecular plant pathology. A practical approach. Volume I (pp. xxiv+-216).*
2. *Barnes, E. H. (2012). Atlas and manual of plant pathology. Springer Science & Business Media.*
3. *Baudoin, A. B. (2011). Laboratory Exercises in Plant Pathology: An Instructional Kit (Teachers Manual). Scientific Publishers.*
4. *Ownley, B. H., & Trigiano, R. N. (2016). Plant pathology concepts and laboratory exercises. CRC press.*
5. *Streets, R. B. (1972). The diagnosis of plant diseases: a field and laboratory manual emphasizing the most practical methods for rapid identification. University of Arizona Press.*
6. *Sinclair, J. B., & Dhingra, O. D. (2017). Basic plant pathology methods. CRC press.*

Discipline Specific Course	
24ZOO0601T: MOLECULAR BIOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**20**
Total Marks	**70**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To know about the genetic material, its mode of replication, damages and repair mechanism, understanding the process of transcription and translation.***	***After successful completion of this course, students should be able to: -*** • ***Understand the structure of DNA and RNA.*** • ***Learn how DNA replication takes place and its significance.*** • ***Know what are the causes of DNA damage, and mechanism of its repair process*** • ***Understand the basics of prokaryotic and eukaryotic transcription and translation.*** • ***Comprehend the different mechanisms of generegulation in prokaryotes.***

UNIT-I [15 Lectures]

DNA Structure: DNA as genetic material: Experiments of Griffith; Avery, McCleod and McCarthy, and Hershey and Chase. RNA as genetic material: Experiment of Frankel and Singer. Structural organization of DNA and RNA

Replication: Semiconservative nature of DNA replication, DNA Replication in prokaryotes: Enzymes and steps of replication. Bidirectional and Rolling circle models of replication, Eukaryotic DNA replication in brief.

UNIT-II [15 Lectures]

DNA Damage and Repair: DNA damage- causes and types. Mechanism of DNA repair- Photo reactivation, Base-Excision repair, Nucleotide excision repair, Mismatch repair, Recombinational repair mechanism- Homologous and non-homologous.

UNIT-III [15 Lectures]

Transcription: Transcription in prokaryotes: Prokaryotic RNA polymerase, Promoter structure and transcription mechanism. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, Mechanism of transcription: initiation, elongation & Termination. Post-transcriptional Processing of RNA

Translation: Genetic code and its characteristics, Ribosomes in prokaryotes and Eukaryotes. Prokaryotic and eukaryotic translation in brief.

Regulation of Gene Expression in Prokaryotes: Operon concept-inducible and repressible systems, Positive and negative control. Structural and functional aspects of lactose, arabinose and tryptophan operon

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology, John Wiley & Sons.*
2. *De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology, Lippincott Williams and Wilkins, Philadelphia.*
3. *Watson J D et al., Molecular Biology of the Gene. Pearson Publications.*

4. *Lodish H et al., Molecular Cell Biology. Scientific American Books.*
5. *Brown T A, Genomes. Bioscientific.*
6. *Weaver Robert F, Molecular Biology. Mc Graw Hill.*
7. *Turner P C, Molecular Biology. Viva Books.*
8. *LA Allison, Fundamental Molecular Biology,Wiley , Blackwell publishing*
9. *Walker J M and Gringold EB, Molecular Biology and Biotechnology*
10. *Benjamin Lewin. Genes 1X. John Wiley*

Discipline Specific Course	
24ZOO0601P: MOLECULAR BIOLOGY LAB	**Credits: 0+1**

External Marks	**20**
Internal Marks	**10**
Total Marks	**30**
Time	**3 H**

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To introduce students to experiments in molecular biology.*** • ***The course is designed to teach students the utility of set of experimental methods in molecular biology in a problem-oriented manner.***	***After successful completion of this course, students should be able to: -*** • ***Understand the general safety routines for laboratory work in molecular biology*** • ***Operate the basic laboratory instruments and understand the preparation as well as standardization of solutions/buffers*** • ***Perform DNA Isolation, gel electrophoresis and PCR*** • ***Critically evaluate and discuss experimental results***

List of Experiments:

1. Good lab practices, preparation of buffers, reagents, stock solutions and working solutions.
2. Extraction of DNA from plant sample and its quantification.
3. Removal of RNA contamination by RNAse treatment.
4. Genomic and/or Plasmid DNA isolation from bacteria
5. Extraction and estimation of total RNA from any suitable material.
6. Qualitative and quantitative estimation of Nucleic acids by gel electrophoresis/ UV-Visible Spectroscopy.
7. Determination of molecular size of DNA
8. Experimental verification that absorption at OD260 is more for denatured DNA as compared to native double stranded DNA. Reversal of the same following DNA renaturation.
9. Amplification of DNA by Polymerase Chain reaction.
10. Restriction digestion of plant DNA using restriction enzymes.
11. Demonstration of southern /western blot
12. Melting temperature of DNA - Tm analysis.

Recommended Textbooks and References:

1. *Sawhney, S.K. & Singh, R., Introductory Practical Biochemistry, Narosa Publishing House. 2009.*
2. *Plummer, D., An Introduction to Practical Biochemistry (3rd Ed.). McGraw Hill Education.2017.*
3. *Sadasivam, S., Biochemical Method (3rd Ed.). New Age International Pvt Ltd Publishers. 2018.*
4. *Jayaraman, J., Laboratory Manual in Biochemistry. New Age International Private Limited. 2011.*

List of Value-Added Courses (VAC) for Life Science

Value-Added Course (VAC)	
24VAC0113T: BIOFERTILIZERS	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To develop an understanding of biological systems used as fertilizers and build skills in handling microbial inoculants.*** • ***To understand the optimum conditions for growth and multiplication of useful microbes*** • ***To understand the role of microbes in mineral cycling and nutrition of plants.*** • ***To gain expertise in various methods of decomposition of biodegradable waste, conversion into compost and apply this knowledge and skill in their daily life.***	***After successful completion of this course, students should be able to understand the: -*** • ***Visualize and identify different types of microorganisms with a compound microscope.*** • ***Understand the classification of microorganisms according to their shape/ structure for morphological identification.*** • ***Prepare and sterilize different types of culture media.*** • ***Isolation of microorganisms from the environmental samples and culture in aseptic conditions.***

UNIT-I [13 Lectures]

Introduction: Introduction to microbial inoculants or biofertilizers, macro and micro nutrition of plants, chemical fertilizers versus biofertilizers; Methods and steps in mass multiplication of biofertilizers: stock culture, broth culture, growth medium, fermentation, blending with the carrier, packaging, and quality check, ISI standard specification for biofertilizers; scope of biofertilizers in India.

Role of Bacteria: Study of important microbial inoculants: *Rhizobium*, *Azospirillum*, *Azotobacter*, *Actinorhizae*; Characteristics, isolation, identification, and crop response.

UNIT - II [17 Lectures]

Role of Cyanobacteria and Mycorrhizal association: Role of Cyanobacteria (blue-green algae) in rice cultivation; Azolla and Anabaena azollae association, nitrogen fixation, and factors affecting growth.

Types of mycorrhizal association, occurrence and distribution; Role of Arbuscular mycorrhizal fungi in phosphorus nutrition, growth and yield of crop plants; AMF – methods in isolation (wet sieving and decanting), identification (morphological and molecular methods). Methods of inoculum production (Pot culture and root culture).

Organic Farming: Introduction to organic farming green manuring, bio-composting, vermicomposting and their field application.

Recommended Textbooks and References:

1. *Hakeem, K. R., Dar, G. H., Mehmood, M. A., & Bhat, R. A. (2021). Microbiota and Biofertilizers. Springer.*
2. *Kannaiyan, S., Kumar, K., & Govindarajan, K. (2010). Biofertilizers Technology. Scientific Publishers.*
3. *Kaushik, B. D., Kumar, D., & Shamim, M. (Eds.). (2019). Biofertilizers +and biopesticides in sustainable agriculture. CRC Press.*
4. *Somani, L., Shilpkar, P., & Shilpkar, D. (2011). Biofertilizers: Commercial Production Technology &*

Quality Control. Agrotech Pub. Academy.
5. *Ahamed, M. I., Boddula, R., & Rezakazemi, M. (Eds.). (2021). Biofertilizers: Study and Impact. John Wiley & Sons.*
6. *Rai, M. K. (2006). Microbial biofertilizers. Haworth press, Inc, 10, 13904-1580.*

Value-Added Course (VAC)	
24VAC0313T: VERMICULTURE AND VERMICOMPOSTING	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - ***To demonstrate techniques of vermiculturing and vermicomposting and related trading and entrepreneurship***	***After successful completion of this course, students should be able to understand the: -*** • ***The characteristics, occurrence, and impact of earthworms on soil fertility and waste management.*** • ***Global and Indigenous vermicomposting methods, the role of microbes in soil fertility, and the advantages and limitations of vermitechnology.*** • ***The benefits of vermiculture products in agriculture and the economics and challenges of vermitechnology.*** • ***How to maintain a small vermicompost bin for converting kitchen waste.***

UNIT-I [15 Lectures]

Earthworm Diversity: Classification Earthworm Types: White Worm Behavior of Earthworms As Indicators of Soil Fertility, Earthworms As Bioreactors; Earthworms and Plant Growth, Organic Matter Dynamics and Nutrient Cycling, Feeding Habit and Food Vermicomposting: Advantages of Vermicomposting, Vermicomposting in Daily Life, Vermiculture Vs. Vermicomposting, Chemical Composition of Vermicompost Vermicomposting at Home and Agricultural Farm; The Business of Worms; Interaction of Vermicompost Earthworms.

UNIT-I [15 Lectures]

Earthworm Biotechnology: Fundamentals of Sustainability; Enrichment of Vermicompost and Earthworms for Sustainable Production, Earthworms in Bioremediation, Earthworms in Alternative Medicine, Earthworm Meal Production Transgenic Earthworms. Organic Farming: Eco Friendly Farming System Technologies. Evaluation Study of Ecological Constraints (Climatic and Edaphic,). Appropriate Technologies, in Agro-Forestry, Natural Management, Planted Forests, (Ranching, Farmers Perception to Organic Farming and any Case Study).

Recommended Textbooks and References:

1. *Sathe, T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.*
2. *Subha Rao, N.S. (2000). Soil Microbiology, Oxford and IBH Publishers, New Delhi.*
3. *Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad.. Ltd.*
4. *Rai, M. K. (2006). Microbial biofertilizers. Haworth press, Inc, 10, 13904-1580.*

Value-Added Course (VAC)

24VAC0413T: MEDICAL DIAGNOSTICS	Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***Provide students with insight into how doctors diagnose, predict, prevent, and treat diseases.*** • ***Teach students about various diagnostic tools, techniques, and technologies in medical practice.*** • ***Focus on selecting appropriate diagnostic methods and interpreting results for patient diagnosis.*** • ***Cover key areas like clinical chemistry, hematology, microbiology, histopathology, molecular diagnostics, and medical imaging***	***After successful completion of this course, students should be able to understand the: -*** • ***Understand the diagnosis of infectious, non-infectious, and lifestyle diseases, including tumors.*** • ***Apply histology, biochemistry, and molecular diagnostics in precision medicine.*** • ***Develop skills in hematology tests, staining procedures, and basic instrument handling.*** • ***Master clinical lab techniques for disease investigation and gain proficiency in research labs.***

UNIT-I [13 Lectures]

Introduction to Medical Diagnostics and Medical Diagnostics of body fluids Blood composition, Blood bank, Transfusion of blood, RBC, WBC and platelet count using hemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.), Analysis of urine, sputum, faeces and semen (sperm count)

UNIT - II [17 Lectures]

Medical Diagnostics of Non-infectious Diseases

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Diagnosis and detection of types of tumors (Benign/Malignant) and metastasis, FNAC

Diagnostics Microbiology and Medical Imaging

Methods to diagnose and isolate infectious agents of diseases like Tuberculosis, Hepatitis and AIDS.

Principle of Medical imaging techniques like X-Ray of Bone fracture, PET, MRI and CT scan

Recommended Textbooks and References:

1. *Park, K. (2007) Preventive and Social Medicine, B.B. Publishers*
2. *Godkar P.B. and Godkar D.P. (2005) Textbook of Medical Laboratory Technology, III Edison, Bhalani Publishing House*
3. *Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd*.

List of Skill Enhancement Courses (SEC) For Life Science

Skill Enhancement Course (SEC)	
24SEC0104T: LIFE STYLE DISORDERS	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The learning objectives of this course are as follows: • ***Introduce students to the concepts of health, nutrition, and influencing factors.*** • ***Inform students about emerging health issues impacting quality of life.*** • ***Help students understand physical and psychological disorders and their management for a healthy lifestyle.*** • ***Highlight lifestyle-related disorders, focusing on risks and remedies for improved well-being.***	***After successful completion of this course, students should be able to understand the: -*** • ***Better understanding of lifestyle choices and the diseases associated with them.*** • ***In-depth understanding of making better lifestyle decisions.*** • ***About various techniques for preliminary diagnosis of lifestyle disorders***

UNIT-I [15 Lectures]

Introduction to Lifestyle: Traditional Indian lifestyle vs modern Indian lifestyle, lifestyle diseases – definition, risk factors- erratic sleep patterns, wrong food choices, smoking, alcohol abuse, stress, lack of optimum physical activity, illicit drug use, Obesity, respiratory diseases, diet and exercise.

Diabetes, Obesity & Cardiovascular Diseases: Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes-pediatric and adolescent obesity-weight control and BMI (Body Mass Index), Prediabetes, PCOS/PCOD.

Coronary atherosclerosis-Coronary artery disease, Causes-Fat and lipid, Alcohol Abuse-Diagnosis, Electrocardiograph, Echocardiograph, Treatment, Exercise and Cardiac rehabilitation

UNIT-II [15 Lectures]

Cancer Introduction to Cancer and general diagnostic methods to detect cancer; Lung Cancer, MouthCancer: associated lifestyle choices, symptoms and treatment.

Hypertension: Risk factors, complications (brain, heart, eye and kidney) and management of hypertension.

WHO Global action plan and Monitoring: WHO Global action plan and Monitoring framework for prevention and control of non- communicable diseases, NPHCE (National Programme for the Health Care of Elderly), Fit India movement (Yoga and meditation).

Recommended Textbooks and References:

1. *James M.R, Lifestyle Medicine, 2nd Edition, CRC Press,2013,*
2. *Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition.John Wiley & Sons*
3. *Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates*
4. *Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. HarcourtAsia PTE Ltd/W.B. Saunders Company.*
5. *Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body*

SKILL ENHANCEMENT COURSE (SEC)	
24SEC0104P: LIFE STYLE DISORDERS LAB	**Credits: 0+1**

External Marks	**15**
Internal Marks	**10**
Total Marks	**25**
Time	**3H**

Course Objectives	Learning Outcomes
The learning objectives of this course are as follows: • ***Introduce students to the concepts of health, nutrition, and influencing factors.*** • ***Inform students about emerging health issues impacting quality of life.*** • ***Help students understand physical and psychological disorders and their management for a healthy lifestyle.*** • ***Highlight lifestyle-related disorders, focusing on risks and remedies for improved well-being.***	***After successful completion of this course, students should be able to understand the: -*** • ***Better understanding of lifestyle choices and the diseases associated with them.*** • ***In-depth understanding of making better lifestyle decisions.*** • ***About various techniques for preliminary diagnosis of lifestyle disorders***

List of practical:

1. Assessment of sleep quality and identify erratic patterns. (students can track their sleep patterns for a week using a sleep app or a journal)
2. Assessment of dietary choices in terms of macronutrients (carbs, proteins, fats) and their impact on health
3. Measurement of stress levels (using a stress questionnaire) before and after trying relaxation techniques such as meditation or breathing exercises.
4. Calculation of BMI and analysis if it falls in a healthy range, understanding the link between BMI, obesity, and lifestyle diseases.
5. Monitoring of blood glucose levels before and after meals relates it to diabetes.
6. Practice measuring resting pulse rate and blood pressure, and observe changes before and after moderate exercise.
7. Measurement of ECG and practice its interpretation
8. Use case studies to identify lifestyle factors (e.g., smoking, alcohol) linked to lung or mouth cancer.
9. Perform a practical on basic yoga and meditation techniques
10. Use a questionnaire to evaluate risk factors for hypertension (e.g., diet, stress, smoking).

Recommended Textbooks and References:

1. *James M.R, Lifestyle Medicine, 2nd Edition, CRC Press,2013,*
2. *Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition.John Wiley & Sons*
3. *Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates*
4. *Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. HarcourtAsia PTE Ltd/W.B. Saunders Company.*
5. *Widmaier E, Raff H and sStrang K. (2013) Vander's Human Physiology: The Mechanismof Body Functions. McGraw-Hill Education 13th Edition*

Skill Enhancement Course (SEC)	
24SEC0204T: MUSHROOM TECHNOLOGY	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The learning objectives of this course are as follows: • ***To demonstrate various types of mushroom cultivating technologies and related trading and entrepreneurship.*** • ***To make aware student about the mushroom growing techniques.*** • ***To make aware that mushrooms have medicinal and nutritional value.***	***After successful completion of this course students can utilize this training in long run to start up business in small areas.*** • ***As mushroom cultivation is a booming field, Government of India is also supporting this type of work because students can learn the techniques and small scale and large-scale industries can be established by the students.***

UNIT-I [15 Lectures]

Introduction, history: Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*. *Cordyceps militaris* Mushroom Cultivation. Cultivation Technology: Infrastructure, Type of substrates, tools, equipment, material, required, Mushroom bed preparation Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low-cost technology, Composting technology in mushroom production.

UNIT-II [15 Lectures]

Storage and nutrition: Short-term storage (Refrigeration - up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fiber content - Vitamins.

Trading and Entrepreneurship: Types of foods prepared from mushroom. Research Centres- National level and regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. Entrepreneurship.

Recommended Textbooks and References:

1. *Bahl, N. Handbook on Mushrooms (4th Ed.) Oxford & Ibh Publishing Co. Pvt Ltd. 2000.*
2. *Hirst, B. Mushrooms: A Beginners Guide to Home Cultivation. Createspace Independent Publishing Platform. 2015.*
3. *Pathak, V.N. Mushroom Production and Processing Technology (1st Ed.) Agro-bios. 2011.*
4. *Eiri Staff, E. Hand Book of Mushroom Cultivation, Processing and Packaging. Engineers India. Research Institute. 2007.*
5. *Tewari, P. and Kapoor, S.C. Mushroom cultivation. Mittal Publications, Delhi. 2018*

Skill Enhancement Course (SEC)

24SEC0204P: MUSHROOM TECHNOLOGY LAB | Credits: 0+1

External Marks	**15**
Internal Marks	**10**
Total Marks	**25**
Time	**3H**

Course Objectives	Learning Outcomes
The learning objectives of this course are as follows: • ***To demonstrate various types of mushroom cultivating technologies and related trading and entrepreneurship.*** • ***To make aware student about the mushroom growing techniques.*** • ***To make aware that mushrooms have medicinal and nutritional value.***	***As mushroom cultivation is a booming field, Government of India is also supporting this type of work because students can learn the techniques and small scale and large-scale industries can be established by the students.*** ***After successful completion of this course students can utilize this training in long run to start up business in small areas.***

List of Experiments:

1. Tests for identification of edible and non-edible mushroom
2. Demonstration of working of Autoclave.
3. Demonstration of working of Laminar Air Flow.
4. Preparation of PDA and MEA media
5. Sterilization Techniques
6. Methods of Preparation of pure culture
7. Maintenance of Pure culture
8. Preparation of mother spawn
9. Different types of substrate preparation
10. Techniques of storage

Recommended Textbooks and References:

1. *Bahl, N. Handbook on Mushrooms (4th Ed.) Oxford & Ibh Publishing Co. Pvt Ltd. 2000.*
2. *Hirst, B. Mushrooms: A Beginners Guide to Home Cultivation. Createspace Independent Publishing Platform. 2015.*
3. *Pathak, V.N. Mushroom Production and Processing Technology (1st Ed.) Agro-bios. 2011.*
4. *Eiri Staff, E. Hand Book of Mushroom Cultivation, Processing and Packaging. Engineers India. Research Institute. 2007.*
5. *Tewari, P. and Kapoor, S.C. Mushroom cultivation. Mittal Publications, Delhi. 2018*

Skill Enhancement Course (SEC)	
24SEC0304T: HERBAL TECHNOLOGY	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
Learning Objectives • ***To familiarize the budding biotechnologist with how plant products can be exploited for the wellbeing of mankind.*** • ***To introduce the students about the use of Herbal Technology as a tool to cure Indian population deprived of costly medicine.***	***Learning outcomes*** ***After successful completion of this course, students should be able to: -*** • ***Define and describe the principle of cultivation of herbal products.*** • ***Gain in-depth knowledge of major herbs, their botanical name, chemical constituents and medicinal uses.*** • ***Evaluate the drug adulteration through the biological testing.*** • ***Formulate the value-added processing / storage / quality control for the better use of herbal medicine***

UNIT-I [15 Lectures]

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Pharmacognosy - systematic position medicinal uses of the following herbs incuring various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka

UNIT-II [15 Lectures]

Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy).

Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster)

Recommended Textbooks and References:

1. *Glossary of Indian medicinal plants, R.N. Chopra, S.L. Nayar and I.C. Chopra, 1956.C.S.I.R, New Delhi.*
2. *The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984.International Book Distributors.*
3. *Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.*
4. *Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.Oxford IBH publishing Co.*
5. *Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsi dass, Delhi.*
6. *Principles of Ayurveda, Anne Green, 2000. Thomsons, London.*
7. *Pharmacognosy, Dr. C. K. Kokate et al. 1999. Nirali Prakashan*

Skill Enhancement Course (SEC)	
24SEC0304P: HERBAL TECHNOLOGY LAB	**Credits: 0+1**

External Marks	**15**
Internal Marks	**10**
Total Marks	**25**
Time	**3H**

Course Objectives	Learning Outcomes
Learning Objectives • ***To familiarize learners with how plant extracts can be made and screened for antimicrobial activity.*** • ***To acquaint students with micropropagation technique*** • ***To acquaint students with latest lab instruments***	***After successful completion of this course, students should be able to: -*** • ***Define and describe the principle and working of various laboratory instruments*** • ***Gain in-depth knowledge of major herbs, their botanical name, chemical constituents and medicinal uses.*** • ***Evaluate the impact of plant growth hormones on seed germination*** • ***Gain deep knowledge of crude extract preparation methods***

List of Experiments:

1. To prepare herbarium of 30 -40 herb/medicinal plants
2. Preparation of standard solutions (Normal, molar and percent solutions)
3. To understand the preparation of serial dilution
4. To study the principle and working of autoclave/ other lab instruments
5. To learn a) use of microscope b) principles of fixation and staining
6. To prepare plant growth hormones stock solution
7. To prepare Murashige and Skoog medium
8. To study the effect of different plant growth hormones on seed germination
9. To study the effect of various growth hormone regime on percent shoot regeneration
10. To study the crude extract preparation of medicinal plants with merceration, soxhlete, ultrasonication.
11. To study the antibacterial activity of various plant extracts
12. To study the antifungal activity of various plant extracts

Recommended Textbooks and References:

1. *Glossary of Indian medicinal plants, R. N. Chopra, S. L. Nayar and I. C. Chopra, 1956.C.S.I.R, New Delhi.*
2. *The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984.International Book Distributors.*
3. *Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.*
4. *Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.Oxford IBH publishing Co.*
5. *Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.*
6. *Principles of Ayurveda, Anne Green, 2000. Thomsons, London.*
7. *Pharmacognosy, Dr. C. K. Kokate et al. 1999. Nirali Prakashan*

List of Minor Courses

Minor Course	
24MIC0118T: LANDMARK DISCOVERIES IN BIOTECHNOLOGY	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***The objectives of this course are to know about the major landmark discoveries in the field of biotechnology and understanding the sequence of events that led to big milestones***	***After successful completion of this course, students should be able to: -*** • ***Understand the sequence of events in the history of biotechnology*** • ***Know the details of most prominent discoveries and their experimental backdrops.***

UNIT-I [15 Lectures]

DNA as the hereditary material: discovery & structure: Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; In vitro Transformation system; Discovery of DNA as the transforming Principle; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation; Additional experiments that supported DNA as the transforming principle; Hershey and Chase experiment. DNA structure elucidation: Early diffraction studies of DNA by Rosalind Franklin; Identification of DNA components by Levene, Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Linus Pauling Use of X – rays in medicines and research; Contribution of William Astbury; Maurice Wilkins; Creeth, Gulland and Jordan; Theodor Boveri and Walter Sutton.

UNIT-II [15 Lectures]

Technical advancements in molecular biology: DNA is replicated in Semi-conservative Fashion- Experimental evidences; Deciphering the Genetic Code- Nirenberg and Leder experiment; Poly U experiment by Nirenberg and Matthaei, One Gene One Enzyme Edict. Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT- PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning Development of transgenics, Genome editing technique and latest developments in the area.

Recommended Textbooks and References:

- ***Books:***
  Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). W.H. Freeman.
  Bruce Alberts ... [and others]. (1989). Molecular biology of the cell. New York :Garland Pub.
- ***Research Articles:***
  1. *Watson and Crick's 1953 paper on the structure of DNA*
  2. *Recent articles on CRISPR and its applications in biotechnology*

Minor Course

24MIC0218T: INTRODUCTORY BIOTECHNOLOGY | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To provide the students a comprehensive understanding of the concept's basic biotechnology.*** • ***To familiarize the students with the different fields of biotechnology i.e. Introduction, microbial, plant, animal, medical, environmental, nano biotechnology and bioinformatics.***	***After successful completion of this course, students should be able to: -*** • ***Understand the various types of biotechnological fields.*** • ***Compare the different methods used microbial, plant, animal, medical, environmental, nano biotechnology and bioinformatics.*** • ***Conclusively explain the various applications of the different fields of biotechnology***

UNIT-I [15 Lectures]

Biotechnology: An overview-definition, scope and importance of Biotechnology, Concept of Recombinant DNA technology and Gene Cloning.
Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

UNIT-II [15 Lectures]

Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering.
Animal Biotechnology: In-vitro fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

Recommended Textbooks and References:

1.Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
2.Natesh S., Chopra V.L. and Ramachandran S. (1987), Biotechnology in Agriculture Oxford & IBH, New Delhi.
3.Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
4.Tizard I.R. (2013) Immunology- An introduction, 5th Edition, Philadelphia Saunders College press.
5.Bhushan, Bharat (Ed.) 2012 Encyclopaedia of Nanotechnology. Springer.
6.Bhushan, Bharat (Ed.) 2010 Handbook of Nanotechnology. Springer.
7.Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
8.Singh B.D. (2010), Biotechnology, 4th edition, Kalyani Publication.
9.Black J.G (2008) Microbiology- Principles and Explorations, 7th edition, John Wiley & Sons.

Minor Course	
24MIC0318T: BIOANALYTICAL TOOLS	**Credits: 4+0**

External Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3H**

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In additional to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
The objective of this course is:- ***To teach the students about fundamentals of basic trends and techniques that utilized in different domains of biotechnology for studying different objects, analyzing data and interpretation of results***	***After successful completion of this course, students should be able to: -*** • ***To develop skills towards basic understanding and practical utility of different biophysical and biochemical techniques that are employed in numerous fields of biotechnological processes ranging from academics, R&D and industries.***

UNIT-I **[15 Lectures]**

Microscopy: Principle and working of pH meter, autoclave, laminar air flow. Fundamentals of optical microscopy: dark filed, bright field, phase contrast microscopy, fluorescence microscopy, production and applications of X rays, Limitations of optical microscopy, Electron microscopes-introduction, types and applications. Importance of vacuum in electron microscopy.

UNIT-II **[15 Lectures]**

Spectroscopy: Characteristics and applications, Principle and applications of atomic absorption and atomic emission spectroscopy, UV-visible spectroscopy, Fluorescence spectroscopy, Raman spectroscopy. Centrifugation: Principle and applications of centrifugation, Analytical and preparative centrifugation, Fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, Differential centrifugation, Density gradient centrifugation and ultracentrifugation.

UNIT-III **[15 Lectures]**

Analytical Techniques: Chromatography-introduction, types and principle. Paper chromatography, Thin layer chromatography, Column chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography, High performance liquid chromatography (HPLC).

UNIT-IV **[15 Lectures]**

Electrophoresis: Introduction to electrophoresis. Agarose-gel electrophoresis, Polyacrylamide gel (native and SDS-PAGE), Pulse field gel electrophoresis, Northern Blotting, Southern Blotting, Western blotting. ELISA, RIA. Radioisotope Techniques: Introduction to Radioisotopes and their biological applications, Radioactive Decay – Types and Measurement. Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, Radiation Dosimetry.

Recommended Textbooks and References:

1. Plummer, D. An Introduction to Practical Biochemistry. 2006.

2. Wilson & Walker. Principles and Techniques in Practical Biochemistry (5th Ed.). Cambridge University Press. 2000.

3. Hofmann, A., Wilson and Walker Principles and Techniques in Biochemistry and Molecular Biology, 8th Edition Cambridge University Press. 2018.
4. Karp, G.. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley & Sons.Inc. 2010
5. De Robertis, E.D.P. and De Robertis, E.M.F.Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.2006
6. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. 5th edition.ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.2009.
7. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.2009
8. Textbook of Biophysical Chemistry by U N Dash Macmillan Publishers India 2006.

Minor Course

24MIC0618T: RECOMBINANT DNA TECHNOLOGY	Credits: 4+0

External Marks	70
Internal Marks	30
Total Marks	100
Time	3H

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In additional to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
Learning Objectives • ***The objective of the course is to familiarize the students with the basic concepts in recombinant DNA technology; to acquaint the students to versatile tools and techniques employed in genetic engineering and to appraise them about applications of recombinant DNA technology.***	***Learning outcomes*** ***After successful completion of this course, students should be able to: -*** • ***To understand and develop the concept of recombinant DNA technique.*** • ***Will have knowledge of tools and strategies used in genetic engineering*** • ***Will understand applications of recombinant DNA technology from academic and industrial perspective*** • ***Can use and apply knowledge of genetic engineering in problem solving and in practice***

UNIT-I **[15 Lectures]**

Introduction to rDNA Technology: Recombinant DNA Technology: introduction and milestone, DNA manipulative enzymes: restriction enzymes, ligases, polymerases, polynucleotide kinase, alkaline phosphatase, Cloning: cutting of DNA molecules, joining of DNA molecules, homopolymer tails, linkers, adapters. Gene cloning vectors: salient features, plasmids, properties, types, pBR322and pUC18, bacteriophage vectors, cosmids, Artificial chromosomes: BAC, YAC, MAC. Steps for cloning a gene in *E. coli*.

UNIT-II **[15 Lectures]**

Transformation: Transformation of r-DNA into target host organisms: calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion, Particle gun bombardment. Screening and selection of recombinant host cells: blue/white screening. Construction of gene libraries: genomic and cDNA libraries, Blotting techniques, Genome mapping, DNA fingerprinting

UNIT-III **[15 Lectures]**

Polymerase Chain Reaction: Polymerase Chain Reaction (PCR) and its applications, Reverse transcription, Random and site-directed mutagenesis: Primer extension and PCR based methods ofsite directed mutagenesis, Random mutagenesis, Gene shuffling, Production of chimeric proteins,Protein engineering concepts and examples

UNIT-IV **[15 Lectures]**

Applications of rDNA Technology: Applications of rDNA technology in animals, plants/agriculture, industry and medicine/pharmacy. Risks and ethical issues in recombinant DNA technology. Social impact of recombinant DNA technology.

Recommended Textbooks and References:

1. *Brown, T. A. Gene cloning and DNA analysis: An Introduction (7th Ed.). Wiley-Blackwell. 2016.*
2. *Sambrook, J. & Green, M.R. Molecular Cloning: A laboratory manual (4th Ed.). CSHL Press. 2012.*
3. *Clark, D.P. & Pazdernik, N.J. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press,USA. 2009.*
4. *Primrose, S.B. & Twyman R.M. Principles of Gene Manipulation and Genomics (7th Ed.). BlackwellPublishing, Oxford, U.K. 2006*

Minor Course	
24MIC0127T: LANDMARK DISCOVERIES IN MICROBIOLOGY	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To understand the historical context and impact of key discoveries in microbiology.*** • ***To explore the methodologies and technologies that enabled these discoveries.*** • ***To appreciate the influence of these discoveries on modern microbiology, and medicine***	***After successful completion of this course, students should be able to: -*** • ***Students will be able to explain the significance of key discoveries in microbiology.*** • ***Students will understand the historical context of these discoveries and their impact on science and society.*** • ***Students will develop an appreciation for the role of microbiology in advancing health.***

UNIT-I [15 Lectures]

View of the invisible Biology & Origin of Life: A question

Pioneers of microbiology: Antonie van Leeuwenhoek, Robert Hooke, and the early microscopists. The role of technology in advancing microbiology (e.g., the development of the microscope). Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Scientific use of Microscopes; Compound Microscope; Development of electron Microscopy.

Germ Theory of Disease: Louis Pasteur: Disproof of spontaneous generation, Pasteurization, Robert Koch: Koch's postulates and identification of causative agents for major diseases.

UNIT-II [15 Lectures

(A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of DPT, BCG, polio, MMR, Hepatitis and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine.

Modern Frontiers in Microbiology: The human microbiome and its role in health and disease; Development of third generation of antibiotics. Advances in metagenomics and the exploration of microbial diversity.

Recommended Textbooks and References:

- ***Books:***
  1. *"Microbiology: An Evolving Science" by Joan Slonczewski and John Foster 4th edition, 2017)*
  2. *"Molecular Genetics of Bacteria" by Larry Snyder and Wendy Champness, 3rd edition, 2007*
  3. *Brock Biology of Microorganisms" by Michael Madigan and John Martinko, 14th edition, 2017*
  4. *"The Microbial World" by Roger Y. Stanier, Michael Doudoroff, and Edward A. Adelberg. "Microbe Hunters" by Paul de Kruif.*
- ***Research Articles:***
  1. *Classic papers by Pasteur, Koch, Fleming, and others.*
  2. *Winogradsky's studies on sulfur and nitrogen bacteria.*

3. *Watson and Crick's 1953 paper on the structure of DNA*
4. *Recent articles on CRISPR and its applications in biotechnology*
5. *Research papers on the use of microbes in sustainable agriculture*
6. *Articles on the human microbiome and its impact on medicine*
7. *Reviews on extremophiles and their potential for life in extreme environments.*

- ***Online Resources:***
  1. *Access to databases like PubMed, Science Direct for research papers*

Minor Course	
24MIC0227T: INTRODUCTORY MICROBIOLOGY	**Credits: 2+0**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***This course is designed to cover fundamental aspects of the microbial world, historical developments, classification of microorganisms with special emphasis on how microbes grow, divide, methods of culturing and their economic importance.***	***After successful completion of this course, students should be able to: -*** • ***Develop a good knowledge of the development of the discipline of microbiology and the contributions made by prominent scientists in this field.*** • ***Develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.*** • ***Explain the useful and harmful activities of the microorganisms.*** • ***Perform basic experiments to grow and study microorganisms in the laboratory.***

UNIT-I **[16 Lectures]**

Origin & Classification of Microbes

Origin of Microbiology: History of microbiology and introduction to the microbial world. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner.

Classification: Characteristics of microorganisms (including viruses); Binomial Nomenclature, Whittaker's five kingdom and Carl Woese three domain classification systems and their utility. Prions & Viroids, classification of bacteria-A brief account.

UNIT-II **[14 Lectures]**

Eukaryotic Microorganisms: General concept of phytoplanktons and zooplanktons. General characteristics, structure, mode of reproduction and economic importance of fungi with special reference to their application in medicine and industry. General characteristics, occurrence, structure, reproduction and importance of protozoa. Beneficial and harmful microorganisms and their role in daily life

Recommended Textbooks and References:

1. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.*
2. *Stainer, R.Y. Adelberg, E.A. & Ingrham J.L. General Microbiology (5th Ed.) Macmillan. 1987.*
3. *Davis, B.D. Dulbecco, R. Eisen, H.N. & Ginsberg H.S. Microbiology. Harper & Row publishers. 1980.*
4. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
5. *Freeman, W., Burrows, W. & Freeman B.A. Text book of Microbiology. WB Saunders Company. 1985.*
6. *Joklik, W.K., Willet, H.P., Amos, D.B. & Wilfert, C.M. Zinssers Microbiology (19th Ed.) Prentice Hall International Inc. 1988.*
7. *Vandemark, P.J. & Batzing, B.L. The microbes. The Benjamin/ Cummings publishing company, Inc. 1987.*
8. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology (8th Ed.). New York: McGraw-Hill. 2011.*
9. *Sequeira, M., Kapoor, K.K., Yadav, K.S., & Tauro, P. Introduction to Microbiology (3rd Ed.). New Age Pub., New Delhi. 2019.*

Minor Course

24MIC0327T: TECHNIQUES IN MICROBIOLOGY	Credits: 4+0

External Marks	70
Internal Marks	30
Total Marks	100
Time	3H

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In additional to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
Learning Objectives • ***To provide the students a comprehensive understanding of the various techniques in microbiology.*** • ***To familiarize the students with tools and techniques i.e. isolation and purification of microbes, sterilization techniques, microscopy and culture preservation techniques.***	***Learning outcomes*** ***After successful completion of this course, students should be able to: -*** • ***To emphasize the importance of sterilization and disinfection and the methods used in a microbiology laboratory and premises.*** • ***To familiarize with various methods for isolation, purification and preservation of microbes.*** • ***Students will be able to understand about various types of microscopy and staining procedures.*** • ***Conclusively able to understand the basic and advanced techniques in the field of microbiology.***

UNIT-I **[15 Lectures]**

Sterilization Techniques: Sterilization and disinfection techniques. Principles and methods of sterilization. Physical methods-Autoclave, Hot air oven, pressure cooker, Laminar air flow, Principles, functioning and types of Biosafety cabinets. Filter sterilization. Radiation methods-U.V rays, Gamma rays, Ultrasonic methods. Chemical methods-use of Alcohols, Aldehydes, Fumigants, Phenol, Halogens and Hypochlorides, Phenol coefficient. Definition of terms- Disinfectants, antiseptics, sanitizers, microbicides, virucide, algicide, fungicide and sporicide, microbistatic-bacteriostatic and fungistatic

UNIT-II **[15 Lectures]**

Pure Culture Techniques: Isolation of Pure culture techniques- Enrichment culture, Dilution plating, streak plate, spread plate, Micromanipulator technique. Preservation of Microbial cultures – Sub culturing, overlaying cultures with mineral oil, lyophilization, sand cultures, storage at low temperature, cryopreservation. Culture Collection Centres

UNIT-III **[15 Lectures]**

Microscopy: History of microscopy, Principles of microscopy, various types of microscopy – simple microscope, phase contrast microscope, fluorescent microscope. Ocular and stage micrometry. Size determination of microorganisms. Preparation of bacterial smears for light microscopy,

Staining procedures: Dyes and stains: Types, Physicochemical basis Fixatives, Mordants, Decolourizers; Simple and differential staining c. Special staining (Cell wall, Capsule, Lipid granules, Spores, Metachromatic granules & Flagella and nuclear staining. Hanging drop method

UNIT-IV **[15 Lectures]**

Advance Techniques: Electron microscope (SEM & TEM). TEM-specimen preparation – negative staining, shadowing, freeze-etching. Polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy. flow cytometry and GM counter.

Antibiotic susceptibility techniques: disc diffusion, agar well diffusion and Minimum Inhibitory Concentration. Metagenomics: Bacterial identification: Biochemical characterization and molecular

identification of bacteria, fungi and virus.

Recommended Textbooks and References:

1. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.*
2. *Stainer, R.Y. Adelberg, E.A. & Ingrham J.L. General Microbiology (5th Ed.) Macmillan. 1987.*
3. *Davis, B.D. Dulbecco, R.Eisen, H.N. & Ginsberg H.S. Microbiology. Harper & Row publishers. 1980.*
4. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
5. *Freeman, W., Burrows, W. & Freeman B.A. Text book of Microbiology. WB Saunders Company. 1985.*
6. *Joklik, W.K., Willet, H.P., Amos, D.B. & Wilfert, C.M. Zinssers Microbiology (19th Ed.) Prentice Hall International Inc. 1988.*
7. *Vandemark, P.J. & Batzing, B.L. The microbes. The Benjamin/ Cummings publishing company, Inc. 1987.*
8. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology (8th Ed.). New York: McGraw-Hill. 2011.*
9. *Sequeira, M., Kapoor, K.K., Yadav, K.S., & Tauro, P. Introduction to Microbiology (3rd Ed.). New Age Pub., New Delhi. 2019.*

Minor Course

24MIC0627T: FOOD MICROBIOLOGY	Credits: 4+0

External Marks	70
Internal Marks	30
Total Marks	100
Time	3H

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In additional to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
Learning Objectives • ***To equip students with theoretical understanding related to different aspects of food biotechnology.*** • ***To encourage students to learn involvement of microorganisms in foods and exploitation of microorganisms in food industries in addition to use of biotechnological tools for production of useful products including food diagnostics***	***Learning outcomes*** ***After successful completion of this course, students should be able to: -*** • ***Describe the association of microorganisms withfood and methods to control.*** • ***Discover useful microorganisms and their role infood fermentations.*** • ***Understand various biotechnological approachesfor food ingredients.*** • ***Evaluate new and rapid molecular techniques used in food diagnostics.***

UNIT-I **[15 Lectures]**

Introduction: Scope and Importance, Microorganisms associated with food, its sources, types and factors affecting growth of microorganisms in foods. Contamination of foods - chemicalcontaminants. Principles under lying food spoilage: chemical, physical and physiological changes caused by microorganisms, Spoilage of milk and meat products, Spoilage of Canned foods.

UNIT-II **[15 Lectures]**

Food Preservation: Heat processing, Low temperature storage, Control of Water activity, Modified atmosphere packaging, Irradiations, Chemical preservatives, Bio-preservatives. Fermented Food Products: Microbiology of food fermentation, Dairy fermented products, Fermented beverages: Beer wine, vinegar; Meat fermentation; Fermented vegetable and Cereal products (Tempeh, Soy sauce, Sauerkraut and Kimchi). Important Food Borne illness- Bacterial, Algal toxins and Mycotoxins- A brief account.

UNIT-III **[15 Lectures]**

Fermentation Biotechnology: Biotechnology & Functional Foods, Nutraceuticals & Nano-nutraceuticals, Single cell protein, Baker's yeast production, Biotechnology routes to food flavour production, Fumaric acid, malic acid, fat substitutes, Natural and artificial sweeteners, Bio-gums etc HACCP & Quality control.

UNIT-IV **[15 Lectures]**

Food Engineering: Protein Engineering in Food Technology- Objectives, methods, applications in food technology and limitations; Impact of Biotechnology on Microbial testing of foods- Physical & Chemical methods, New approaches in Food diagnostics- Real time PCR, BAX system, Immunological methods, Riboprinter, Biotracing etc.

Nanotechnology in Food industry for value addition and quality control

Recommended Textbooks and References:

1. *Shetty, K. & Sarkar, D. Functional Foods and Biotechnology: Biotransformation and Analysis of Functional Foods and Ingredients. CRC press. 2020.*
2. *Adams, M.R., Moss M.O. & McClure. P.J. Food Microbiology (4th Ed.). Royal Society of Chemistry, UK. 2016.*
3. *Matthews, K.R., Kniel, K.E. & Montville, T.J. Food Microbiology: An Introduction (4th Ed.). ASM Press, Washington, DC. 2019.*
4. *Goldberg, I., Williams, R.A. & Williams. R. Biotechnology and Food Ingredients. Van Nostrand Reinhold, New York. 1991.*
5. *Ricke, S., Donaldson, J.R. & Phillips, C.A.. Food Safety: Emerging Issues, Technologies and Systems.*

Academic Press. 2015

List of Vocational Courses

VOCATIONAL COURSE

24VOC0418T: BASIC CONCEPTS OF IMMUNOLOGY | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Student Learning Outcomes
The objectives of this course are: • ***To introduce the students about the history, cell and organ of the immune system, innate immunity, response of the innate immunity, antigen, Antibody and types of antibodies, TCR and types of T cells.*** • ***It will also provide an insight into Antigen Processing and presentation, MHC, hybridoma technology, hypersensitivity and autoimmunity and various new immunological techniques and Vaccines***	***After successful completion of this course, students should be able to: -*** • ***Understand general aspects of immune system, PAMP and PRR and response of the immunity.*** • ***Understand the concept of BCR, TCR, Antigen processing and presentation, MHC, hypersensitivity and autoimmunity.*** • ***Gain in-depth knowledge of important immunological techniques and different types of Vaccines***

UNIT-I **[15 Lectures]**

Basic concepts in immunology, Brief history, origin of vertebrate immune system, principal of innate immunity, principal of adaptive immunity, primary and secondary lymphoid organ, the effector mechanism of immunity

Innate immunity-first lines of defense, Anatomical barriers and initial chemical defenses, AMP, the complement system and innate immunity

Induced responses of innate immunity-pattern recognition by cells of innate immune system, respiratory brust and inflammatory responses,

Induced innate response to infection-Chemokines released by macrophage and dendritic cells, inflammation, acute phase response, Interferons induced by viral infection, NK cells, Vaccine and its type, Active and passive immunization; live, killed, attenuated, subunit vaccines

UNIT-II **[15 Lectures]**

Antigen, immunogen, heptane, adjuvants, antigen recognition by B and T cells receptor, Antibody structure and function, and types of antibodies, Monoclonal antibody, interaction of antibody molecules with specific antigen, Antigen-Antibody interaction- Agglutination, Precipitation, RIA, ELISA and its types, biological activity of antibody, Antigen recognition by T cells. Peptide binding with MHC I and II structure and function and its type, TCR, types of T cells Antigen processing and presentation to T lymphocyte, overview of hypersensitivity and Autoimmunity

Recommended Textbooks and References:

1. *Kenneth, M. & Weaver, C. Janeway's Immunobiology (10th Ed.). Garland Science. 2022.*
2. *Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (Eds.) (2012). Kuby Immunology, W.H.Freeman Publishing*
3. *Punt, J., Stranford, S., Jones, P. & Owen, J.A. Kuby Immunology (8th Ed.). Macmillan International Higher Education. 2018.*
4. *Delves, P.J., Martin, S.J., Burton, D.R. & Roitt, I.M. Roitt's Essential Immunology (13th Ed.). Wiley Blackwell. 2017.*
5. *Abbas, A.K., Lichtman, A.H. & Pillai, S. Cellular and Molecular Immunology (9th Ed.). Saunders Publication, Philadelphia. 2017.*

VOCATIONAL COURSE

24VOC0418P: BASIC CONCEPTS OF IMMUNOLOGY LAB	Credits: 0+2

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

List of Practicals

1 Separation of Plasma and Serum from Blood
2 Determination of blood group
3 To demonstrate double immune diffusion
4 To demonstrate radial immune diffusion
5 To demonstrate agglutination
6 To demonstrate immune electrophoresis
7 To demonstrate the identification of leucocytes by Giemsa stain
8 Demonstration of ELISA

Recommended Textbooks and References:

1. *Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (Eds.) (2012). Kuby Immunology, W.H.FreemanPublishing*
2. *Punt, J., Stranford, S., Jones, P. & Owen, J.A. Kuby Immunology (8th Ed.). Macmillan International Higher Education. 2018.*
3. *Delves, P.J., Martin, S.J., Burton, D.R. & Roitt, I.M. Roitt's Essential Immunology (13th Ed.). Wiley Blackwell. 2017.*
4. *Abbas, A.K., Lichtman, A.H. & Pillai, S. Cellular and Molecular Immunology (9th Ed.). Saunders Publication, Philadelphia. 2017.*

VOCATIONAL COURSE

24VOC0518T: FUNDAMENTALS OF BIOINFORMATICS | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Student Learning Outcomes
The objectives of this course are: • ***To introduce students about the bioinformatics tools of analyzing biological data and testing hypotheses using computer science algorithms.*** • ***The course will provide a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases.*** • ***This will build the foundation of sequence alignment techniques and finding evolutionary connections.***	***After successful completion of this course, students should be able to: -*** • ***Perform computational analyses of biological sequences.*** • ***Browse or retrieve gene, protein sequences and related information from biological databases.*** • ***Learn to align sequences using various approaches.*** • ***Understand the notion of similarity, identity, and gaps in the context of sequence*** • ***Alignment and deduce evolutionary relationships among sequences.***

UNIT-I **[16 Lectures]**

General Introduction: Basics of computer and information technology in context to bioinformatics, History of Bioinformatics. Goal, Scope and application of Bioinformatics, The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene.

Sequence and Phylogeny Analysis**:** Detecting Open Reading Frames, Pairwise Alignments, Introduction to BLAST, FASTA using it on the web, Interpreting results, Multiple Sequence Alignment, Introduction to molecular phylogeny and Phylogenetic Analysis

UNIT-II **[14 Lectures]**

Protein Information Sources: PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Protein Modeling, Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry

Recommended Textbooks and References:

1. *Ghosh, Z. & Bibekanand, M. Bioinformatics: Principles and Applications. Oxford University Press. 2008.*
2. *Xiong, J. Essential Bioinformatics. (1st Ed.). Cambridge University Press. 2006.*
3. *Rastogi, S.C. Bioinformatics: methods and applications (4th Ed.). PHI learning. 2013.*
4. *Pevsner, J. Bioinformatics and Functional Genomics (2nd Ed.). Wiley-Blackwell. 2009.*
5. *Campbell, A.M., & Heyer, L.J. Discovering Genomics, Proteomics and Bioinformatics (2nd Ed.). Benjamin Cummings. 2006.*

VOCATIONAL COURSE

24VOC0518P: FUNDAMENTALS OF BIOINFORMATICS LAB	Credits: 0+2

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

List of Practicals

1. Align DNA or protein sequences by BLAST to identify regions of similarity
2. Construct a phylogenetic tree to visualize evolutionary relationships between species.
3. Visualize the 3D structure of a protein by RASMOL.
4. Align multiple sequences by Clustal Omega to identify conserved regions.
5. Identify functional domains within a protein sequence.
6. Predict potential microRNA binding sites on mRNA sequences.
7. Identify and analyze Single Nucleotide Polymorphisms (SNPs) in a gene
8. Predict interactions between proteins.
9. Identify recurring sequence motifs in a set of DNA sequences.
10. Simulate PCR to predict amplicons from a given set of primers.
11. Identify and annotate genes in a given DNA sequence.
12. Predict potential promoter regions in a DNA sequence.
13. Identify enriched GO terms in a list of genes.
14. Compare the genomes of different species to identify conserved regions.
15. Predict the 3D structure of a protein based on homology to a known structure.

Recommended Textbooks and References:

1. *Rastogi, S.C. Bioinformatics: methods and applications (4th Ed.). PHI learning. 2013.*
2. *Pevsner, J. Bioinformatics and Functional Genomics (2nd Ed.). Wiley-Blackwell. 2009.*
3. *Campbell, A.M., & Heyer, L.J. Discovering Genomics, Proteomics and Bioinformatics (2nd Ed.). Benjamin Cummings. 2006.*

VOCATIONAL COURSE

24VOC0618T: INDUSTRIAL BIOTECHNOLOGY | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - ***The objectives of this course are to prepare the students for the bulk production of commercially important fermented products, industrial enzymes, vaccines and diagnostics.***	***After successful completion of this course, students should be able to understand the: -*** • ***To explain the steps involved in the bulk production of biotechnology products.*** • ***To acquire broad grounding in industrial biotechnology, the innovation opportunities in the global bio-economy and the governance of the technology as well as expertise in the area.*** • ***To design and deliver useful modern biotechnology products to the society.***

UNIT-I **[15 Lectures]**

Introduction:

Scope and historical development: Isolation, screening and preservation of Industrial cultures, genetic improvement of industrially important microorganisms, culture collections. Batch, fed-batch and continuous cultures, fermentation, growth kinetics.

Fermentation: fermentation Media, Bioreactor design, Instrumentation and control. Sterilization and downstream processing.

UNIT - II **[15 Lectures]**

Immobilization: Immobilization of enzymes and cells, and their application. Production of vaccines, amino acids (glutamic acid), organic acids (Acetic acid and citric acid), antibiotics (penicillin).

Microbial Technology: Fermented beverages (Beer & Wine), production of single cell protein, silage production, waste water treatment, aerobic & anaerobic. Use of computers in fermentation operations.

Recommended Textbooks and References:

1. *Alberghina, L. Protein Engineering for Industrial Biotechnology. Routledge. 2000.*
2. *Kun, L.Y. Microbial Biotechnology. World Scientific Publisher. 2006.*
3. *Singh, R. & Ghosh, S.K. Industrial Biotechnoogy. Global Vision Publ. House. 2004.*
4. *Thomson, J. Your Guide to Industrial Biotechnology. Abhishek Publication. 2006.*

VOCATIONAL COURSE

24VOC0618P: INDUSTRIAL BIOTECHNOLOGY Lab	Credits: 0+2

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

Course Objectives	Learning Outcomes
Learning Objectives • ***To familiarize learners with how plant extracts can be made and screened for antimicrobial activity.*** • ***To acquaint students with micropropagation technique*** • ***To acquaint students with latest lab instruments***	***After successful completion of this course, students should be able to: -*** • ***Define and describe the principle and working of various laboratory instruments*** • ***Gain in-depth knowledge of major herbs, their botanical name, chemical constituents and medicinal uses.*** • ***Evaluate the impact of plant growth hormones on seed germination*** • ***Gain deep knowledge of crude extract preparation methods***

List of Experiments:

1. Isolation of industrially important microorganisms (lactic acid bacteria, yeast)
2. Isolation of protease producing microorganisms
3. Microbial production of wine
4. Microbial production of alcohol
5. Microbial production of lactic acid
6. Isolation of antibiotic producing microrganisms
7. Microbial production of antibiotics
8. Demonstration of working of bioreactor, instrumentation & control
9. Production of fermentation media (inoculum media & fermentation media)
10. Demonstration of scale-up stages of Baker's yeast production
11. Production of yoghurt

Recommended Textbooks and References:

1. *Glossary of Indian medicinal plants, R. N. Chopra, S. L. Nayar and I. C. Chopra, 1956.C.S.I.R, New Delhi.*
2. *The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984.International Book Distributors.*
3. *Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.*
4. *Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.Oxford IBH publishing Co.*
5. *Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.*
6. *Principles of Ayurveda, Anne Green, 2000. Thomsons, London.*
7. *Pharmacognosy, Dr. C. K. Kokate et al. 1999. Nirali Prakashan*

VOCATIONAL COURSE

24VOC0427T: FUNDAMENTALS OF IMMUNOLOGY | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Student Learning Outcomes
The objectives of this course are: • ***To introduce the students about the history, cell and organ of the immune system, innate immunity, response of the innate immunity, antigen, Antibody and types of antibodies, TCR and types of T cells.*** • ***It will also provide an insight into Antigen Processing and presentation, MHC, hybridoma technology, hypersensitivity and autoimmunity and various new immunological techniques and Vaccines***	***After successful completion of this course, students should be able to: -*** • ***Understand general aspects of immune system, PAMP and PRR and response of the immunity.*** • ***Understand the concept of BCR, TCR, Antigen processing and presentation, MHC, hypersensitivity and autoimmunity.*** • ***Gain in-depth knowledge of important immunological techniques and different types of Vaccines***

UNIT-I **[15 Lectures]**

Basic concepts in immunology, Brief history, origin of vertebrate immune system, principal of innate immunity, principal of adaptive immunity, primary and secondary lymphoid organ, the effector mechanism of immunity

Innate immunity-first lines of defense, Anatomical barriers and initial chemical defenses, AMP, the complement system and innate immunity

Induced responses of innate immunity-pattern recognition by cells of innate immune system, respiratory brust and inflammatory responses,

Induced innate response to infection-Chemokines released by macrophage and dendritic cells, inflammation, acute phase response, Interferons induced by viral infection, NK cells, Vaccine and its type, Active and passive immunization; live, killed, attenuated, subunit vaccines

UNIT-II **[15 Lectures]**

Antigen, immunogen, heptane, adjuvants, antigen recognition by B and T cells receptor, Antibody structure and function, and types of antibodies, Monoclonal antibody, interaction of antibody molecules with specific antigen, Antigen-Antibody interaction- Agglutination, Precipitation, RIA, ELISA and its types, biological activity of antibody, Antigen recognition by T cells. Peptide binding with MHC I and II structure and function and its type, TCR, types of T cells Antigen processing and presentation to T lymphocyte, overview of hypersensitivity and Autoimmunity

Recommended Textbooks and References:

1. *Kenneth, M. & Weaver, C. Janeway's Immunobiology (10th Ed.). Garland Science. 2022.*
2. *Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (Eds.) (2012). Kuby Immunology, W.H.Freeman Publishing*
3. *Punt, J., Stranford, S., Jones, P. & Owen, J.A. Kuby Immunology (8th Ed.). Macmillan International Higher Education. 2018.*
4. *Delves, P.J., Martin, S.J., Burton, D.R. & Roitt, I.M. Roitt's Essential Immunology (13th Ed.). Wiley Blackwell. 2017.*
5. *Abbas, A.K., Lichtman, A.H. & Pillai, S. Cellular and Molecular Immunology (9th Ed.). Saunders*

Publication, Philadelphia. 2017.

VOCATIONAL COURSE	
24VOC0427P: FUNDAMENTALS OF IMMUNOLOGY LAB	**Credits: 0+2**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

List of Practicals

1 Separation of Plasma and Serum from Blood

2 Determination of blood group

3 To demonstrate double immune diffusion

4 To demonstrate radial immune diffusion

5 To demonstrate agglutination

6 To demonstrate immune electrophoresis

7 To demonstrate the identification of leucocytes by Giemsa stain

8 Demonstration of ELISA

Recommended Textbooks and References:

1. *Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (Eds.) (2012). Kuby Immunology, W.H.Freeman Publishing*
2. *Punt, J., Stranford, S., Jones, P. & Owen, J.A. Kuby Immunology (8th Ed.). Macmillan International Higher Education. 2018.*
3. *Delves, P.J., Martin, S.J., Burton, D.R. & Roitt, I.M. Roitt's Essential Immunology (13th Ed.). Wiley Blackwell. 2017.*
4. *Abbas, A.K., Lichtman, A.H. & Pillai, S. Cellular and Molecular Immunology (9th Ed.). Saunders Publication, Philadelphia. 2017.*

VOCATIONAL COURSE

24VOC0527T: BASIC CONCEPTS OF BIOINFORMATICS | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Student Learning Outcomes
The objectives of this course are: • ***To introduce students about the bioinformatics tools of analyzing biological data and testing hypotheses using computer science algorithms.*** • ***The course will provide a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases.*** • ***This will build the foundation of sequence alignment techniques and finding evolutionary connections.***	***After successful completion of this course, students should be able to: -*** • ***Perform computational analyses of biological sequences.*** • ***Browse or retrieve gene, protein sequences and related information from biological databases.*** • ***Learn to align sequences using various approaches.*** • ***Understand the notion of similarity, identity, and gaps in the context of sequence*** • ***alignment and deduce evolutionary relationships among sequences.***

UNIT-I **[16 Lectures]**

General Introduction: Basics of computer and information technology in context to bioinformatics, History of Bioinformatics. Goal, Scope and application of Bioinformatics, The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene.
Sequence and Phylogeny Analysis: Detecting Open Reading Frames, Pairwise Alignments, Introduction to BLAST, FASTA using it on the web, Interpreting results, Multiple Sequence Alignment, Introduction to molecular phylogeny and Phylogenetic Analysis.

UNIT-II **[14 Lectures]**

Protein Information Sources: PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Protein Modeling, Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry

Recommended Textbooks and References:

1. *Ghosh, Z. & Bibekanand, M. Bioinformatics: Principles and Applications. Oxford University Press. 2008.*
2. *Xiong, J. Essential Bioinformatics. (1st Ed.). Cambridge University Press. 2006.*
3. *Rastogi, S.C. Bioinformatics: methods and applications (4th Ed.). PHI learning. 2013.*
4. *Pevsner, J. Bioinformatics and Functional Genomics (2nd Ed.). Wiley-Blackwell. 2009.*
5. *Campbell, A.M., & Heyer, L.J. Discovering Genomics, Proteomics and Bioinformatics (2nd Ed.). Benjamin Cummings. 2006.*

VOCATIONAL COURSE

24VOC0527P: BASIC CONCEPTS OF BIOINFORMATICS LAB	Credits: 0+2

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

List of Practicals

1. Align DNA or protein sequences by BLAST to identify regions of similarity
2. Construct a phylogenetic tree to visualize evolutionary relationships between species.
3. Visualize the 3D structure of a protein by RASMOL.
4. Align multiple sequences by Clustal Omega to identify conserved regions.
5. Identify functional domains within a protein sequence.
6. Predict potential microRNA binding sites on mRNA sequences.
7. Identify and analyze Single Nucleotide Polymorphisms (SNPs) in a gene
8. Predict interactions between proteins.
9. Identify recurring sequence motifs in a set of DNA sequences.
10. Simulate PCR to predict amplicons from a given set of primers.
11. Identify and annotate genes in a given DNA sequence.
12. Predict potential promoter regions in a DNA sequence.
13. Identify enriched GO terms in a list of genes.
14. Compare the genomes of different species to identify conserved regions.
15. Predict the 3D structure of a protein based on homology to a known structure.

Recommended Textbooks and References:

1. *Rastogi, S.C. Bioinformatics: methods and applications (4th Ed.). PHI learning. 2013.*
2. *Pevsner, J. Bioinformatics and Functional Genomics (2nd Ed.). Wiley-Blackwell. 2009.*
3. *Campbell, A.M., & Heyer, L.J. Discovering Genomics, Proteomics and Bioinformatics (2nd Ed.). Benjamin Cummings. 2006.*

VOCATIONAL COURSE

24VOC0627T: INDUSTRIAL MICROBIOLOGY | Credits: 2+0

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**2H**

Note: The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In additional to that four more questions will be set, two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1.

Course Objectives	Learning Outcomes
The objectives of this course are: - ***To educate students about the fundamental concepts of industrial microbiology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of fermentation industry.***	***After successful completion of this course, students should be able to understand the: -*** • ***The industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.*** • ***Attains knowledge about designing of industrial strains and various media optimization strategies*** • ***Learns about the design, types of fermenters and various components of bioreactors*** • ***Acquire knowledge about critical various industrially relevant microbial products and their production process***

UNIT-I [15 Lectures]

Introduction: Scope and historical development: Isolation, screening and preservation of Industrial cultures, genetic improvement of industrially important microorganisms, culture collections. Batch, fed-batch and continuous cultures, fermentation, growth kinetics.

Fermentation: fermentation Media, Bioreactor design, Instrumentation and control. Sterilization and downstream processing.

UNIT - II [15 Lectures]

Immobilization: Immobilization of enzymes and cells, and their application. Production of vaccines, amino acids (glutamic acid), organic acids (Acetic acid and citric acid), antibiotics (penicillin).

Microbial Technology: Fermented beverages (Beer & Wine), production of single cell protein, silage production, waste water treatment, aerobic & anaerobic. Use of computers in fermentation operations.

Recommended Textbooks and References:

1. *Stanbury, P.F., Hall, S., Whitaker, A., Principles of Fermentation Technology (3rd Ed.). Butterworth Heinemann Ltd., Elsevier. 2016.*
2. *Ward, O.P., Fermentation Biotechnology - Principles, Process and Products. Prentice Hall Publishing, New Jersey. 1999.*
3. *Rehm, H.J., Reed, G.B., Puehler, A. & Stadler, Biotechnology, Vol. 1-8, VCH Publication. 1993.*
4. *Prescott, S.C. & Dunn, G.C., Prescott and Dunn's Industrial Microbiology (4th Ed.). CBS Publication, New Delhi. 1992*
5. *Demain, A.I. & Davies, J. E., Manual of Industrial Microbiology and Biotechnology (2nd Ed.), ASM Press, Washington D.C. 1999.*
6. *Glazer, A.N. & Nikaido, H., Microbial Biotechnology: Fundamentals of Applied Microbiology. WH Freeman & Company, New York. 1998.*
7. *Cruger, W. & Kruger, A., Biotechnology -A Textbook of Industrial Microbiology (2nd Ed.). Panima*

Publishing Corporation, New Delhi. 2002.
8. Clarke, W., Industrial Microbiology. CBS Publisher and Distributors PVT .LTD New Delhi. 2016.

VOCATIONAL COURSE	
24VOC0627P: INDUSTRIAL MICROBIOLOGY Lab	**Credits: 0+2**

External Marks	**35**
Internal Marks	**15**
Total Marks	**50**
Time	**3H**

Course Objectives	Learning Outcomes
Learning Objectives • ***To familiarize learners with how plant extracts can be made and screened for antimicrobial activity.*** • ***To acquaint students with micropropagation technique*** • ***To acquaint students with latest lab instruments***	***After successful completion of this course, students should be able to: -*** • ***Define and describe the principle and working of various laboratory instruments*** • ***Gain in-depth knowledge of major herbs, their botanical name, chemical constituents and medicinal uses.*** • ***Evaluate the impact of plant growth hormones on seed germination*** • ***Gain deep knowledge of crude extract preparation methods***

List of Experiments:

1. Isolation of industrially important microorganisms (lactic acid bacteria, yeast)
2. Isolation of protease producing microorganisms
3. Microbial production of wine
4. Microbial production of alcohol
5. Microbial production of lactic acid
6. Isolation of antibiotic producing microrganisms
7. Microbial production of antibiotics
8. Demonstration of working of bioreactor, instrumentation & control
9. Production of fermentation media (inoculum media & fermentation media)
10. Demonstration of scale-up stages of Baker's yeast production
11. Production of yoghurt

Recommended Textbooks and References:

1. *Glossary of Indian medicinal plants, R. N. Chopra, S. L. Nayar and I. C. Chopra, 1956.C.S.I.R, New Delhi.*
2. *The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984.International Book Distributors.*
3. *Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.*
4. *Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.Oxford IBH publishing Co.*
5. *Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.*
6. *Principles of Ayurveda, Anne Green, 2000. Thomsons, London.*
7. *Pharmacognosy, Dr. C. K. Kokate et al. 1999. Nirali Prakashan*

List of Multi-Disciplinary Courses (MDC)

Multi-Disciplinary Course (MDC)

24MDC0104T: FUNDAMENTALS OF BIOLOGY	Credits: 3+0

External Marks	**50**
Internal Marks	**25**
Total Marks	**75**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: • ***To sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules*** • ***The course shall make the students aware of various theories of origin of life and evolution and to understand various biological processes***	***After successful completion of this course, students should be able to:*** • ***Learn about biomolecule, prokaryotic and eukaryotic cell and cell organelles, cell membrane and transport across the membrane, cell division*** • ***Understand origin of life and various theories of evolution and documentary evidence***

UNIT-I **[15 Lectures]**

Molecules of Life: pH and Buffers in Biology. Chemistry of water. Chemical Bonding and various types of bonds, Carbohydrate: Sugars and polysaccharides. Lipids: Fat, phospholipids and steroids. Proteins: polypeptides, protein confirmation and function. Nucleic acids as information molecules. DNA and RNA.

UNIT-II **[15 Lectures]**

Cell Structure and Cell Processes: Prokaryotic cells and eukaryotic cells Organelles of eukaryotic cell: Nucleus, endoplasmic reticulum, Golgi apparatus, vesicles, peroxisomes, Mitochondria and Plastid. The evolution of eukaryotic organelles.

Membranes as Fluid Layers of Lipid: The phospholipids bilayer. The fluid mosaic model. Model Membranes Membrane proteins. Passive transport across membranes: Diffusion, facilitated diffusion, Osmosis. Active transport

UNIT-III **[15 Lectures]**

Origin of Life and Evolution: Different theories of origin of life, Experimental evidences supporting different theories. Lamarck, Darwinism and other theories of evolution, Documentary evidences supporting different evolution theories.

Recommended Textbooks and References:

1. *Campbell, N.A. & Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*
2. *Raven, P., Johnson, G., Mason, K., Losos, J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*

Multi-Disciplinary Course (MDC)	
24MDC0204T: CYTOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**25**
Total Marks	**75**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: ***Structure and function of various cellular compartment and organelles Fundamentals of transport of biomolecule inside the cell and its cytoskeleton.***	***The Learning Outcomes of this course are as follows:*** • ***Students will learn about how the cell has evolved and the basic types of cells present.*** • ***Students will acquire insights into the composition and structure of cell membrane by navigating through various proposed cell models. Students will also learn the functions in detail about the processes of transport across cell membranes.*** • ***Students will learn about the structure and function of various cellular compartments and organelles along with the concept to protein sorting and distribution in unique ways.***

UNIT-I **[15 Lectures]**

Overview of Cells: Prokaryotic and eukaryotic cells, Plasma Membrane: Various models of plasma membrane, Transport across membranes: Active and Passive transport, Facilitated transport. Cytoskeleton: Structure and functions of microtubules, microfilaments and Intermediate filaments.

UNIT-II **[15 Lectures]**

Endomembrane System: Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Peroxisomes. Vesicular transport from ER to Golgi apparatus, Protein sorting and transport from Golgi apparatus.

UNIT-III **[15 Lectures]**

Mitochondria and Chloroplast: Mitochondria: Structure and Function, Endosymbiotic hypothesis. Chloroplast: Structure, function and composition; Chloroplast DNA, Semiautonomous nature of mitochondria and chloroplast. Nucleus: Structure of Nucleus: Chromatin: euchromatin and heterochromatin and packaging (nucleosome). Nucleolus and ribosome formation.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the cell (6th Ed.). Garland Science. 2014.*
3. *Cooper, G.M. The Cell: A Molecular Approach (8th Ed.) Oxford University Press. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12 th Ed.). Pearson Benjamin Cummings, San Francisco. 2020*

Multi-Disciplinary Course (MDC)	
24MDC0304T: INTRODUCTION TO BIOTECHNOLOGY	**Credits: 3+0**

External Marks	**50**
Internal Marks	**25**
Total Marks	**75**
Time	**2.5 H**

Note: The examiner is required to set seven questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In additional to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks i.e 12.5 marks

Course Objectives	Learning Outcomes
The objectives of this course are: • ***To provide the students a comprehensive understanding of the concept's basic biotechnology.*** • ***To familiarize the students with the different fields of biotechnology i.e. Introduction, microbial, plant, animal, environmental.***	***The Learning Outcomes of this course are as follows:*** • ***Understand the various types of biotechnological fields.*** • ***Compare the different methods used microbial, plant, animal, environmental.*** • ***Conclusively explain the various applications of the different fields of biotechnology***

UNIT-I **[15 Lectures]**

Biotechnology: An overview-definition, scope and importance of Biotechnology, Concept of Recombinant DNA technology and Gene Cloning.

Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

UNIT-II **[15 Lectures]**

Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction).

Animal Biotechnology: *In-vitro* fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

UNIT-III **[15 Lectures]**

Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

Recommended Textbooks and References:

1. *Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.*
2. *Natesh S., Chopra V.L. and Ramachandran S. (1987), Biotechnology in Agriculture Oxford & IBH, New Delhi.*
3. *Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.*
4. *Tizard I.R. (2013) Immunology- An introduction, 5th Edition, Philadelphia Saunders College press.*
5. *Bhushan, Bharat (Ed.) 2012 Encyclopedia of Nanotechnology. Springer.*
6. *Bhushan, Bharat (Ed.) 2010 Handbook of Nanotechnology. Springer.*
7. *Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.*
8. *Singh B.D. (2010), Biotechnology, 4th edition, Kalyani Publication.*
9. *Black J.G (2008) Microbiology- Principles and Explorations, 7th edition, John Wiley & Sons*

List of Minor Courses (MIN) for Scheme C (UTD)

MINOR COURSE (MIN)

24MIN0127T Landmark Discoveries in Microbiology | Credits: 4+0

External Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In additional to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
The objectives of this course are: - • ***To understand the historical context and impact of key discoveries in microbiology.*** • ***To explore the methodologies and technologies that enabled these discoveries.*** • ***To appreciate the influence of these discoveries on modern microbiology, and medicine***	***After successful completion of this course, students should be able to: -*** • ***Students will be able to explain the significance of key discoveries in microbiology.*** • ***Students will understand the historical context of these discoveries and their impact on science and society.*** • ***Students will develop an appreciation for the role of microbiology in advancing health.***

UNIT-I **[15 Lectures]**

Invisible Biology & Origin of Life: Pioneers of microbiology: Antonie van Leeuwenhoek, Robert Hooke, and the early microscopists. The role of technology in advancing microbiology (e.g., the development of the microscope). Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Scientific use of Microscopes; Compound Microscope; Development of electron Microscopy.

UNIT-II **[15 Lectures]**

Origin and evolution of microbial world: Pathway of discovery in Microbiology; Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese. Germ Theory of Disease: Louis Pasteur: Disproof of spontaneous generation, Pasteurization, Robert Koch: Koch's postulates and identification of causative agents for major diseases.

UNIT-III **[15 Lectures]**

Microbiology as a Backbone of Health Science: A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of DPT, BCG, polio, MMR, Hepatitis and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine.

UNIT-IV **[15 Lectures]**

Modern Frontiers in Microbiology & Molecular Biology: The human microbiome and its role in health and disease; Development of third generation of antibiotics. Advances in metagenomics and the exploration of microbial diversity. Polymerase Chain Reaction-a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT- PCR for RNA amplification; Advent of gene cloning, Development of transgenics, Genome editing technique and latest developments in the area.

Recommended Textbooks and References:

1. *Microbiology: An Evolving Science by Joan Slonczewski and John Foster 4th edition, 2017*
2. *Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd edition, 2007*
3. *Brock Biology of Microorganisms by Michael Madigan and John Martinko, 14th edition, 2017*
4. *The Microbial World by Roger Y. Stanier, Michael Doudoroff, and Edward A. Adelberg. "Microbe Hunters" by Paul de Kruif*

Minor Course	
24MIN0227T: INTRODUCTORY MICROBIOLOGY	**Credits: 4+0**

External Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3H**

Note: The examiner is required to set nine questions in all. The first question will be compulsory consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two questions from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 1. All questions shall carry equal marks.

Course Objectives	Learning Outcomes
This course is designed to cover fundamental aspects of the microbial world, historical developments, and classification of microorganisms with special emphasis on how microbes grow, divide, methods of culturing and their economic importance.	***After successful completion of this course, students will be able to: -*** • ***Develop a good knowledge of the development of the discipline of microbiology and the contributions made by prominent scientists in this field.*** • ***Develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.*** • ***Explain the useful and harmful activities of the microorganisms.*** • ***Perform basic experiments to grow and study microorganisms in the laboratory.***

UNIT-I **[15 Lectures]**

Origin of Microbiology: History of microbiology and introduction to the microbial world. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner, Bacterial growth.

UNIT-II **[15 Lectures]**

Classification: Physiochemical and biological characteristics of microorganisms (including viruses); Baltimore classification of viruses. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese three domain classification systems and their utility. General characteristics of Cellular microorganisms, wall-less forms (mycoplasma and spheroplasts) with emphasis on distribution and occurrence, morphology, Mode of reproduction and economic importance. Classification of bacteria-a brief account.

UNIT-III **[15 Lectures]**

Eukaryotic Microorganisms: General concept of phytoplanktons and zooplanktons. General characteristics, structure, mode of reproduction and economic importance of fungi with special reference to their application in medicine and industry. General characteristics, occurrence, structure, reproduction and importance of protozoa.

UNIT-IV **[15 Lectures]**

Microbial Methods: Methods of studying microorganism; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. Sterilization techniques (physical & chemical sterilization). Culture media and conditions for microbial growth. Pure culture isolation: Streaking, serial dilution and plating methods; Cultivation, Maintenance and preservation of pure cultures.
Beneficial and harmful microorganisms and their role in daily life. Concept of disease in plant and animal caused by microorganism.

Recommended Textbooks and References:

1. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of*

Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.

2. *Stainer, R.Y. Adelberg, E.A. & Ingrham J.L. General Microbiology (5th Ed.) Macmillan. 1987.*
3. *Davis, B.D. Dulbecco, R.Eisen, H.N. & Ginsberg H.S. Microbiology. Harper & Row publishers. 1980.*
4. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
5. *Freeman, W., Burrows, W. & Freeman B.A. Text book of Microbiology. WB Saunders Company. 1985.*
6. *Joklik, W.K., Willet, H.P., Amos, D.B. & Wilfert, C.M. Zinssers Microbiology (19th Ed.) Prentice Hall International Inc. 1988.*
7. *Vandemark, P.J. & Batzing, B.L. The microbes. The Benjamin/ Cummings publishing company, Inc. 1987.*
8. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology (8th Ed.). New York: McGraw-Hill. 2011.*
9. *Sequeira, M., Kapoor, K.K., Yadav, K.S., & Tauro, P. Introduction to Microbiology (3rd Ed.). New Age Pub., New Delhi. 2019.*