Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)

Ganeshkhind, Pune – 411 016

Affiliated to SPPU

B.Sc. (Chemistry)
(Three Years Integrated Degree Program)

T. Y. B. Sc. CHEMISTRY

From Academic year 2025-26

Board of Studies in Chemistry
Modern College of Arts, Science and Commerce, (Autonomous)
Ganeshkhind, Pune – 16

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

Sem	Credits related to Major					Minor	OE	SEC	AEC	VEC	CC	Total
5	Mandatory	Elective	VSC	IKS	FP / CEP / OJT		0	0	0	0	0	22
Vertical	V-1	V-1	V-4	V-5	V-6	V-2	V-3	V-4	V-5	V-5	V-6	
5	4 (T) + 2 (T) + 4 (P) CHE35101: Advanced Physical Chemistry-I (2C) CHE35102: - Advanced Inorganic Chemistry-I (2C) CHE35103: Advanced Organic Chemistry-I (2C) CHE35104: Physical Chemistry Practical-I (2C) CHE35105: Organic Chemistry Practical-I (2C)	2 (T) + 2 (T/P) CHE35106A: Chemistry of Biomolecules (2C) OR CHE35106B: Introduction to Medicinal Chemistry (2C) CHE35107: Inorganic Chemistry Practical-I (2C)	2 (P) CHE35408 Chemistry Software Practical (2C)	0	2 (FP/CEP) CHE35609 FP/ CEP- (2C)	2 (T) + 2 (P) CHE35210: Concepts of Physical and Inorganic Chemistry (2C) CHE35211: Analytical Chemistry Practical-I (2C)	0	0	0	0	0	22
6	4 (T) + 2 (T) + 4 (P) CHE36101: Advanced Physical Chemistry-II (2C) CHE36102: Advanced Inorganic Chemistry-II (2C) CHE36103: - Advanced Organic Chemistry-II (2C) CHE36104: Physical Chemistry Practical-II (2C) CHE36105 Organic Chemistry Practical-II (2C)	2 (T) + 2 (T/P) CHE36106 A: Polymer Chemistry (2C) OR CHE36106 B: Analytical Chemistry (2C) CHE36107 : Inorganic Chemistry Practical-II (2C)	0	0	CHE36608: OJT (4C)	2 (T) + 2 (P) CHE36209: Concepts of Organic and Analytical Chemistry- (2C) CHE36210: Analytical Chemistry Practical-II (2C)	0	0	0	0	0	22

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

Structure of T. Y. B. Sc. Chemistry
(NEP Version 1)

Semester	Paper Code	Code and Title	Credits, Lectures
V	CHE-35101	Advanced Physical Chemistry-I	Credit-2, 30 hrs
	CHE-35102	Advanced Inorganic Chemistry-I	Credit-2, 30 hrs
	CHE-35103	Advanced Organic Chemistry - I	Credit-2, 30 hrs
	CHE-35104	Physical Chemistry Practical - I	Credit-2, 60 hrs
	CHE-35105	Organic Chemistry Practical - I	Credit-2, 60 hrs
	CHE-35106A	**ELE** Chemistry of Biomolecules	Credit-2, 30 hrs
	CHE-35106B	**ELE** Introduction to Medicinal Chemistry	Credit-2, 30 hrs
	CHE-35107	Inorganic Chemistry Practical-I	Credit-2, 60 hrs
	CHE-35408	Chemistry Software Practical	Credit-2, 60 hrs
	CHE-35609	FP/CEP	Credit-2, 30 hrs
	CHE-35210	Concepts of Physical and Inorganic Chemistry	Credit-2, 30 hrs
	CHE-35211	Analytical Chemistry Practical-1	Credit-2, 60 hrs
VI	CHE-36101	Advanced Physical Chemistry - II	Credit-2, 30 hrs
	CHE-36102	Advanced Inorganic Chemistry-II	Credit-2, 30 hrs
	CHE-36103	Advanced Organic Chemistry - II	Credit-2, 30 hrs
	CHE-36104	Physical Chemistry Practical - II	Credit-2, 60 hrs
	CHE-36105	Organic Chemistry Practical - II	Credit-2, 60 hrs
	CHE-36106A	**ELE** Polymer Chemistry	Credit-2, 30 hrs
	CHE-36106B	**ELE** Analytical Chemistry	Credit-2, 30 hrs
	CHE-36107	Inorganic Chemistry Practical - II	Credit-2, 60 hrs
	CHE-36608	OJT	Credit-4, 120 hrs
	CHE-36209	Concepts of Organic and Analytical Chemistry	Credit-2, 30 hrs
	CHE-36210	Analytical Chemistry Practical - II	Credit-2, 60 hrs

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

Important points:

i. Each credit is equivalent to 15 lectures of 60 minutes for theory courses and 30 lectures of 60 minutes for practical courses.
ii. There will be 10 practical sessions per semester of 4 hours each.
iii. Total weeks for teaching and internal evaluation are15. Out of the 15 weeks, 12 weeks for teaching and 03 weeks for internal evaluation. (Theory as well as Practical).

Evaluation Pattern (NEP 1 Autonomous 2022 Pattern)

1. Each theory and practical course carry 50 marks equivalent to 2 credits.
2. Each course will be evaluated with Continuous Internal Assessment (CIA) and End Semester Examination (ESE)
3. Continuous internal assessment shall be of 20 marks (40%) while End Semester Examination shall be of 30 marks (60%).
4. To pass each course, a student has to secure a 40% mark in continuous assessment as well as End Semester Examination i.e. minimum 08 marks in continuous assessment and 12 in End Semester Examination in the respective course.
5. Method of assessment for internal exams: written test, MCQ type test, Viva-Voce, Project, survey, field visits, tutorials, assignments, group discussion, etc. (on approval of the head of centre).

Preamble:

The syllabus of Chemistry for third year has been redesigned for Choice Based Credit System (NEP 2020 pattern) and to be implemented from academic year 2025-26. The (NEP 2020 pattern semester system has been adopted for B. Sc. degree programme. Different types of courses are introduced at degree level viz. Major, Minor, Vocational Skill Course (VSC), Field Project (FP), Community Engagement and Services (CEP) and On Job Training (OJT). The courses in each of these catagories are designed for subject knowledge, skill enhancements and better employability. It will also help the students to develop research aptitude and become globally competent.

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

SEMESTER-V

CHE35101: Advanced Physical Chemistry- I

[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lectures
1	Quantum Chemistry	10
2	Investigation of Molecular structure	10
3	Photochemistry	10
	Total	**30**

Course Outcomes

CO1: Students will become familiar with Quantum Chemistry and its significance.

CO2: Students will learn use of molecular spectroscopy in determination of a molecular structure.

CO3: Students will understand the laws of photochemistry and various types and tools.

CO4: Students should be able to solve numerical problems.

1. Quantum Chemistry [10 L]

Introduction, de Broglie hypothesis, The Heisenberg's uncertainty principle, quantisation of energy, Operators, Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the ψ and ψ2, sketching of wave function and probability densities for 1D box, degeneracy, applications to conjugated systems, zero-point energy and quantum tunneling, Numericals.

Expected Learning Outcomes:

After successful completion, students will be able to:

1. Know the history of development of quantum mechanics in chemistry.
2. Understanding of De Broglie hypothesis and the uncertainty principle
3. Understanding the operators: Position, momentum and energy
4. Solving Schrodinger equation for 1D, 2D and 3D model

Reference books:

1. Principles of Physical Chemistry by Puri, Sharma, Pathania,; (Page No: 21-110)
2. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 50-58)

2. Investigation of Molecular structure [10L]

Introduction: Molar refraction and molecular structure, Dipole moment and molecular structure, electromagnetic spectrum, energy of molecules, Types of molecular spectra.

Microwave Spectroscopy: Introduction, Classification of molecules on the basis of moment of Inertia, Rotational spectra of rigid diatomic molecules, relative intensities of spectral lines, effect of isotopic substitution on the rotational spectra, Determination of bond length and moment of inertia from rotational spectra, Problems.

Infrared Spectroscopy: Introduction, Simple Harmonic oscillator, Modes of vibration, force constant, Vibrational spectrum of a diatomic molecule: Vibrational Energy expression, Allowed vibrational energies, zero-point energy, Selection rule, Vibrational energy level diagram with transitions, spectrum depiction, Problems.

Expected Learning Outcomes:

After studying this chapter, the student will be able to:

1. Understand the term additive and constitutive properties.
2. Understand the term specific volume, molar volume and molar refraction.
3. Understand the meaning of electrical polarization of molecule, induced and orientation polarization.
4. Dipole moment and its experimental determination by temperature variation method. Electromagnetic spectrum, Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity, Energy level diagram.
5. Classification of molecules on the basis of moment of Inertia.
6. Rotational spectra of rigid diatomic molecules, selection rules, nature of spectral lines.

Reference books:

1. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash. (Page No: 33-59, 60-75, 111-119)
2. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000. (Page No: 413-455)

3. Photochemistry [10 L]

Introduction, Difference between thermal and photochemical processes, Laws of photochemistry: i) Grothus - Draper law ii) Stark-Einstein law, Quantum yield, Reasons for high and low quantum yield., Factors affecting Quantum yield, Experimental method for the

determination of quantum yield, types of photochemical reactions - photosynthesis, photolysis, photocatalysis, photosensitization, Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence, Chemiluminescence, Problems.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Difference between thermal and photochemical processes.
2. Photochemical laws: Grothus - Draper law, Stark-Einstein law,
3. Quantum yield and reasons for high and low quantum yield, factors affecting the quantum yield
4. Experimental method for the determination of quantum yield
5. Photochemical reactions: photosynthesis, photolysis, photocatalysis, photosensitization
6. Various photochemical phenomena like fluorescence and phosphorescence, Chemi-luminescence
7. Problems

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 1154-1178)
2. Principles of Physical Chemistry by Puri, Sharma, Pathania,; (Page No: 1112-1135)
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000. (Page No: 262-2810).

Additional Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition,McGraw Hill. University General Chemistry by C.N.R. Rao, Macmillan.
2. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
3. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
4. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
5. Quantum Chemistry by Donald A McQuarrie, Viva Student Edition.
6. Quantum Chemistry by I. Levine.
7. Quantum Chemistry by R.K. Prasad.

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

CHE35102: Advanced Inorganic Chemistry- I
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lectures
1	Valence Bond Theory of Coordination Complexes	10
2	Crystal Field Theory of Coordination Complexes	14
3	Molecular Orbital Theory of Coordination Compounds	06
	Total	**30**

Course Outcomes

CO 1: Students are able to explain coordinate complexes using VBT.

CO 2: Students are able to explain coordinate complexes using CFT.

CO 3: Students are able to draw MOT diagrams of octahedral coordination complexes.

1. Valence Bond Theory of Coordination Complexes [10 L]

Introduction of Valence Bond Theory (VBT), Need of concept of hybridization, Aspects of VBT, Assumptions, VB representation of tetrahedral, square planer, trigonal bipyramidal and octahedral complexes with examples, Inner and outer orbital complexes, Electro neutrality principle, Multiple bonding (dπ-pπ and dπ-dπ), Limitations of VBT.

Expected Learning Outcomes:

After studying student will able to:

1. Apply principles of VBT to explain bonding in coordination complexes of different geometries.
2. Correlate no of unpaired electrons and orbitals used for bonding.
3. Identify / explain / discuss inner and outer orbital complexes.
4. Explain / discuss limitations of VBT.

Reference books:

1. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008 Pg 592-597
2. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson. Pg 350-351

2. Crystal Field Theory of Coordination Complexes [14 L]

Introduction and need of Crystal Field Theory (CFT), Assumptions, shapes and degeneracy of d orbitals, splitting of d-orbitals, Application of CFT to octahedral complexes, pairing energy

(P) and distribution of electrons in e_g and t_{2g} level, calculation of magnetic moment using spin-only formula, Crystal Field Stabilization Energy (CFSE), calculation of CFSE in weak O_h field and strong O_h field complexes, Evidence for CFSE, Interpretation of spectra of complexes, calculation of 10 Dq and factors affecting magnitude of 10Dq, Jahn-Teller distortion theorem for octahedral complexes and its illustration, CFT of tetrahedral and square planar complexes, calculations of CFSE, Spectrochemical series, Nephelauxatic effect and Nephelauxetic series, Limitations of CFT, modified CFT (LFT), Problems related to CFT.

Expected Learning Outcomes:

After studying student will able to:

1. Explain the principle of CFT.
2. Apply crystal field theory to different type of complexes (T_d,O_h, Sq.planar complexes)
3. Explain: i) strong field and weak field ligand approach in O_h complexes ii) Magnetic properties of coordination compounds on the basis of weak and strong ligand field ligand concept. iii) Origin of color of coordination complex.
4. Calculate field stabilization energy and magnetic moment for various complexes.
5. To identify tetrahedral and square planar complexes on the basis of magnetic properties / unpaired electrons.
6. Explain spectrochemical series, tetragonal distortion / Jahn-Teller effect in Cu(II) O_h complexes only.
7. Explain Nephelauxetic effect towards covalent bonding.

Reference book:

1. Concise Inorganic Chemistry by J.D. Lee - 4 th Edition (Pg 194-225).

3. Molecular Orbital Theory of Coordination Compounds [06 L]

Need and introduction of MOT, Assumptions, MO treatment to octahedral complexes with sigma bonding, Formation of MOs from metal orbitals and Composite Ligand Orbitals (CLO), MO correlation diagram for octahedral complexes with sigma bonding, effect of π bonding on MO correlation diagram, Charge transfer spectra, Advantages of MOT over VBT and CFT.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Explain electroneutrality principle and different types of pi bonding.
2. Able to explain Nephelauxetic effect towards covalent bonding.

3. Explain MOT of Octahedral complexes with sigma bonding.
4. Able to explain Charge Transfer Spectra.

Reference books:

1. Concise Inorganic Chemistry by J.D. Lee - 4 th Edition pg 226-231
2. Physical Inorganic Chemistry: A Coordination Chemistry Approach S. F. A. Kettle Springer-Verlag Berlin Heidelberg GmbH, 1996 pg 95-120
3. Theoretical Inorganic Chemistry by Day and Selvin (Relevant Pages)

CHE35103: Advanced Organic Chemistry- I
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lectures
1	Polynuclear and Heteronuclear Aromatic Compounds	08
2	Rearrangement Reactions	14
3	Elimination Reactions	08
	Total	**30**

Course Outcomes

CO1: To learn classification and properties of aromatic compounds
CO2: To understand synthetic uses of active methylene compounds
CO3: To know various rearrangement reactions
CO4: To understand different types of elimination reactions and their mechanism

1. Polynuclear and Heteronuclear Aromatic Compounds [08 L]

Introduction, Classification of aromatic compounds, Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine. (Ref.1: Pages 759 – 779. Ref.3: Pages 952 – 962. 2.)

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Define and classify polynuclear and hetreonuclear aromatic hydrocarbons.
2. Write the structure, synthesis of polynuclear and hetreonuclear aromatic hydrocarbons.

3. Understand the reactions and mechanisms
4. Explain the reactivity of polynuclear and hetreonuclear aromatic hydrocarbons.
5. Describe the synthesis of chemical reactions of polynuclear and hetreonuclear aromatic Hydrocarbons.

2. Rearrangement Reactions [14 L]

Introduction, Types of rearrangement, Types of reactive intermediate involved in different rearrangements, Rearrangement – Beckmann, Baeyer-Villiger, Favorskii, Curtius, Lossen, Schmidt and Pinacol-Pinacolone with mechanism. Electrocyclic Rearrangements- Claisen, Cope and Mc-Lafferty rearrangements with mechanism.

(Ref.4: Pages 618-656. Ref.7: Pages 89-94, 105-107, 112-114, 122-125, 158-161. Ref.10: Pages 130-132.)

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. What is rearrangement reaction?
2. Different types of intermediate in rearrangement reactions
3. To write the mechanism of some named rearrangement reactions and their applications
4. Electrocyclic rearrangement with their mechanisms

3. Elimination Reactions [08 L]

Introduction; Types of eliminations-1,1; 1,2 elimination, Mechanism with evidences of E1and E2, E1cB reactions, stereochemistry of E1 and E2 elimination, Orientations and reactivity in E1 and E2 elimination- Hoffmann and Saytzeff's orientation, Factors affecting the reactivity-effect of structure, attacking base and leaving groups. (Ref.1: Pages 305-326. Ref. 3: Pages 260-265. Ref.4: Pages 472-496. Ref.6: Pages 188-194)

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. 1,1 and 1,2 elimination
2. E1, E2 and E1cB mechanism with evidences of these reactions 4
3. Understand stereochemistry by using models and learn reactivity of geometrical isomers
4. Orientation and reactivity in E1 and E2 elimination
5. Hoffmann and Saytzeff's Orientation
6. Effect of factors on the rate elimination reactions

References

1. R.T. Morrison & R.N. Boyd: Organic Chemistry, 7th edition, Prentice Hall.
2. Organic Chemistry: Clayden, Greeves, Wothers, Warren, Oxford Press.
3. Organic Chemistry: Graham Solomans
4. E. S. Gould: Mechanism and Structure in Organic Chemistry

5. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman
6. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
7. S. N. Sanyal: Reactions, Rearrangements and Reagents
8. Eliel: Stereochemistry of Organic Compounds, Tata Mc Graw Hill, 1989
9. D. Nasipuri: Stereochemistry of Organic Compounds- Principles and Applications, New Age International Publishers, 3rd edition.
10. Jagdamba Singh, Jaya Singh: Photochemistry and Pericyclic reactions.3rd edition

CHE35104: Physical Chemistry Practical - I

[Credit – 2, 60 hrs]

Total TEN experiments to be completed.

A. Refractometry: (Any two)

1) To determine the specific refractivity of the given liquids A and B and their mixture and hence determine the percentage composition of their mixture C.
2) To determine the molecular refractivity of the given liquids A, B, C and D.
3) To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by $-CH_2$ group.
4) To determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution.

B. Spectrophotometry and Colorimetry (Any three)

1) To titrate Cu2+ ions with EDTA photometrically.
2) To determine the indicator constant of methyl red indicator
3) To estimate of Fe3+ ions by the thiocyanate method.
4) To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium calorimetrically.
5) Simultaneous determination of Cu2+ and Ni2+ ions by colorimetry or spectrophotometry method.

C. Conductometry (Any four)

1) Titration of a mixture of weak acid and strong acid with strong alkali.
2) To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conductometric method.
3) To determine the normality of citric acid in given fruit by titrating it against standard NaOH solution by conductometric method.
4) To determine $\lambda\infty$ of strong electrolyte (NaCl or KCl) and to verify the Onsager equation.

5) To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate
6) To determine the relative strength of monochloroacetic acid and acetic acid conductometrically.

D. Viscosity: (Any one)

1) To determine the molecular weight of a high polymer by using solutions of different concentrations.
2) Determine the radius of glycerol molecules from viscosity measurement.

CHE35105 Organic Chemistry Practical-I
[Credit – 2, 60 hrs]

Total TEN Experiments to be performed

A. Separation of Binary Mixtures and Qualitative Analysis (Any Four)

1) Solid-Solid (3 Mixtures)
2) Solid-Liquid (2 Mixtures)
3) Liquid-Liquid (1 Mixture)

At least one mixture from each of the following should be given-Acid-Base, Acid- Phenol, Acid Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral. (Solid-solid mixtures must be insoluble in water)

B. Preparations

1) Green Chemistry Preparations (Any Two)

a) Preparation of dibenzalpropanone from benzaldehyde and acetone using $LiOH.H_2O$ / NaOH
b) Nitration of phenol or substituted phenols using $CaNO_3$.
c) Bromination of acetamide using ferric ammonium nitrate and KBr in aqueous medium.

2) Organic Preparations (Any Two)

a) Preparation of 1, 4- dihydropyrimidinone from ethyl acetoacetate, benzaldehyde and urea using oxalic acid as catalyst.
b) Preparation p-Iodonitrobenzene from p-Nitroaniline by Sandmeyer Reaction
c) Preparation P-chloro benzoic acid and p-chloro benzyl alcohol from p-chloro benzaldehyde.

3) Preparations of Organic Derivative (Any Two)

a) Amide derivative of Carboxylic acid

b) Glucosazone derivative of Glucose

c) Paracetamol from p-Aminophenol

CHE35106A Chemistry of Biomolecules

[Credit – 2, 60 hrs]

Chapter No.	Title	No. of lecture
1	Introduction to molecular logic of life	03
2	Carbohydrates	07
3	Lipids	06
4	Amino acids and Proteins	08
5	Enzymes	06
	Total	30

Course Outcomes:

CO 1: Students will be able to know basic concepts of biomolecules.
CO 2: Students will be able to draw different structures of carbohydrates and reactions of carbohydrates.
CO 3: The students will understand the structures and chemistry of lipids.
CO 4: The student will understand the structures and types of amino acids.
CO 5: The student will understand the important reaction of amino acids.
CO 6: The student will understand the significance of amino acids.
CO 7: Structural features in proteins.

1. Introduction to molecular logic of life [3L]

Unicellular and multicellular organisms, prokaryotes and eukaryotes. List of cell organelles and its functions. Molecules that constitute the organisation of cell and its organelles. types of bonds in biomolecules

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Cell types, Difference between a bacterial cell, Plant cell and animal cell.
2. Biological composition and organization of cell membrane, structure and function of various cell organelles of plant and animal cell.
3. Concepts of biomolecules, Bonds that link monomeric units to form macromolecules

2. Carbohydrates [7L]

Introduction, classification of carbohydrates, their structures and biological significance. Concept of anomers, epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenyl hydrazine, oxidizing agents, reducing agents and its significance, Glycosidic bonds.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. The types of carbohydrates and their biochemical significance in living organisms
2. structure of carbohydrates and reactions of carbohydrates with Glucose as example.
3. Properties of carbohydrates.

3. Lipids [6L]

Introduction, classification of lipids, their structures and biological significance. Reactions of Lipids-Saponification Hydrolysis, emulsification, oxidation. Concept of saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance. Blood group substances.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. the types of lipids with examples,
2. structure of lipids
3. properties of lipids

4. Amino acids and Proteins [8L]

Amino acids: classification of amino acids. Cocept of ampholytes, isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance. Peptide bond and its features.
Proteins: Classification based on function, nutrition and composition. Structural organization of proteins- primary, secondary, tertiary and quaternary structures.

Expected learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. the structure and types of amino acids. Reactions of amino acids.
2. Properties of amino acids.
3. Peptide bond formation. Types of proteins.
4. Structural features in proteins. Effect of pH on structure of amino acid, Determination of N and C terminus of peptide chain.

5. Enzymes [6L]

Classification of enzymes. Features of active site. ES complex formation, Enzyme specificity, Factors affecting enzyme activity. Basics of Enzyme kinetics. MM and LB equation and Significance of Km. Types of Enzyme inhibitions. Concept of Conjugated enzymes- Holoenzyme, Apoenzyme, prosthetic groups. Coenzymes of vitamins. Industrial applications of enzymes.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. the classes of enzymes with subclasses and examples.
2. Enzyme specificity, Equations of enzyme kinetics Km and its significance
3. features of various types of enzyme inhibitions, industrial applications of enzymes

References

1. Lehninger's Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4th Edn.
2. Biochemistry by U. Satyanarayana
3. Harper's Illustrated Biochemistry, 26th Edition
4. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.
5. Organic Chemistry, Morrison, R. T. & Boyd, R. N.
6. Organic Chemistry (Volume 1) Finar, I. L.
7. Organic Chemistry (Volume 2) Finar, I. L.

CHE-35106 (B): Introduction to Medicinal Chemistry
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of Lectures
1	An Introduction to Drugs, their Action and Immunobiologicals	09
2	Bio-physicochemical Properties in Drug Action and Design	09
3	Drugs for Infectious Diseases	12
	Total	**30**

1. An Introduction to Drugs, their Action and Immunobiologicals [9L]

A. Introduction, Need of new drugs, Historical background of drug discovery and design, Sources of drugs, Classification of drugs, Introduction to drug action (*Ref.1 Pages 37-53, Ref.2*

Pages 4-11, Ref.4 Pages 4-9)

B. Immunobiologicals: Vaccines: Introduction, Methods of vaccine production: Inactivated pathogens, Live/Attenuated Pathogens and Cellular Antigen from a pathogen, SARS-CoV-19 (*Ref.3 Pages 165-168, Ref.9, Ref.10*)

2. Bio-physicochemical Properties in Drug Action and Design [9L]

Introduction, Acidity/Basicity, Solubility, Ionization, Hydrophobic and hydrophilic properties, Lipinski Rule, **Terminology in Medicinal Chemistry:** Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics, metabolites, antimetabolites and therapeutic index. Importance of stereochemistry in drug action (Example: Ibuprofen), Concept of rational drug design: Structure activity relationship, Drug-receptor understanding

(*Ref.1 Pages 57-75, 95-96 Ref.2 Pages 189-274, 384-392, Ref.4 Pages 29-61*)

3. Drugs for Infectious Diseases [12L]

Introduction, Structures, Mode of Action and Applications**:**

a. **Antimicrobial Agents**: Classification on i) Type of action: Bacteriostatic and Bactericidal ii) Source (Natural, Synthetic and Semisynthetic) iii) Spectrum of activity: Narrow and Broad Spectrum iv) Chemical structure: β-lactams (Penicillin), Macrolides (Azithromycin), Sulphonamides (Sulfadiazine), and Tetracyclins (Chlortetracycline)

b. **Anti-fungal and anti-viral agents**: Example: Amphotericin-B, Acyclovir

(*Ref.1 Pages 131-157, Ref.2 Pages 413-472, Ref.3 Pages 258-308, Ref.4 Pages 191-228*)

Learning Outcomes:

Upon completion of the course the student shall be able to understand,

1. The basics of medicinal chemistry, biophysical properties, overview of basic concepts of traditional systems of medicine.
2. Over view of the overall process of drug discovery, and the role played by medicinal chemistry in this process.
3. Biological activity parameters and importance of stereochemistry of drugs and receptors.
4. Knowledge of mechanism of action of drugs belonging to the classes of infectious and non-infectious diseases.
5. Enhancement of practical skills in synthesis, purification and analysis.

Additional Study Material: NPTEL Video lecture on Medicinal Chemistry:

1. https://youtu.be/UHEXXGiegd0 ;
2. https://youtu.be/rVN_HybZ-Vk
3. https://youtu.be/-fCXLW-jF2o
4. https://youtu.be/n5C-peu54Wk

5. https://youtu.be/0wx4hep1low
6. https://youtu.be/9lWrNuUzP4A
7. https://youtu.be/84-q3SAVEQk

CHE-35107: Inorganic Chemistry Practical – I
[Credit – 2, 60 hrs]

Total TEN experiments to be completed.

Course Outcomes:

CO 1: Students should be able to perform experiments related to gravimetry.

CO 2: Students should be able to prepare coordination complexes.

CO 3: Students should be able to analyze acidic radicals in inorganic binary mixtures.

CO 4: Students should be able to analyze basic radicals in inorganic binary mixtures.

A. Gravimetric estimations (Any three)

1. Gravimetric estimation of Fe as Fe_2O_3. Ref-1: 457
2. Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method. Ref-1: 448
3. Gravimetric estimation of Nickel as $[Ni(DMG)_2]$. Ref-1: 462
4. Analysis of sodium bicarbonate from mixture by thermal decomposition method. Ref.-6

B. Inorganic preparations (Any three) (Ref-7, 8, 9)

Preparation of inorganic complexes and spot tests for metal ions and ligands:

1. Preparation of tetramminecopper(II) chloride, $[Cu(NH_3)_4]SO_4$.
2. Preparation of Potassium trioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]$.
3. Preparation of Manganese (III) acetylacetonate, $[Mn(acac)_3]$.
4. Preparation of tris(glycinato)nickelate(II), $[Ni(gly)_3]^-$

C. Inorganic Qualitative Analysis (Any four mixtures)

(Two Experiments - Acidic Radicals Separation and Two Experiments - Basic Radicals Separation)

(*DST manual green chemistry monograph procedure must be followed strictly*)

References:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)

2. Indian Pharmacoepia, Vol-2; 2007
3. Green Chem - [PDF Document] – FDOCUMENTS; (https://fdocuments.in/document/green-chem.html)
4. https://www.studocu.com/ec/document/universidad-de-investigacion-de-tecnologia-experimental-yachay/fisica-matematica/otros/the-gravimetric-analysis-of-barium-chloride-hydrate/8364963/view
5.https://effectiveness.lahc.edu/academic_affairs/sfcs/chemistry/Shared%20Documents/Decomposing%20Baking%20Soda.pdf
6. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horword Publishing, Chichester) 1999.
7. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House

CHE35408 Chemistry Software Practical -VSC
[Credit – 2, 30 hrs]

1. ChemDraw: [15 L]

Introduction to ChemDraw software, understanding its features, Drawing different structures using in-build templates and understanding open databases, Use of different tools to draw and edit structures other than templates and Converting structure to its IUPAC name and vice versa, Finding physical properties and spectral data of given structure.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Using the software to draw structures and writing reactions
2. Making use of different tools in drawing structures
3. about IUPAC nomenclature and spectral information from structure.
4. Visualize a molecule in 3-D space

2. Excel, Origin and Mapping data: [15L]

Using MS-Excel in data analysis of Chemistry experiments, Hands-on training for plotting bar graphs, pie charts, finding slope in excel (Errors), Introduction to Mindmap software for making flowcharts in Chemistry, Introduction to Amcharts for plotting graphs in chemistry (Demo and Hands-on),Use of Origin software in chemistry for structure determination, Hands-on training for plotting stack graphs, double axis graphs in Origin.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. About plotting different types of graphs using excel

2. Drawing concept maps and flowcharts
3. Use of origin to plot graphs for the use in research papers.

Reference Books:

1. Analytical Chemistry, Ed. by Kellner, Mermet, Otto, Valcarcel, Widmer, Second Ed. Wiley –VCH
2. Practical High-Performance Liquid Chromatography, Veronika R. Meyer, Fifth Ed. John Wiley and Sons, Ltd.
3. Liquid Chromatography Mass Spectrometry: An Introduction by Bob Ardery, Publisher: Wiley India Pvt. Ltd. (2003). A book from series- Analytical techniques in the Science.
4. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
5. Instrumental methods of Analysis; Willard, Merritt, Dean, Settle, CBS Publication; 7edition (1 December 2004).
6. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
7. Practical Data Analysis in Chemistry; Marcel Maeder, Yorck-Michael Neuhold, Elsevier Science Publication, 2007.

CHE35609- Field Project/Community Engagement Programme

[Credit – 2, 60 hrs]

Students will do a field project or get associated with a NGO or involve in some community engagement service and at the end semester exam will present the work for assessment.

CHE35210-Concepts of Physical and Inorganic Chemistry (Minor)

[Credit – 2, 30 hrs]

Course Outcomes:

CO 1: Students will be able to plot graphs of linear, exponential and logarithmic function.

CO 2: Students should be able to understand the concept of real and ideal gases.

CO 3: Students will know basics of Coordination chemistry.

Section-I Physical Chemistry (15L)

1. States of Matter [07L]

Introduction: States of matter and their properties. Gaseous states: Significance of ideal and kinetic gas equation (no derivation), Real gases Compressibility factor, Van der Waal's equation of state. Liquid state – Properties of liquids, Comparison between gaseous and solid states – Experimental determination of vapor pressure by isoteniscopic method and viscosity by Ostwald method, liquid crystals and their applications.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1.the behavior of gases.

2. to solve problems regarding Van der Waal's equation and Critical constant and regarding P-V-T relations.

2. Ionic Equilibria [08L]

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

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. the concepts of common ion effect and its applications.
2. to solve the numerical problems on degree of hydrolysis and pH for different salts, buffer solutions

References:

1. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
2. B S Bahl, G D Tuli, Arun Bahl, Essentials of Physical Chemistry

Section-II Inorganic Chemistry (15 L)

3. Introduction to Coordination Compounds [15 L]

Double salt and coordination compound, basic definitions: coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio; Werner's work and theory, Effective atomic number, equilibrium constant and types, chelate effect, IUPAC nomenclature.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. basic concepts of coordination chemistry.
2. IUPAC nomenclature of complexes.

References:

1. Concise Inorganic Chemistry, J. D. Lee, 5th Ed (1996) Blackwell Science.
2. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015).
3. Basics Inorganic Chemistry, Cotton and Wilkinson.

CHE35211-Analytical Chemistry Practical-I (Minor)

[Credit – 2, 60 hrs]

1. **Flame photometry:** Analysis of given samples for alkali metals. (any **four** metals)
2. Food adulteration in different brands (Any **six**)
3. Adulteration in milk, spices and oil (any **four**)

SEMESTER-VI

CHE36101: Advanced Physical Chemistry-II

[Credit – 2, 30 hrs]

Chapter No.	Title	No. of Lectures
1.	Electrochemical Cells	10
2.	Crystal Structure	10
3.	Nuclear Chemistry	10
	Total	30

CO1: Students will be able to understand different types of electrochemical cells along with their construction and working
CO2: Students will be able to understand the crystal structures and numericals based on the same.
CO3: Students will be able to know the concepts of nuclear chemistry.

1. Electrochemical Cells [10 L]

Electrochemical cells, reversible and irreversible cells with examples, The e.m.f. of electrochemical cell and its measurement, The Weston standard cell, Reference electrodes: The primary reference electrode and Secondary reference electrodes, The Nernst equation for E.M.F. of a cell. Types of reversible electrodes, the sign convention for electrode potentials, Thermodynamics of reversible cells and reversible electrodes, E.M.F. and equilibrium constant of cell reaction, Electrochemical series, Types of concentration cells, liquid junction potential, salt bridge, Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes.2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations. (iii) Precipitation titration,

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Electrochemical cells: Explanation of Daniell cell, Conventions to represent electrochemical cells
2. Thermodynamic conditions of reversible cell, Explanations of reversible and irreversible electrochemical cell with suitable example,
3. Nernst Equation for theoretical determination of EMF.
4. Applications of emf measurements.

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No:1154-1178) 2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 835-880) 3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000, (Page No: 320-412)
4. Modern Electrochemistry Second Edition by John O'M Bockris, Molecular Green Technology College Station, Texas and Amulya K. N. Reddy, President International Energy Initiative Bangalore, India, (Page No: 1789-1888).

2. Crystal Structure [10 L]

Types of Solids: Isotropy and Anisotropy, Laws of crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of crystal symmetry, Weiss indices and Miller indices, Crystal Structure: Parameters of the Unit Cells, Cubic Unit Cells: Three Types of Cubic Unit Cells, Calculation of Mass of the Unit Cell, Methods of Crystal structure analysis: TheLaue method and Bragg's method: Derivation of Bragg’s equation, Determination of crystal structure

of NaCl by Bragg's method, X ray analysis of NaCl crystal system, Calculation of d and λ for a crystal system, Numerical.

Expected Learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solids.
2. Explain the term crystallography and laws of crystallography.
3. Weiss and Miller's Indices, determination of Miller Indices
4. Bravais lattices, space groups, seven crystal systems and fourteen Bravais lattices;
5. Cubic lattice and types of cubic lattice

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).,(Pp: 491-507, 518-528)
2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 1165-1180)

Chapter 3. Nuclear Chemistry [10L]

Radioactivity, Types of Radiations, Properties of Radiations, Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter and Film Badges, Nuclear structure, Classification of nuclides, Types of Radioactive Decay, The Group Displacement Law, Kinetics of Radioactive Decay, Half-life, average life, Energy released in nuclear reaction, Mass Defect, Nuclear Binding Energy, Some applications of radio-isotopes as tracers: Chemical investigation – Esterification, Friedel -Craft reaction, Structural determination – Phosphorus pentachloride, Age determination – use of tritium and C14 dating, Problems.

Expected Learning Outcomes:

After studying this topic students are expected to know

1. Radioactivity, Application of radioisotopes as a tracer: Chemical investigation- Esterification, Friedel -Craft reaction and structure determination w.r.t PCl_5, Age determination use of tritium and C14 dating.
2. Types and properties of radiations: alpha, beta and gamma
3. Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter, Film Badges
4. Kinetics of Radioactive Decay, Half-life, average life and units of radioactivity
5. Energy released in nuclear reaction: Einstein's equation, Mass Defect, Nuclear binding Energy.

Reference books:

1. Elements of Nuclear Chemistry by H.J. Arnikar
2. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No: 117-145)

Additional Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4thEdition. Principles of Physical Chemistry by Puri, Sharma, Pathania,
6. Chemical applications of radioisotopes by H.J.M. Brown
7. Source book of Atomic energy by S. Glasstone and D. Van .
8. Modern Electrochemistry Second Edition by John O'M Bockris
9. Molecular Green Technology College Station, Texas and Amulya K. N. Reddy President International Energy Initiative Bangalore, India, Kluwer, Academic Publishers New York, Boston, Dordrecht, London, Moscow.

CHE36102: Advanced Inorganic Chemistry -II
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lecture
1	Organometallic Chemistry	10
2	Homogeneous Catalysis	05
3	Bioinorganic Chemistry	08
4	Inorganic Reaction Mechanism	07
	Total	**30**

Course Outcomes

CO 1: Students are able to draw structures of metal carbonyl complexes.

CO 2: Students are able to explain homogeneous catalytic processes.

CO 3: Students are able to explain bioinorganic chemistry of iron and cobalt.

CO4: Students are able to understand classification of inorganic reaction mechanisms.

1. Organometallic Chemistry [10 L]

Definition of Organometallic compounds and Organometallic chemistry, CO as a π-acid donor ligand, binary metal carbonyls, classification of metal carbonyls, synthesis of metal carbonyls; (a)Direct reaction (b) Reductive carbonylation (c) Photolysis and thermolysis. Hepticity, Molecular and electronic structures of binary metal carbonyls, Electron count in complexes (18 electron rule). Applications of organometallic compounds in industrial catalysis (list of examples). Chemistry of ferrocene;

Introduction, synthesis and physical properties of ferrocene. Reactions of ferrocene such as Friedel-Craft Acylation, Friedel-Craft Alkylation, Mannich reaction, Nitration and Halogenation.

[Further Reading: Student should also read about the interaction of different organic ligands with metals and their possible bonding.]

Expected Learning Outcomes:
Students should be able:

1. To understand M-C bond and to define organometallic compounds
2. To understand the multiple bonding due to CO ligand.
3. To understand the structure and bonding using valence electron count (18 ele. rule)
4. To understand the catalytic properties of binary metal carbonyls.
5. Chemistry of ferrocene

References:

1. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Langford – Oxford, 5th Edn., 1994, pp 534-542,553-564.
2. Concise Inorganic Chemistry by J. D. Lee (Relevant pages)
3. General Chemistry by Raymond Chang(Relevant pages)
4. Basic Organometallic Chemistry: Concepts, Syntheses and Applications of Transition Metals (CRC), B. D. Gupta and Anil J. Elias, Universities Press; 2nd Edition, 2013.

2: Homogeneous Catalysis [05 L]

Introduction to Catalysis, basic principles, activity and selectivity in catalysis, Types of catalysis, homogeneous vs. heterogeneous catalysis, importance of catalysis in the synthesis of high value chemicals. Homogeneous catalysis: Catalytic cycles for following reactions: a) Hydrogenation of olefins using Wilkinson complex, b) Hydroformylation of olefins using Cobalt and Rhodium complexes, c) Carbonylation reaction: Methanol to Acetic acid process i.e. Monsanto processes d) C-C coupling reactions: Heck reaction. [References 1 to 3]

Expected Learning Outcomes:
Students should be able:

1. Understand the phenomenon of catalysis, its basic principles and terminologies.
2. Define and differentiate homogeneous and heterogeneous catalysis.
3. Give examples and brief account of homogeneous catalysts.
4. Understand the essential properties of homogeneous catalysts, the catalytic reactions for Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis, Heck reaction

References:

1. Homogeneous Catalysis: The Applications and Chemistry of Catalysis by Soluble Transition Metal Complexes, G.W. Parshall and S.D. Ittel, Wiley, New York 1992.
2. Inorganic Chemistry D.F. Shriver and P.W. Atkins, 5th Edn, Oxford University Press, 2010, Chapter 26 pp 690-721.
3. Homogeneous Catalysis: Mechanisms and Industrial Applications, S.Bhaduri and D. Mukesh, Wiley, New York, 2000.pp 13-23, 55-61,85-102, 161-163.

3: Bioinorganic Chemistry [8 L]

Introduction, Role of metals in bioinorganic chemistry, Classification as enzymatic and non-enzymatic metals, enzymatic redox metals such as Cu (SOD) and enzymatic non-redox metals such as Zn (Hydrolase). Role of metal ions in non-enzymatic processes-Na, K, Ca, Mg (one example of each and brief discussion). I. Role of metals in enzymatic processes-Transition metals- Catalase, peroxidase and nitrogenase (Redox active). II. Metalloproteins-Iron proteins-Introduction of Fe-S proteins, Electron transfer proteins (Fe-S, Fe2S2, Fe3S4, Fe4S4). Transport protein (transferrin) and Storage protein (ferritin) III. Bioinorganic Chemistry of Fe: Hemoglobin and myoglobin, its structure and functions and IV. Bioinorganic Chemistry of Co: Vitamin-B12, its structure and function.

Expected Learning Outcomes:

After learning this chapter students should be able to:

1. Identify the biological role of inorganic ions & compounds.
2. Know the abundance of elements in living system and earth crust.
3. Give the classification of metals as enzymatic and non-enzymatic.
4. Understand the role of metals in non-enzymatic processes.
5. Know the metalloproteins of iron.
6. Explain the functions of hemoglobin and myoglobin in O2 transport and storage.

References:

1. Concise Inorganic Chemistry by J.D. Lee - 5th edition, Pages 353, 775, 779, 796-797.
2. Inorganic Chemistry,-D.F. Shiver & P.W. Atkins- C.H. Longford ELBS- 2nd Ed,782-806.
3. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edn., Pages 1-13, 24, 285-290.

4: Inorganic Reaction Mechanism [07L]

Basic concepts of stability and lability, stability constants, Factors affecting lability, chelate effect. Classification of inorganic reactions, ligand substitution reactions: Intimate and stoichiometric mechanism of ligand substitution. Substitution Reactions in Four Coordinated

square planar complexes: Trans effect and Trans effect series, applications of trans effect, stereochemistry of substitution.

Expected Learning Outcomes:
A student should know and understand:

1. To understand about inert and labile complexes and stability of complexes in aqueous solutions
2. Classification of reactions of coordination compounds
3. The basic mechanisms of ligand substitution reactions.
4. Substitution reactions of square planer complexes.
5. Tran's effect and applications of Trans effect

References:

1. Inorganic Chemistry – Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter & R. L. Keiter, 4th Edn. Harper Collins College Publ. New York, Chapt.13, p.537-576, (1993).
2. Martin L. Tobe and John Burgess, Inorganic Reaction Mechanisms, Addison Wesley Longman Inc., 1999.
3. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Lamgford – Oxoford, 5th Edn., 1994, pp507-517.
4. Inorganic Chemistry - Messler and Tarr - Pearson Publishers pages 412-420, 434-440

CHE36103: Advanced Organic Chemistry-II
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lectures
1	Introduction to Spectroscopy	04
2	Ultra Violet and Visible Spectroscopy	06
3	Infra-Red Spectroscopy	08
4	Nuclear Magnetic Resonance Spectroscopy (PMR)	08
5	Combined problems based on U.V., I.R. and PMR spectroscopy	04
Total		**30**

Course Outcomes:

CO1. To understand various organic spectroscopic methods of structure determination
CO2. To identify the structure of given compounds from given spectral data
CO3. To find out lambda max values
CO4. To monitor the reaction using IR
CO5. To understand various conformations of substituted cyclohexanes and study their optical properties

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1: Introduction to Spectroscopy [04 L]

Introduction, meaning of spectroscopy, Types of spectroscopy, nature of electromagnetic radiation and regions of electromagnetic spectrum, Terms used in spectroscopy; wavelength, amplitude, frequency, wavenumber, energy and their relations and conversions (Ref 2: Page Nos. 43-55)

Expected Learning Outcomes:
A student should know and understand:

1. the interaction of radiation with matter.
2. different regions of electromagnetic radiation.
3. different wave parameters.

2: Ultra Violet and Visible Spectroscopy [06 L]

Introduction, Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts, Application of visible, ultraviolet spectroscopy in organic molecules. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α, β – unsaturated compounds. (Ref 1: Page Nos.367-398)

Expected Learning Outcomes:
A student should know and understand:

1. the principle of UV spectroscopy and the nature of UV spectrum
2. types of electronic excitations.
3. to calculate maximum wavelength for any conjugated system. And from the value of λ-max they will be able to find out the extent of conjugation in the compound.

3: Infra-Red Spectroscopy [08 L]

Introduction, Infrared radiation and types of molecular vibrations, functional group and fingerprint region. Infra-red spectroscopy in organic molecules, IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). (Ref 1: Page Nos 26-93).

Expected Learning Outcomes:
A student should know and understand:

1. the principle of IR spectroscopy
2. types of vibrations and the nature of IR spectrum.
3. From the IR spectrum, they will be able to find out IR frequencies of different functional groups. And thus, they will be able to find functional groups present in the compound.

4: Nuclear Magnetic Resonance Spectroscopy (PMR) [08 L]

Introduction, Principles, Magnetic and nonmagnetic nuclei, nuclear resonance, chemical shift,

shielding, & deshielding effect. Measurement of chemical shift, TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, J-value, problems based on NMR. Ref 1: Page Nos.108-175 and 225-366.

Expected Learning Outcomes:
A student should know and understand:

1. the principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy.
2. To measure chemical shift and coupling constants.
3. To interpret the NMR data and will be able to use it for determination of structure of organic compounds.

5: Combined Problems Based on U.V., I.R. and PMR Spectroscopy [05 L]

(Ref 1: Page Nos. 501 to 567)

Expected Learning Outcomes:
A student should know and understand:

1. to determine the structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values).

References:

1. Pavia D.L.; Lampman G.M. Kriz G. S.; Vyvyan J.R. Spectroscopy, First Indian Reprint 2008 : Brooks/Cole CENGAGE Learning.
2. Silverstein and Basallar: Spectroscopic Identification of Organic Compounds.
3. M. Parikh :Absorption Spectroscopy Organic Compounds (John Wiley)
4. P. S. Kalsi : Spectroscopy of organic compounds (New Age)
5. J. R. Dyer: Application of absorption spectroscopy of organic compounds.
6. V. M. Parikh:Application spectroscopy of Organic molecules. (Mehata)
7. D.W. Williams and Flemming: Spectroscopic methods of Organic compound.
8. J. D. Roberts:Nuclear magnetic resonance (J. Wiley)
9. Eliel: Stereochemistry of Organic Compounds, Tata Mc Graw Hill, 1989
10. D. Nasipuri: Stereochemistry of Organic Compounds- Principles and Applications, New Age International Publishers, 3rd edition.

CHE36104: Physical Chemistry Practical-II

[Credit – 2, 60 hrs]

Total TEN Experiments to be performed.

1. Potentiometry (any Five)

1. To determine the pKa value of given monobasic weak acid by potentiometric titration.
2. To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentiometrically.
3. To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.
4. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.
5. Estimate the amount of Cl-, Br- and I- in given unknown halide mixture by titrating it against standard $AgNO_3$ solution (mixture of any two ions).
6. To prepare standard 0.2 M Na_2HPO_4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknown

solution.

7. To determine the composition of Zinc ferrocyanide complex potentiometrically
8. To determine the standard electrode potentials of Cu and Ag electrodes and to determine the EMF of a concentration cell.

2. pHmetry (any Three)

1. To determine the degree of hydrolysis of aniline hydrochloride.
2. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.
3. Determination of pka of given weak acid by pH metry titration with strong base
4. To determine the acid and base dissociation constant of an amino acid and hence the isoelectric point of an acid.
5. pH metric titration of strong acid against strong base by pH measurement and hence determine the concentration and strength of strong acid.
6.

3. Colligative properties (any one)

1. To determine the molecular weight of solute by depression in freezing point method
2. To study the association of Benzoic acid in benzene by Beckmann Method
3. Determine the molecular weight of given electrolyte and non-electrolyte by Landsberger's method and to study the abnormal molecular weight of electrolyte.

4. Table work

Analysis of crystal structure from X-ray diffraction spectra of any **TWO** compounds (Calculation of d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data).

Reference Books:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.).
2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. Richett (Pergamon Press).
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co.Delhi).
4. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
5. Physical chemistry by Wien (2001).
6. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut)
7. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House.
8. Practical Physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books.
9. Vogel-qualitative-inorganic-analysis-5th-edition-1979.
10. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
11. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

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CHE36105: Organic Chemistry Practical-II
[Credit – 2, 60 hrs]

Total TEN Experiments to be performed

A) Interpretation of IR and NMR spectra (Two spectra of each type)

1. Determination of functional group of organic compound from given IR spectra. (any TWO)
2. Determination of structure of organic compound from given NMR spectra. (any TWO) (Ethyl alcohol, Cis-2-butene, Trans-2-butene, Benzoic acid, Propanaldehyde, Ethyl methyl ether, 1 Butyne, Ethyl acetate, Propyl Cyanide, Salicylic Acid, Nitro phenols, Isopropyl benzene, Propanamine, Benzamide, n-Pentane, 2-chloro butane, Acetophenone)

B) Organic Estimations (Any Three)

1. Estimation of glucose
2. Estimation of glycine
3. Saponification value of oil
4. Estimation of Alkali content in Antacid using HCl.

C) Organic Extractions (Any Three)

1. Caffeine from tea leaves
2. Eugenol from cloves
3. Lycopene from tomato peels
4. Cinnamic acid from cinnamon
5. Trimyristin from nutmeg

D) Column Chromatography

1. Separation of mixture of aldehyde and carboxylic acid by column chromatography
2. Separation of mixture of O-nitrophenol and P-nitrophenol by column chromatography

CHE36106 (A): Polymer Chemistry
[Credit – 2, 30 hrs]

Chapter No	Title	Number of lectures
1	Introduction and history of polymeric materials	06
2	Polymerization Chemistry	12
3	Important Polymers	12
	Total	**30**

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Course Outcome: The students are expected to learn

CO1: History of polymers.

CO2: Difference between natural, synthetic, organic and inorganic polymers.

CO3: Mechanisms of polymerization, Polymerization techniques.

CO4: Uses & properties of polymers.

1. Introduction and history of polymeric materials [6 L]

Brief history, Basic terms- monomer, polymer, polymerisation, degree of polymerisation, functionality. Different schemes of classification of polymers, polymer nomenclature, molecular forces and chemical bonding in polymers, glass transition temperature of polymer.

(Ref. 1: Pages 1-20, 150; Ref. 2: Pages 1-16; Ref. 5, 7 & 8 Relevant Pages)

2. Polymerization Chemistry [12 L]

Classification of polymerization processes, mechanism of- step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations. Polymerization techniques-bulk, solution, suspension, emulsion and interfacial condensation.

(Ref. 1: Pages 20-58, 71-79; Ref. 2: Pages 25-32, 49-56, 82-86, 88-94, 126-132; Ref. 3 & 4 Relevant Pages)

3. Important Polymers [12 L]

Brief introduction to preparation, structure, properties and application of the following polymers: polyethylene, polystyrene, polyvinyl chloride, polyvinyl alcohol, polymethyl methacrylate, polytetrafluoroethylene, polyamides, polyesters, phenol formaldehyde resins (Bakelite, Novolac), silicone polymers, polyisoprene, conducting Polymers. (Ref. 1: Pages 215-255; Ref. 3, 4 & 6 Relevant Pages)

Reference Books:

1. Polymer Science by V.R. Gowarikar, N.V.Vishvanathan, JaydevShreedhar New Age International Ltd. Publisher 1996. (Reprint 2012)
2. Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiley& Sons New York 1984. (Reprint 2008)
3. Introductory Polymer Chemistry by G.S.Misra New Age International (P) Ltd. Publisher 1996.
4. Polymer Chemistry by Charles E. Carraher (Jr.), 6th Edn, (First Indian Print 2005), New York- Base
5. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4th Edn, 2012.
6. Principles of Polymerisation by George Odian3rd Edn. John Wiley & Sons New York.

MCGK T.Y.B.Sc. Chemistry – NEP I SYLLABUS 2025-26

CHE36106 B Analytical Chemistry
[Credit – 2, 30 hrs]

Chapter No.	Title	No. of lectures
1	Gravimetry	09
2	Inorganic Qualitative Analysis	07
3	Parameters of instrumental analysis	04
4	UV-Visible spectroscopy	10
	Total	**30**

Course outcomes:

CO 1: Students should be able to define basic terms in gravimetry, such as: Gravimetry, precipitation, solubility product, ionic product, common ion effect, precipitating agent, washing of ppt., drying and ignition of ppt.

CO 2: Students should learn different interfering anions such as oxalate, borate, Phosphate and methods to remove interfering anions**.**

CO 3: Students should be able to learn various parameters in instrumental analysis such as linearity range, detection limit, precision, accuracy, Sensitivity, Selectivity, Robustness and Ruggedness, electromagnetic radiations, spectrophotometry.

CO4: Students should be able to learn principle and instrumentation of spectrophotometer and able to solve numerical based on Lambert Beer's Law (w.r.t absorbance, transmittance, molar absorptivity, monochromator, wavelength of maximum absorbance).

1. Gravimetry [9 L]

Introduction to gravimetric analysis; Precipitation methods; The colloidal state; Supersaturation and precipitate formation; The purity of the precipitate: Co-precipitation; Conditions of precipitation; Precipitation from homogeneous solution; Washing the precipitate; Ignition of the precipitate: quantitative separations based upon precipitation methods: Fractional precipitation;, Gravimetric Calculations—How Much Analyte is there (Ref-3).

Applications of Gravimetry: Determination of Al(III) by 8-hydroxyquinoline, Determination of calcium as oxalate; Determination of potassium as potassium tetraphenylborate, Determination of phosphate as ammonium molybdophosphate, Numericals. Key Reference-1: 417-428, 433-444, 446, 451, 464, 485; [Supplementary Ref-2: Pp-342 to 362].

Expected Learning Outcomes:
A student should know and understand:

1. the basic terms of precipitation, co-precipitation, post-precipitation.

2. various reagents and conditions for good precipitation.
3. to solve numerical based upon gravimetric factor, to determine amount of analytes in sample.

2: Inorganic Qualitative Analysis: [07 L]

Basic principle, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals, removal of interfering anions (phosphate and borate), detection of acid radicals. Ref-6.

Expected Learning Outcomes:
A student should know and understand:

1. terms such as common ion effect, solubility, solubility product.
2. principle and method of inorganic qualitative analysis w.r.t separation of basic radical and acidic radicals from mixture
3. removal of interfering anions (phosphate and borate),
4. solve numericals based on common ion effect, solubility, solubility product.

3: Parameters of instrumental analysis [04 L]

Techniques, Methods, Procedures, and Protocols, Selecting an Analytical Method, Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness, Time, and Cost, Making the Final Choice, Developing the Procedure, Calibration and Standardization, Sampling, Validation, Protocols, Key Reference -5: 35-48

Expected Learning Outcomes:
A student should know and understand:

1. various industrial analytical parameters such as Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness Time, and Cost, Making the Final Choice, Developing the Procedure, Calibration and Standardization, Sampling, Validation
2. to solve numericals based on Accuracy, Precision.

4: UV-Visible Spectroscopy [10 L]

Introduction, Theory of spectrophotometry and colorimetry-Beer's law, Application of Beer's Law, Spectrophotometry: Wavelength selection by prism and diffraction grating, Radiation source, cells, data presentation, single-beam spectrophotometer, Double-beam spectrophotometers, Choice solvent, general procedure for colorimetric estimation, simultaneous analysis, Applications: Estimation of metal ions from aqueous solution: Boron in steel, Chromium in steel with diphenyl carbazide reagent, ammonia in water, spectrophotometric titration (example Cu(II) with EDTA), Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method., Numericals Key Reference- 2: 658-717 and Ref-1: 645-725.

Expected Learning Outcomes:
A student should know and understand:

1. the principle and instrumentation of spectrophotometer.
2. To solve numerical problems based on Lambert Beer's Law (w.r.t absorbance, transmittance, molar absorptivity, monochromator, wavelength of maximum absorbance).
3. learn applications of UV-Visible spectroscopy spectrophotometer.

References:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)
2. Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education
3. Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.
4. Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education
5. Vogel's Qualitative Inorganic Analysis, G. Svehla, Pearson, 7th Ed.

CHE-36107: Inorganic Chemistry Practical-II
[Credit – 2, 60 hrs]

Total TEN Experiments to be performed.

A. Volumetric Estimations (any Four)

1. Analysis of Phosphate (PO_4^{3-}) from Fertilizer. (Ref-1)
2. Analysis of Iodine from Iodized salt.(Ref-2)
3. Strength of medicinal H_2O_2. (Ref-1)
4. Analysis of Calcium from milk powder. (Ref-1)
5. Analysis of Cu from Cu-Fungicide. (Ref-1)

B. Column Chromatography (Ref-1)

1. Purification of water using cation/anion exchange resin and analysis by qualitative analysis.

C. Verification of periodic trends using solubility of alkaline earth metal hydroxides of $Ca(OH)_2$, $Mg(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$. (Ref-1)

D. Determination of the Metal to ligand ratio (M : L) in complexes. (Ref- 5)

E. Fenton reaction: Degradation of H_2O_2 using Fe catalyst. (Ref-6)

F. Preparation of nanomaterial of ZnO : using Zinc acetate / Zinc nitrate

G. Table work: Band gap calculation for the nanomaterial TiO_2/ SnO_2/ ZnO from its electronic spectra (UV-Visible). (Ref-3, 4)

References:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)
2. General Chemistry Experiment – Anil J Elias (University press).
3. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horword Publishing, Chichester) 1999.
4. Environmental Chemistry Microscale Laboratory Experiments, Jorge G.Ibanez Margarita Hemandez-Esparza Carmen Doria-Serrano Arturo Fregoso-Infante, Springer

CHE36608 On Job Training (OJT)
[Credit – 4, 120 hrs]

Under the on job training, the students acquire skills and knowledge required in chemistry based industries/institutions. The learning by doing approach is developed amongst the students under the guidance of industry expertise/professionals. During on job training, students get an experience to handle cutting edge instruments and the working environment of the research and development department of chemical industries and start-ups.

CHE36209: Concepts of Organic and Analytical Chemistry (Minor)
[Credit – 2, 30 hrs]

Course Outcomes:

CO 1: Students will learn fundamentals of organic chemistry and functional group approach for aliphatic and aromatic hydrocarbons.

CO 2: Students will learn basic concepts of stereochemistry.
CO 3: Student should understand the concept of ionization process in acids and bases.

CO4: Students should understand the perspectives of Analytical Chemistry.

1: Fundamentals of Organic Chemistry: [6 L]

Physical Effects, Electronic Displacements: Inductive Effect, Electrometric 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. Concept of acidity and basicity.

Expected Learning Outcomes:
A student should know and understand:

1. the fundamental concepts which govern the structure and bonding of organic molecules.
2. the basic terminologies like acidity, basicity, electrophiles and nucleophiles.

2: Chemistry of Hydrocarbons: [9 L]

Definition, Classification, IUPAC nomenclature, Examples of aliphatic and aromatic simple organic compounds

Basics of stereochemistry: Introduction, Classification, Interconversion of Wedge formula, Newman, Saw-horse and Fischer representation of organic molecules, conformations of ethane and butane.

Expected Learning Outcomes:
A student should understand and be able:

1. to write IUPAC names of simple organic molecules.
2. to identify the given stereo chemical structures.
3. the stereochemistry of acyclic compounds.

References:

1. A guide book to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition.
2. Organic Chemistry by Morrison & Boyd, 6th Edition
3. Organic Chemistry by J. Clayden, S.Warren et al

3: Introduction to Analytical Chemistry [02L]

Definition of analytical Chemistry and analytical perspectives.

Expected Learning Outcome:

Students should understand the basic concepts of Analytical Chemistry

4: Stoichiometry [13L]

Some important units of measurements-SI units, distinction between mass and weight, mole, millimole and calculations and significant figures. Chemical Stoichiometry- Empirical and Molecular Formulae, Stoichiometric Calculations, Problems. Mole concepts and Stoichiometry, Solution and their concentrations- Molar concentrations, molar analytical concentrations, molar equilibrium concentration, percent concentration, part per million, part per billion, part per thousand, Solution –dilatant volume ration, functions, density and specific gravity of solutions and problems.

Expected Learning Outcomes:
A student should be able:

1. to do the calculations of moles, molar concentrations and conversion of various units of concentrations.
2. to understand the relation between molecular formula and empirical formula.
3. to understand the concept of Normality, Molarity, Molality, Normal solution, Molar solution, equivalent weight, ppm, and % w/v and % v/v.
4. to solve the related problems.

References:

1. Analytical Chemistry by G.D. Christian.
2. Calculation of Analytical Chemistry by Hamilton, Simpson &Ellis 7th Edn.

CHE36209: Practical on Analytical Chemistry II (2C)

[Credit – 2, 60 hrs]

1. Analysis of Iodine from Iodized salt. (Ref-2)
2. Analysis of Calcium from milk powder.
3. pH of food samples having added preservatives.
4. Density measurement of liquid food samples.
5. Analysis of brass alloy.
6. Cobalt estimation using colorimetry
7. Antacid estimation
8. Aspirin estimation.
9. Monobasic acid estimation.
10. Acetamide Estimation.

Progressive Education Society's

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Ganeshkhind,Pune-16

Autonomous

NEP 2020 (1)

Department of Mathematics

(Under Faculty of Science and Technology)

T.Y.B.Sc.(Regular) : Minor : Mathematics

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

T.Y.B.Sc. (Regular) : Minor : Mathematics

Semester	Paper Number	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
5	I	MAT35201	Basic Course in Computational Geometry	T	2
	II	MAT35202	Practical Course based on Basic Course in Computational Geometry	P	2

Evaluation Pattern

Semester	Paper Number	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
5	I	MAT35201	Basic Course in Computational Geometry	20	30	50
	II	MAT35202	Practical Course based on Basic Course in Computational Geometry	20	30	50

CIE : Continuous Internal Evaluation **ESE :** End Semester Examination

Syllabus for T.Y.B.Sc. (Regular) : Minor : Mathematics

Academic Year : 2025-26

Semester – 3

Paper No. : I		Paper Code : MAT35201
Name of the Paper : Basic Course in Computational Geometry (Theory)		
Total No. of Credits : 2		Total No. of lectures : 30
Course Outcome		
CO	Student will	
CO1	Be able to understand basic properties of Matrices.	
CO2	Be able to understand various transformations.	

Course Outcome			
CO3	Be able to generate Circle and Ellipse through parametric representation.		
CO4	Understand properties of Bezier curve		
Unit	**Subunit**	**Content**	**No. of lectures**
1	**Two dimensional transformations I.**		**10**
	1.1	Introduction.	
	1.2	Representation of points.	
	1.3	Transformations and matrices.	
	1.4	Transformation of points.	
	1.5	Transformation of straight lines.	
	1.6	Midpoint Transformation.	
	1.7	Transformation of intersecting lines.	
2		**Two dimensional transformations II.**	**10**
	2.1	Transformation: rotations, reflections, scaling, shearing.	
	2.2	Combined transformations.	
	2.3	Transformation of a unit square.	
	2.4	Solid body transformations.	
	2.5	Translations and homogeneous coordinates.	
	2.6	Introduction to Three Dimensional Transformations.	
3	**Plane Curves.**		**6**
	3.1	Introduction.	
	3.2	Curve representation.	
	3.3	Parametric curves.	
	3.4	Parametric representation and generation of a Circle and an Ellipse.	
4	**Bezier Curves.**		**4**
	4.1	Introduction.	
	4.2	Properties.	

Unit	Subunit	Content	No. of lectures
4	**Bezier Curves.**		
	4.3	Parametric equation.	
	4.4	Bezier Curve fitting (up to n = 3), equation of the curve in matrix form (upto n = 3).	

Textbook

D. F. Rogers, J. A. Adams, Mathematical elements for Computer graphics, Mc Graw Hill Intnl Edition.

Unit 1 and 2: Chapter 2: Sec. 2-1 to 2.17
Unit 3 and 4: Chapter 4: Sec. 4.1, 4.2, 4.5, Chapter 5: Sec. 5.1, 5.8

Reference books

1. Computer Graphics with OpenGL, Donald Hearn, M. Pauline Baker, Warren Carithers, Pearson (4^{th} Edition)
2. Schaum Series, Computer Graphics.

Paper No. : II	**Paper Code : MAT35202**
Name of the Paper : Practical Course based on Basic Course in Computational Geometry (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Written practical on Unit 1.
Practical 2.	Written practical on Unit 1.
Practical 3.	Written practical on Unit 1.
Practical 4.	Python Programming practical based on Unit 1.
Practical 5.	Written practical on Unit 2.
Practical 6.	Written practical on Unit 2.
Practical 7.	Written practical on Unit 2.
Practical 8.	Python Programming practical based on Unit 2.
Practical 9.	Written practical on Unit 3.
Practical 10.	Written practical on Unit 3.

List of Practical	
Practical 11.	Written practical on Unit 3.
Practical 12.	Python Programming practical based on Unit 3.
Practical 13.	Written practical on Unit 4.
Practical 14.	Python Programming practical Miscellaneous I.
Practical 15.	Python Programming practical Miscellaneous II.

Text Books

1. Jaan Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, (2005)
2. Robert Johansson, Introduction to Scientific Computing in Python
3. Jason Brownlee, Basics of Linear Algebra for Machine Learning, Discover the Mathematical Language of Data in Python

Reference Books

1. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015.
2. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
3. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.
4. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle and Associates Inc.
5. Jim Arlow, Interactive Computational Geometry in Python

Modalities for conducting practical and practical Examination :

1. There will be one 4 hours practical session for each of batch of 15 students per week for each practical course.
2. A question bank consisting of 50 problems in all for each semester, will be the course work for this paper. Question bank will be prepared by the individual subject teacher and the problems included should be changed every year.
3. Each student will maintain a journal to be provided by the college.
4. The internal 20 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.
5. External examiner shall be appointed by the college for Mathematics Practical Examination.
6. The duration of practical examination is 2 hours.

7. The practical examination will consist of written examination of 30 marks out of which theory Question paper will be of 25 marks and 5 marks oral examination.
8. The pattern for the practical written (Theory) examination will be as follows:

- **Solve any 5 questions out of 8 questions.**
- **Each question will be of 5 marks.**

9. Study tours may be arranged at places having important Mathematical institutes orhistorical places.

Special Instruction:

a) Before starting each practical necessary introduction, basic definitions and prerequisites must be discussed.

b) Examiners should set separate question papers, solutions and scheme of marking for each batch and claim the remuneration as per rule.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous) Ganeshkhind, Pune 411016

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(Faculty of Science & Technology)

T.Y. B. Sc. Microbiology

Under NEP
(To be implemented from 2025-2026)

Title of the Course: B. Sc. Honors (Microbiology)

Preamble:

Microbiology is a broad discipline of biology involving study of five types of microorganisms i.e., bacteria, protozoa, algae, fungi and viruses. It deals with the interaction of microorganisms with each other and with plants, animals and the environment. Microorganisms were discovered over three fifty years ago and it is thought that a huge diversity still remains to be explored. Since the inception of microbiology as a branch of science, it has remained an ever-expanding field of active research, broadly categorized as pure and applied science. Knowledge of different aspects of Microbiology has become crucial and indispensable to society. Microbes can be harnessed for human welfare. They find applications in the fields such as nanotechnology, genetic engineering, pharmaceutical, fermentation, food and agriculture industries and as study models. Some microorganisms cause important diseases of plants and animals including humans. Microbiologists play a significant role in diagnosis, prevention and control of these diseases. There is a continuous demand for microbiologists as a work force in the fields of education, industry and research. Career opportunities for the graduate students are available in industry and research equally.

Introduction:

In the post globalization world higher education has to play a significant role in creation of skilled human resources for the well-being of humanity. The barriers among the academic fields seem to have dissolved. However, the disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing scenario at local and global level, the syllabus restructuring should keep pace with developments in the education sector. The National education policy aims to incorporate interdisciplinary approach to insure overall development of students. NEP is being adopted and implemented to address the issues related to traditional systems and it also aims to maintain the best of earlier curriculum. It caters skill based education where the graduate attributes are first kept in mind to reverse design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in **B.Sc. (Honours) Microbiology** is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages.

Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability. The college provides an environment for the overall development of students into responsible citizens with multi-dimensional personalities by inculcating among students a blend of scientific insights, compassionate and progressive attitude, cultural awareness, and time-tested traditional values.

Programme outcomes after completing B. Sc. Students are expected to develop
Knowledge Outcomes:
PO1: Demonstrate and apply the fundamental knowledge of the basic principles in the fields of Microbiology
PO2: Create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.
PO3: Apply fundamental knowledge for doing qualitative and quantitative analyses in various fields.

Skill Outcomes:
PO4: Collaborate effectively on team-oriented projects in the field of sciences.
PO5: Communicate scientific information in a clear and concise manner both orally and in writing PO6: Explain environmental pollution issues and the remedies thereof.
PO7: Apply the knowledge to develop the sustainable and eco-friendly technology in Industry. **Generic Outcomes:**
PO10: Ability of critical reasoning and judgment.
PO11: Acquired a basic knowledge and skillset for becoming employable.
PO12: Will enhance the scientific temper so as to develop a research interest.

Objectives to be achieved:
- To enrich students' knowledge and train them in the pure microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate a sense of scientific responsibilities and social and environment awareness.
- To help students build-up a progressive and successful career.

Course Structure:
The structure of the Three/Four-year bachelor's degree programme allows the opportunity to the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning in different institutions. The minimum and maximum credit structure for different levels under the Three/Four -year UG Programme with multiple entry and multiple exit options are as given below:

Levels	**Qualification**	**Credit Requirements**		**Semester**	**Year**
		Minimum	**Maximum**		
4.5	UG certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree-Honours	160	176	8	4

Medium of Instruction: English

Award of Credits:

- Each course having 4 credits shall be evaluated out of 100 marks and student should secure at least 40 marks to earn full credits of that course.

- Each course having 2 credits shall be evaluated out of 50 marks and student should secure at least 20 marks to earn full credits of that course.

- GPA shall be calculated based on the marks obtained in the respective subject, provided that student should have obtained credits for that course.

- For First year: Student has to selects one major and one minor among the subjects offered by the College /Institute. The student has to earn 22 credits per semester by selecting courses such as open elective course, VSEC, SEC, AEC, IKS and CC from different verticals.
- For Second year: Student will continue with selected major and can select minor among the subjects offered by the College /Institute. The student will earn total of 22 credits through OE, VSEC, SEC, FP, CEP, AEC and CC.
- For Third year: : Student will continue with selected major and can select minor among the subjects offered by the College /Institute. The student will earn total of 22 credits through VSEC, SEC, CEP, OJT, AEC and CC.
- CGPA will be calculated based on core 132 credits only.
- Each theory credit is equivalent to 15 clock hours of teaching (12 hrs classroom+3 hrs of tutorials-active learning method) and each practical credit is equivalent to 30 clock hours of teaching in a semester.
- For the purpose of computation of workload, the following mechanism may be adopted as per UGC guidelines:
- Each theory Lecture time for FY, SY, TY is of 1 lecture = 60 min
- Each practical session time for 2 credits is 4 hours.

GENERAL INFORMATION

Evaluation Pattern

Each theory and practical course carry 50 marks equivalent to 2 credits.

1. Each course will be evaluated with Continuous Assessment (CA) and University Assessment (UA) mechanism.
2. Continuous assessment shall be of 20 marks (40%) while End Semester Evaluation shall be of 30 marks (60%).
3. To pass each course, a student has to secure 40% mark in continuous assessment as well as university assessment i.e. 6 marks in continuous assessment and 14 marks in university assessment for the respective course.
4. For Continuous Assessment (internal assessment) minimum two tests per paper must be organized, of which one must be written test of 10 marks. 6. Method of assessment for internal exams: Viva-Voce, Project, survey, field visits, tutorials, assignments, group discussion, etc.

Department of Microbiology NEP BSc Honours Subject basket

Level	Semester	Disciplinary Major Mandatory	DSE Elective	Minor	OE	VC/SEC	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Total credits
4.5	I	4(Cr)(T) Microbial world and Principles of Microbiology 2(Cr)(P) Practical based on Microbial world and Principles of Microbiology	----		OE-2(Cr)(T) Microbiology in day to day life, OE-2 (Cr)(P) Microbiology in day to day life	VC-2 (Cr)(T) Dairy Microbiology, SEC-2(Cr)(P) Microscopy and Special staining techniques	AEC- 2Cr (T) English I, VEC- 2Cr (T) , IKS- 2Cr (T) Foundation course on Indian Knowledge	CC - 2Cr (Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts)	22
	II	4(Cr)(T) Microbial biochemistry and growth+ 2(Cr)(P) Practical based on Microbial biochemistry and growth	----	2(Cr)(T) Introduction to Microbiology	OE-2(Cr)(T) Human health and diseases+ OE-2(Cr)(P) Human health and diseases	VC-2(Cr) (P) Food and Dairy Microbiology, SEC-2(Cr)(P) Isolation and cultivation of microorganism	AEC- 2Cr (T) English II VEC- 2 Cr	CC - 2Cr (Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts)	22
		12		2	8	8	10	4	44
5	III	2(Cr)(T) Bacterial Physiology and Fermentation Technology +2(Cr) (T) Environmental Microbiology + 2 (Cr)(T) Food Microbiology+ 2(Cr)(P) Practical based on Bacterial Physiology and Environmental Microbiology	----	2(Cr)(T) Growth and cultivation of bacteria+ 2(Cr) (P) Practical on Growth and cultivation of bacteria	OE-2 (T) Microbes in agriculture	VC-2(Cr)(T) Industrial Microbiology	AEC 2Cr(T) Modern Indian Language I	2Cr FP, 2CC	22
	IV	2(Cr)(T)Bacterial Genetics+ 2(Cr)(T) IKS+ 2(Cr)(T) Agricultural Microbiology +2(Cr)(P) Practicals based on Bacterial genetics and agricultural Microbiology	----	2(Cr)(T) Industrial Microbiology 2(Cr)(P) Practical on Industrial Microbiology	OE-2 (P) Microbes in agriculture	SEC-2 (T) Microbial nanotechnology	AEC 2Cr(T) Modern Indian Language II	CEP-2Cr, 2CC	22
		28		10	12	12	14	18	44
5.5	V	2(Cr)(T) Medical Microbiology, 2 (Cr)(T) Basic and conceptual Immunology 2(Cr)(T) Enzymology 2(Cr)(P) Practicals based on Medical Microbiology and Basic and conceptual Immunology , 2 (Cr)(P) Practicals based on Enzymology and Genetics	2(Cr)(T) Genetics + 2(Cr) (T) Bioprocess technology	2 (Cr)(Th) Medical Microbiology and immunology, 2(Cr)(P) Practical based on Medical Microbiology and immunology		VC-2(Cr)(P) Practicals based on Bioprocess technology		2Cr FP/CEP	22

	VI	2(Cr)(T) Microbial diseases and Chemotherapy, 2 (Cr)(T), Advanced immunology and immunological techniques 2(Cr) (Th) Metabolism, 2 (Cr)(P) Practicals based on Microbial diseases and Chemotherapy and Advanced immunology and immunological techniques , 2(Cr) (P) Practicals based on Molecular biology and Metabolism	2 (T) Molecular Biology+ 2 (T/P) Practicals based on Applied microbiology	2(Cr)(T) Nanobiotechnology, 2(Cr)(P) Practicals based on nanobiotechnology				4Cr OJT	22
		48	8	18	12	14	14	18	44
6	VII	2(Cr)(T) Microbial systematics+ 4(Cr) (T) Quantitative Biology+ 4(Cr)(T) Biochemistry and Metabolism+ 4(Cr)(P) practicals based on Microbial systematics, Quantitative Biology, Biochemistry and	2(Cr)(T) Bioremediation and biomass utilization+ 2 (Cr)(P) Practical based on Bioremediation and biomass utilization	4(Cr)(T) Research Methodology					22
	VIII	2(Cr)(T) Instrumentation and Molecular biophysics+ 4(Cr) (T) Molecular Biology+ 4(Cr)(T) Cell organization and biochemistry+ 4 (Cr)(P) Practicals based on Instrumentation and Molecular biophysics, Molecular Biology, Cell organization and biochemistry	2(Cr)(Th) Microbial communication, Membrane transport and signal transduction+ 2 (Cr)(P) Practical based on Microbial communication, Membrane transport and signal transduction					4Cr OJT	22
		76	16	22	12	14	14	22	176

Evaluation Pattern

T. Y. B. Sc. Microbiology

	Semester-V			
Course type	**Course code**	**Course Title**	**Internal examination Marks**	**End Semester examination Marks**
Disciplinary Major Mandatory	MIC35101	Medical Microbiology 2(Cr)(T)	20	30
	MIC35102	Basic and conceptual Immunology 2(Cr)(T)	20	30
	MIC35103	Enzymology 2(Cr)(T)	20	30
	MIC35104	Practicals based on Medical Microbiology, Immunology 2 (Cr)(P)	20	30
	MIC35105	Practicals based Enzymology and Genetics 2(Cr)(P)	20	30
DSE Elective	MIC35106	Genetics 2 Cr (T)	20	30
	MIC35107	Bioprocess Technology 2 Cr (T)	20	30
Minor	MIC35208	Medical Microbiology and immunology 2(Cr)(T)	20	30
	MIC35209	Practical based on Medical Microbiology and immunology 2(Cr)(P)	20	30
VSEC	MIC35410	Practicals based on Bioprocess technology 2(Cr)(P)	20	30
FP/CEP	MIC35611	Field project/CEP 2(Cr)	20	30

	Semester-VI			
Course type	**Course code**	**Course Title**	**Internal examination Marks**	**End Semester examination Marks**
Disciplinary Major Mandatory	MIC36101	Microbial diseases and chemotherapy 2(Cr)(T)	20	30
	MIC36102	Advanced immunology and immunological techniques 2(Cr)(T)`	20	30
	MIC36103	Metabolism 2(Cr)(T)	20	30
	MIC36104	Practicals based on Microbial diseases and chemotherapy, Advanced immunology and immunological techniques 2 (Cr)(P)	20	30
	MIC36105	Practicals based Metabolism and Molecular Biology 2(Cr)(P)	20	30
DSE Elective	MIC36106	Molecular Biology 2 Cr (T)	20	30
	MIC36107	Practicals based on Applied Microbiology	20	30
Minor	MIC36208	Nano biotechnology 2(Cr)(T)	20	30
	MIC36209	Practical based Nano biotechnology 2(Cr)(P)	20	30
OJT 4(Cr)	MIC36610	On Job Training (4 Cr)	40	60

Semester V

Disciplinary Major Mandatory

MIC35101: Medical Microbiology 2(Cr)(T)

Course outcomes:

At the end of the course students will be able to

CO1: Explain the human anatomy, pathogens associated with diseases

CO2: Describe principles underlying establishment of pathogens in human body.

CO3: Correlate pathogenesis of specific pathogens causing human diseases.

CO4: Assess epidemiological patterns, mode of transmission, reservoirs, of microbial diseases

Unit No.	Topics	No. of Lectures (30)
Unit I	**1. Introduction to Brief anatomy, Physiology and Pathogens associated with following human body systems:** a. Respiratory system b. Gastrointestinal system and liver c. Urogenital system d. Central nervous system	4
	2. Epidemiology: a. Introduction to Epidemiology (Scope, definition and examples of Epidemic, Endemic, Pandemic diseases) b. Case control and cohort studies – Study design and application c. Clinical trials of drugs and vaccines – Principle and methods 1.Randomized control trials 2.Concurrent parallel 3.Cross-over trials	5
Unit II	Study of pathogens of GIT & UT with respect to to - Classification and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *E.coli*, *Klebsiella*, *Proteus*, *Salmonella*, *Vibrio*, *Shigella*	11

Unit III	**Study of following groups of pathogens:** (With respect to- Classification and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *a. Streptococcus pneumoniae, Streptococcus pyogenes, Neisseria meningitidis and Neisseria gonorrhoeae* *b. Pseudomonas aeruginosa* *c. Treponema, Leptospira* *d. Clostridium tetani* *e. Mycobacterium tuberculosis* and *Mycobacterium leprae* f. Rickettsial diseases - Scrub typhus, Spotted fevers	10

References:

1. Chakraborty P. (2013). A Textbook of Microbiology. 3rd edition. New Central Book Agency. India. ISBN-13: 978-8173818769
2. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4th edition. Ryan K. J. and Ray C. G. (editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
3. Dey N. C., Dey T. K. and Sinha D. (2013). Medical Bacteriology Including Medical Mycology and AIDS. 17th Edition. New Central Book Agency (P) Ltd (Publisher). India
4. Dulbecco R., Eisen H. N. and Davis B. D. (1990). Microbiology. United States: Publisher - Lippincott. ISBN: 9780608072432
5. Goering R., Dockrell H., Zuckerman M., Roitt I. and Chiodini P. L. (2018). Mims' Medical Microbiology and Immunology. 6th Edition. Elsevier. ISBN: 9780702071546
6. Kanungo Reba. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. Tenth edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251
7. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
8. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240
9. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
10. Park K. (2019). Park's Preventive and Social medicine. 25th Edition. Banarsidas Bhanot Publisher, Jabalpur. ISBN-13: 978-9382219156
11. Schuenke S. (1997). Medical Microbiology. Fourth edition. University of Texas Medical Branch of Galvesion. Samuel Baron (Editor). ASIN: B008UYPLIO
12. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An introduction 12th Edition,

Pearson. ISBN-13: 9780321929150

Links:

1. https://www.who.int/travel-advice/disease-information
2. https://Microbenotes.Com/Remdesivir/#Mechanism-Of-Action-Of-Remdesivir
3. *Aspergillus* https://www.cdc.gov/fungal/diseases/aspergillosis/index.html
4. *Histoplasma cap*sulatum https://www.cdc.gov/fungal/diseases/histoplasmosis/
5. *Cryptococcus neoformans* www.cdc.gov/fungal/diseases/cryptococcosis-neoformans/

Semester V

Disciplinary Major Mandatory

MIC35102: Basic and Conceptual Immunology 2(Cr)(T)

Course Outcomes:

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

CO1: Define types of immunity and diagrammatically represent the structure of immune cells and organs of immune system.
CO2: Describe various mechanisms underlined in first and second line of defense.
CO3: Site examples of Antigens and state factors affecting immunogenicity.
CO4: Explain antibody diversity, and give applications of monoclonal antibodies.
CO5: Compare the structure and function of MHC molecules, to correlate the role of MHC molecules in antigen presentation.
CO6: Correlate function of cytokines with its role in immune responses.

Unit No	Topics	No. of Lectures
Unit I	**Immunity Hematopoiesis and Lymphoid Organs**	**30**
	A. Definitions, types and cells involved in Innate and acquired immunity, Active & Passive immunity, Humoral and cell mediated immunity. **B.** Formation of Blood Cells (Hematopoiesis) **C.** Organs of immune system (Structure and Functions) 1. Primary lymphoid organs -Thymus and Bone marrow **2.** Secondary lymphoid organs- Lymph node, spleen, Mucous associated lymphoid tissue	3 5
	Defense mechanisms 1. First line of defense: Physical, chemical and biological barriers. 2. Second line of defense: a. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, and acute phase reactants. b. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells c. Phagocytosis (oxygen dependent and independent systems) d. Complement activation (Classical, Alternative and lectin pathway) e. Inflammation and fever (cardinal signs, mediators, vascular and cellular changes) f. Role of Toll-like receptors	1 6

Unit II	**Components of Immune System:** **A. Antigen:** a. Factors affecting immunogenicity b. Antigenic determinants, haptens and cross-reactivity, Carrier, Adjuvants c. Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens, superantigens ,blood Group Antigens	4
	B. Immunoglobulins: a. Structure and function of Immunoglobulins b. Antigenic nature of immunoglobulin molecules (Idiotypic, Isotypic, Allotypic) c. Molecular basis of antibody diversity (kappa, lambda and heavy chain) d. Hybridoma Technology and applications of monoclonal Antibodies	6
	C. MHC molecules a. Genetic organization, structure and functions of MHC molecules: class–I and class–II b. MHC antigen typing (micro cytotoxicity and mixed lymphocyte reaction) **D. Cytokines** **c.** Cytokines: Properties, Attributes and biological functions of cytokines.	**5**

References: MIC35102 Basic and conceptual Immunology

1. Abbas A. K. and Lichtman A. H. (2004). Basic Immunology- Functions and Disorders of Immune System. 2nd Ed. Saunders. Elsevier Inc. PA. USA.
2. Aderem A., and Underhill D. M. (1999). Mechanisms of phagocytosis in macrophages. Annu. Rev. Immunol. 17: 593-623.
3. Austin J. M. and Wood K. J. (1993). Principles of Molecular and Cellular Immunology. Oxford University Press, London
4. Barret J. D. (1983). Text Book of Immunology. 4th edition, C. V. Mosby and Co. London.
5. Bendelac A. Savage P. B. and Teyton L. (2007). The biology of NKT cells. Annu Rev Immunol. 25: 297-336.
6. Bohlson S. S., Fraser D. A. and Tenner A. J. (2007). Complement proteins C1q and MBL are pattern recognition molecules that signal immediate and long-term protective immune functions. Mol. Immunol. 44: 33–43.
7. De Smet K. and Contreras R. (2005). Human antimicrobial peptides: defensins, cathelicidins and histatins. Biotechnol. Lett. 27:1337–1347.
8. Fathman G., Soares L., Cha S. M. and Utz P. J. (2005). An array of possibilities for the study of autoimmunity. Nature Rev. 435(2):605-611
9. Ganz T. (2003). Defensins: antimicrobial peptides of innate immunity. Nat. Rev.

Immunol., 3:710–720.

10. Guyton A. C. and Hall J. E. (1996) Text Book of Medical Physiology, Goel Book Agency, Bangalore.
11. Janeway C. A., Travers P. Jr., Walport M. and Shlomchik M. J. (2005). Immuno- biology Interactive. Garland Science Publishing. USA.
12. Kindt T. J., Goldsby R. A. and Osborne B. A. (2007). Kuby Immunology. 6th Ed. W. H. Freeman and Co., New York
13. Kuby J. (1996) Immunology. 3rd Ed. W. H. Freeman and Co, New York
14. Pancer Z. and Cooper M. D. (2006). The Evolution of Adaptive Immunity, Ann. Rev. Immunol., 24: 497–518
15. Pathak S. S. and Palan V. (1997) Immunology - Essential and Fundamental. Pareen Publications Bombay.
16. Roitt E., Brostoff J. and Male D. (1993) Immunology. 6th Ed. Mosby and Co. London.
17. Roitt I. M. (1988). Essentials of Immunology. ELBS, London.
18. Roitt M. (1984). Essentials of Immunology. P. G. Publishers Pvt. Ltd., New Delhi.
19. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V. (1982). Basic and Clinical Immunology. 14th Ed. Lange Medical Publications. Maruzen Asia Pvt. Ltd., Singapore
20. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. NewDelhi.

Semester V

Disciplinary Major Mandatory

MIC35103: Enzymology 2(Cr)(T)

Course Outcomes:

At the end of the course students will be able to

CO1: Describe methods of active site structure determination, Role of enzymes and its cofactors in various biochemical reactions.
CO2: Explain theory behind enzyme assay, purification and quantification of enzyme activity, enzyme kinetics.
CO3: Derive mathematical equations for enzyme kinetics.
CO4: Explain metabolic regulation mechanisms occurring at enzymatic level and methodology for commercial applications of enzymes.

Unit No.	Topics	No. of lectures
Unit I	**Enzymes:**	**15**
	1. Structure of enzymes: a. Methods to determine amino acid residues at active site (Physical method e.g. x-ray crystallography and chemical methods such as trapping of ES complex, use of inhibitors, use of pseudo- substrate change of pH) b. Role of vitamins in metabolism: Occurrence, Structure and Biochemical functions of the following: i. Thiamine (Vitamin B1) and Thiamine Pyrophosphate ii. Vitamin D	4
	2. Enzyme assays: a. Principles of enzyme assays and calculation of enzyme unit, specific activity b. Enzymes assays with examples by: i. Spectrophotometric methods ii. Radioisotope assay	2

Unit II	**Principles and Methods of Enzyme purification:** a. Methods of cell fractionation b. Principles, methodology and applications of enzyme purification methods i. Gel exclusion/Filtration chromatography, Polyacrylamide Gel electrophoresis (SDS PAGE, Native PAGE), Two dimensional electrophoresis ii. Ion exchange Chromatography, Isoelectric focusing iii. Solvent precipitation , Salt precipitation iv. Affinity chromatography , Adsorption chromatography c. Construction of enzyme purification chart	9
Unit III	**Enzyme Kinetics, metabolic regulation and Immobilization Enzymes:**	**15**
	1. Enzyme Kinetics: a. Concept and use of initial velocity b. Michaelis-Menton equation for the initial velocity of single substrate enzyme catalyzed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Mentonplot, Lineweaver and Burk plot. Definition with significance of Km, Ks, Vmax	7
	2. Metabolic Regulations: a. Enzyme compartmentalization at cellular level b. Allosteric enzymes c. Feedback mechanisms d. Covalently modified regulatory enzymes (Glycogenphosphorylase) e. Proteolytic activation of zymogens f. Isozymes - concept and examples g. Multienzyme complex e.g. Pyruvate dehydrogenase complex (PDH)	7
	3. Immobilization of enzymes: Concept, methods of immobilization and applications	1

References: MB 353 Enzymology

1. Berg J. M., Stryer L., Tymoczko J. and Gatto G. (2019). Biochemistry. 9th Edition. Palgrave Macmillan. ISBN-978-1319114657.
2. Conn E. E., Stumpf P. K., Bruening G. and Doi R. H. (1987). Outlines of Biochemistry. 5th Edition. John Wiley and Sons. ISBN-13: 9780471052883

3. Hall D. A. and Krishna Rao K. (1994). Photosynthesis (Studies in Biology). 6thEdition. Cambridge University Press, London. ISBN-13: 978-1-133-10629-6
4. Garrett R. H. and Grisham C. M. (2013). Biochemistry. 5th Edition. Brooks/Cole, Publishing Company, California. ISBN-13: 978-1-133-10629-6
5. Katoch R. (2011). Analytical Techniques in Biochemistry and Molecular Biology. Springer New York. ISBN 978-1-4419-9785-2.
6. Nelson D. L. and Cox M. M. (2021). Lehninger's Principles of Biochemistry.8th Edition. Mac Millan Worth Pub. Co. New Delhi. ISBN:9781319228002
7. Palmer T. (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry. Horwood Pub. Co. Chinchester, England. ISBN-9781898563785
8. Segel I. H. (2010). Biochemical Calculations. 2nd Ed. Wiley India Pvt. Limited. ISBN: 9788126526437
9. Stanier R. Y., Adelberg E. A. and Ingraham J. L. (1985). General microbiology. 4th Edition. London: Macmillan.
10. Wilson K. and Walker J. (Editors). (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press, New York. ISBN-13: 978-0521731676

Semester V

Disciplinary Major Mandatory

MIC35104: Practicals based on Medical Microbiology, Immunology 2 (Cr)(P)

Course outcomes

At the end of the course students will be able to

CO1: Isolate and Identify Pathogens from clinical samples.
CO2: Determine the haematological Indices and blood cell counts.
CO3: Estimate the antibody titers in diagnosis of diseases.

Sr. No	Title of the Practical	No. of Practicals
1.	**Clinical microbiology:** **Physical, Chemical and Microscopic examination of Clinical samples -** Urine, Stool(occult blood test), Sputum.	3
2.	**Isolation, identification of following pathogens from clinical samples: Urine, stool, pus** i. *E. coli, Klebsiella* sp./ *Enterobacter* sp., *Proteus* sp. ii. *Salmonella* sp. iii. *Pseudomonas* sp. iv. *S. aureus or Streptococcus sp. or Enterococcus sp.* (for identification use of keys as well as Bergey's Manual is recommended)	5
3.	**Agglutination tests:** Widal test (Slide test/ tube test) Rapid Plasma Reagin Test(RPR)	2
4.	**Hemogram:** a. Estimation of hemoglobin: • by Cyanmethemoglobin method • Demonstration of Acid hematin method b. Determination of ESR and PCV values c. Differential Leukocyte Count from peripheral blood d. Determination of Total RBC and WBC Counts using Neubauer's chamber e. Calculation of hematological indices	5
	Total	15

Note: Students should learn to perform minimum 12 practical's from the course.

References:

1. Abramson J. and Abramson Z. H. (2011). Research Methods in Community Medicine: Surveys, Epidemiological Research, Programme Evaluation, Clinical Trials. Sixth Edition. Wiley. ISBN: 978-0-470-98661-5
2. Baveja C. P. and Baveja V. (2019). Text and Practical Microbiology for MLT. 3rd Edition. Arya Publishing Company. ISBN-13: 9788178558387
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0-387-24143-2
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., andStaley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
6. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9
7. Cappuccino, J.G. and Sherman, N. (2013) Microbiology: A Laboratory Manual. 10th Edition, Pearson Education Limited, London.
8. Godkar P. B. (2020). Textbook of Medical Laboratory Technology Volume 1 and 2. 3rd edition Bhalani Publishing House. ASIN: 9381496196. ISBN-13: 978- 9381496190
9. Greer D. L., Kane J., Summerbell R., Sigler L., Krajden S. and G. Land (Editors). (1999). Laboratory handbook of dermatophytes: a clinical guide and laboratory manual of dermatophytes and other filamentous fungi from skin, hair, and nails. Mycopathologia. 147: 113–114
10. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978- 9386261182
11. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
12. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240

13. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257

14. Rosana Y., Matsuzawa T., Gonoi T. and Karuniawati A. (2014). Modified slide culture method for faster and easier identification of dermatophytes. Microbiology Indonesia.8(3): 135-139 https://doi.org/10.5454/mi.8.3.7

15. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

Semester V
Disciplinary Major Mandatory

MIC35105: Practicals based Enzymology and Genetics 2(Cr) (P)

Course outcomes
After completion of this course the students will be able to
CO1: Determine the molar extinction coefficient, total carbohydtates, protein and reducing sugars.
CO2: Prepare acetate buffer
CO3: Separate amino acids and sugars by chromatography
CO4: Isolate and estimate DNA.
CO5: Transform bacteria by known plasmid.

Sr. No.	Title of the Practical	No. of Practical
1.	Determination of absorption spectra and molar extinction co-efficient of two different dyes (by colorimetry /spectrophotometry)	**1**
3.	Preparation of acetate buffer and calibration of pH meter	**2**
4.	Paper Chromatography and thin layer chromatography i. Separation and Identification of amino acids from mixture by paperchromatography ii. Separation and Identification of sugars from mixture by thin layer chromatography	**2**
5.	Extraction and quantitative estimation of total carbohydrate /proteins from naturalsample: i. Estimation of total carbohydrates from natural sources by Phenol Sulphuricacid method ii. Estimation of reducing sugar from natural sources by DNSA method ii. Estimation of proteins from natural sources by Folin Lowry method	**3**
6.	Isolation of genomic DNA from bacteria	**1**
7.	Determination purity of DNA and its quantification: a. Estimation of DNA by UV- spectrophotometric method, 260/280 ratio b. Estimation of DNA by the diphenylamine	**2**
8.	Preparation of competent cells, Bacterial Transformation, screening of antibiotic resistant recombinants and blue-white screening	**4**
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. David Plummer (2017) An Introduction to Practical Biochemistry, McGraw Hill Education; 3rd edition
2. S. Sadasivam and A Manickam (2018) Biochemical Methods New Age International Pvt Ltd Publishers

3. Joseph Sambrook, E.F. Fritsch,T. Maniatis (1989) Molecular Cloning: A Laboratory Manual, 3rd edition, Cold Spring Harbor Laboratory Press,U.S.

Semester V

Discipline Specific Elective

MIC35106: Genetics 2 Cr (T)

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

CO1: Explain the mechanism of prokaryotic DNA Replications
CO2: Explain and diagrammatically represent mechanisms of gene expression
CO3: Describe mechanisms of genetic transfer and recombination amongst bacteria
CO4: Carry out mapping of genes of bacteria from the data provided

Unit No.	Topics	No. of lectures
Unit I	**DNA Replication and Gene Expression**	**15**
	1. Process of prokaryotic DNA replication a. Single replicon b. Bidirectional movement of replication fork c. Ori C d. Pre-priming and Priming reaction. e. DNA polymerases, DNA synthesis of leading, lagging strand Okazaki fragments. f. Comparative study of prokaryotic and eukaryotic DNA replication. g. Termination- *ter* sequence, Tus protein	4
	2.Transcription in prokaryotic and eukaryotic cells **i. Transcription in prokaryotic cells** a. Structure of promoter b. Structure and function of RNA polymerase c. Steps of transcription: Initiation, Elongation and termination **ii. Transcription in eukaryotes with respect to protein coding Gene:** a. Promoter, promoter proximal elements and enhancers b. Transcription regulatory proteins c. RNA polymerases d. Steps in transcription: Initiation, Elongation, Termination e. Post transcriptional modifications: 5' capping, 3' polyadenylationand introduction to RNA splicing	3 3

3. Regulation of transcription: Concept and components of operon:Lac operon: Inducible operon	2
4. Translation in prokaryotes and eukaryotes a. Structure and role of m-RNA, t-RNA and Ribosomes in Translation b. Role of Aminoacyl t-RNA synthetase in translation c. Steps in translation: Initiation, elongation, translocation and termination of protein synthesis d. Salient features of Eukaryotic translation	3
Gene transfer and mapping techniques	**15**
5. Gene transfer by Transformation a. Natural transformation Systems- *Streptococcus pneumoniae* and *Haemophilus influenzae*. b. Factors affecting transformation i. Competence development ii. Size of DNA iii. Concentration of DNA	3
6. Gene transfer by Conjugation a. Discovery of Conjugation, b. Properties of F plasmid, F^+, F^-, Hfr and F′ strains c. Process of conjugation between F^+ and F^- , Hfr and F^-, F 'and F-	3
7. Gene transfer by Transduction a. Discovery of Transduction b. Generalized transduction mediated by P22 c. Specialized transduction mediated by lambda phage	3
8. An introduction to Gene mapping a. Gene linkage and concept of genetic recombination b. Recombination mapping: Map unit, recombination frequency c. Mapping of genes by co-transformation d. Mapping of genes by co-transduction e. Mapping by interrupted mating experiment f. Numerical problems based on co-transformation, co-transduction and interrupted mating	6

References: MIC35106 Genetics

1. Birge E. A. (2013). Bacterial and Bacteriophage Genetics. Springer, New York. ISBN: 9781475732580
2. Brooker R. J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw- HillPublication.
3. Clokie M. R. J. and Kropinski A. M. (editors): Bacteriophage: Methods and Protocols.Volume 1. Isolation, Characterisation and Interactions. Series Volume 501. Humana Press, New York
4. Clutterbuck A. J. (1996). Parasexual recombination in fungi. J. Genet. 75(3): 281-286, @Indian Academy of Sciences
5. Dubey R. C. (2014). Advanced Biotechnology. S. Chand Publishing. ISBN: 9788121942904
6. Freifelder D. (2005). Microbial Genetics. 2nd Edition. Narosa Publishing House Pvt.Limited, India.
7. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics. 8th edition. John Wiley and Sons Publication. ISBN-13: 9788126510436
8. Goodenough U. (2016). Genetics. Publisher: Holt, Rinehart and Winston. ISBN- 13:978-0030197161
9. Gupta P. K. (2020). Elements of biotechnology. 4th Reprint (2nd Edition). Product Code: BC-22. Rastogi Publications. Meerut, India. ISBN: 978-81-7133-937
10. Hartwell L., Goldberg M., Fischer J. and Hood L. (2018). Genetics: from genes to genomes. McGraw-Hill. ISBN13: 9781259700903
11. Hayes W. (1968). Genetics of Bacteria and their Viruses. 2nd Edition. Oxford-Edinburgh: Blackwcll Scientific Publications.
12. Hyman P. and Abedon S.T. (2009). Practical methods for determining Phage growth parameters. Methods Mol Biol. 501:175-202. doi: 10.1007/978-1-60327-164-6_18. PMID: 19066822.
13. Klug W. S., Cummings M. R., Spencer C. A., Michael A. and Palladino M. (2019).Genetics. Pearson Publisher. ISBN 13: 978-0-134-60471-8
14. Kohli D. V. and Vyas S. P. (2009). Pharmaceutical Biochemistry. Published by CBSPublishers and Distributors CBS. ISBN 13: 9788123916903
15. Lewin's GENES X (2011). Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). 10th Edition. Sudbury, Mass.: Jones and Bartlett, c2011.
16. Lodish H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., Martin K. C., Yaffe M. and Amon A. (2021). Molecular Cell Biology, 9th Edn. Macmillan Learning. ISBN: 9781319208523
17. Pal J. K. and Ghaskadabi S. (2009). Fundamentals of Molecular Biology. Oxford UniversityPress. ISBN: 9780195697810
18. Russel P. J. (2000). Fundamentals of Genetics. Publisher: Benjamin/Cummings. ISBN: 9780321036261

19. Russel P. J. (2010). iGenetics: A Molecular Approach. 3rd Edition. BenjaminCummings. ISBN: 9780321569769
20. Stanier R. Y. (1999). General Microbiology. 5th Edition. Palgrave Macmillan
21. Strickberger M.W. (2012). Genetics. 3rd Edition. New Delhi: PHI LearningGardner.
22. Tamarin R. H. (2002). Principles of Genetics. Publisher: McGraw-Hill Education (India) Pvt Limited. ISBN:9780070486676
23. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014).Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436

Discipline Specific Elective Course

MIC35107: Bioprocess Technology 2 Cr (T)

Course Outcomes
At the end of the course students will be able to:
CO1:Explain downstream processing of fermentation product.
CO2: Describe process patentability and process validation.
CO3: Describe solid state, submerged and large scale fermentations
CO4: Explain with a flow sheet production of primary metabolites, secondary metabolites, enzymes and food items.
CO5 : Explain production processes of immune sera and vaccines

Unit No.	Topics	No. of lectures
Unit I	**Downstream processing and Quality assurance of fermentation Products**	**15**
	1. Downstream processing of fermentation products: (method, principle, types, examples of fermentations, factors affecting, merits and demerits at large scale operation) a. Cell disruption methods b. Filtration c. Centrifugation d. Liquid-liquid extraction e. Distillation f. Drying	**5**
	2. Quality assurance of fermentation products (as per IP, USP) a. Methods of detection and Quantification of the fermentation product: physicochemical, biological and enzymatic methods b. Sterility testing (direct inoculation method, membrane filtration method) c. Bioburden test d. Microbial limit test e. Concept of pyrogen, mutagen (Ames Test) and toxicity testing f. Shelf life determination	**8**
	3.Introduction to Intellectual Property Rights – Types of IPR (patenting in fermentation industry) 4.Concept of validation (significance of SOPs)	**2**

UNIT II	**Solid state and Submerged state fermentations and Large scale fermentations**	**15**
	1. Introduction to Solid State Fermentation and Submerged Fermentation: Process, production strains, media, fermenter design, fermentation conditions, applications, merits and demerits	8
	2. Large scale production of (process with flow sheet, nature of the product, production pathway, applications, production strains, media, fermentation process, parameters, product recovery) **a. Primary Metabolites:** i. Vitamins (B12) ii. Amino acids – Glutamic Acid iii. Organic acids -Citric acid **b. Secondary metabolites:** i. Alcoholic Beverages - a. Beer (Lagering, Maturation, Types of beer) b. Wine (Aging, Malo-lactic acid fermentation, types of wine, wine defects, comparison of white and red wine) Antibiotics -Penicillin (natural and semi synthetic)	
	Large scale production of enzymes, biomass-based products, milk products, vaccines, immune sera	**7**
	i. **Enzymes-**Amylase	1
	5. **Biomass based products:** Probiotics: *Lactobacillus sporogenes*	1
	6. Milk products: i. Cheese (Processed, soft, semi-hard, hard ripened types- bacterial and mold) ii. Yogurt (plain, flavored, probiotic yoghurt)	2
	7. Vaccines i. Polio – Inactivated Polio Vaccine, Oral Polio Vaccine ii. Tetanus – Tetanus toxoid (TT)	2
	8. Immune sera i. Anti rabies serum (ARS)	1

References: MIC35107 Bioprocess Technology

1. A. and Bakker W. A. M. (2013). Scale-down of the inactivated polio vaccine production process. Biotechnology and Bioengineering. 110(5):1354-1365. DOI: 10.1002/bit.24798.
2. Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. AcademicPress, New York,
3. Arora D. K. (Editor). (2003). Fungal Biotechnology in Agriculture, Food and Environmental Applications (Mycology). CRC Press. ISBN 9780824747701.
4. Bailey J. A., Bailey J. E., Bailey J., Simpson R. J. and Ollis D. F. (1986). Biochemical Engineering Fundamentals. 2nd Edition. McGraw-Hill. Chemical Engineering Series. McGraw-Hill Publisher. ISBN: 0070032122, 9780070032125
5. BIOTOL series. (1992). Bioreactor Design and Product Yield. Butterworths- Heinemann (Publisher). ISBN-13: 978-0750615082
6. BIOTOL series. (1992). Operational Modes of Bioreactors. Butterworths-Heinemann.ISBN-13: 978-0750615082
7. British Pharmacopeia. (2021). The Stationery Office Ltd (TSO), PO Box 29, Norwich, NR3 1PD. https://www.pharmacopoeia.com/Catalogue/Products
8. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited.ISBN-9788122438024
9. Ferreira I. N. S., Rodríguez D. M., Campos-Takaki G. M. and da Silva Andrade R. F. (2020). Biosurfactant and bioemulsifier as promissing molecules produced by *Mucor hiemalis* isolated from Caatinga soil. Electron J Biotechnol. DOI: 10.1016/j.ejbt.2020.06.006
10. Flickinger M. C. (2010). Encyclopedia of Bioprocess Technology. Seven Volume Set. Wiley-Interscience, New Jersey. ISBN: 978-0-471-79930-6
11. Indian Pharmacopeia. (2018- Addendum 2021): https://www.indianpharmacopoeia.in/index.php
12 .Lydersen B. K., D' Elia N. A. and Nelson K. L. (Eds.). (1994). Bioprocess Engineering: Systems, Equipment and Facilities. Wiley. ISBN: 978-0-471-03544-2
13. Meshram S. U. and Shinde. G. B. (2009). Applied Biotechnology. I K International Publishing House. ISBN-13: 978-93-80026-56-5, ISBN: 93-80026-56-0
14. Moo-Young M. (2019). Comprehensive biotechnology. Third edition. Volume 1: Scientific Fundamentals of Biotechnology. Volume 2: Engineering Perspectives in Biotechnology. Volume 3: Industrial Biotechnology and Commodity Products. Volume 4: Agricultural and Related Biotechnologies. Volume 5: Medical Biotechnology and Healthcare. Volume 6: Environmental and Related Biotechnologies. Pergamon Press Limited, England. ISBN: 978- 0-444-64047-5

15. Patel. A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-

16. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: Microbial Processes. Academic Press, New York. ISBN: 978-0-12-551501-6

17. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279

18. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVI Publishing Co Inc.

19. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology. 3rd Edition. Butterworth-Heinemann. ISBN: 9780080999531

20. Thomassen Y. E., van't Oever A. G., Vinke M, Spiekstra A., Wijffels R. H, van der Pol L.

21. Uzoigwe C., Burgess J.G., Ennis C.J. and Rahman P.K.S.M. (2015). Bioemulsifiers are not biosurfactants and require different screening approaches. Front. Microbiol.6:245. doi: 10.3389/fmicb.2015.00245.

22. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics. Marcel Dekker Inc. New York. ISBN-13: 978-0824770563

23. Van Wezel A. L., van Steenis G., van der Marel P. and Osterhaus A. D. M. E. (1984). Large scale production of polio vaccine - Inactivated Poliovirus Vaccine: Current Production Methods and New Developments. Reviews of Infectious Disease. 6 (2): S335–S340. https://doi.org/10.1093/clinids/6.Supplement_2.S335

24. Vaughn, R. H., & Reed, G. (1981). Prescott & Dunn's Industrial Microbiology. 4th Edition. MacMillan publishers.

25. Wiseman A. (1983) Topics in Enzyme and Fermentation – Biotechnology. Volume 7. Ellis Horwood Limited, Publishers: Chichester. John Wiley and sons,New York.

Reference links:

26. Guidelines for Tetanus Vaccine production:

https://www.who.int/biologicals/vaccines/Tetanus_Recommendations_TRS_980_Annex_5

https://academic.oup.com/jimb/article-pdf/18/5/340/34773995/jimb0340.pdf.

27 .Large scale production of rabies vaccine:

28. Large scale production of tetanus vaccine:

http://nopr.niscair.res.in/bitstream/123456789/26533/1/JSIR%2060%2810%29%20773- 778.pdf.

29. USA Clinical Laboratory Standards Institute(CLSI) Guidelines 2021: https://clsi.org

Minor

MIC35208: Medical Microbiology and Immunology 2(Cr)(T)

Course Outcomes

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

CO1: Explain the concept of epidemiology with respect to key terms like Incubation period, Viability etc.

CO2: Discuss various aspects of human pathogens such as *Escherichia coli*, *Staphylococcus aureus*, *Candida* and Dermatophytes.

CO3: Delineate Principles of Chemotherapy.

CO4: Describe haematopoiesis, Antigens and antibodies, Immunohematology, Inheritance of ABH antigens, Medico legal applications of blood groups

CO5: Summarize Active and Passive immunization.

Unit I	**Medical Microbiology**	**No. of Lectures (15)**
1	**Definitions** Incubation period, Viability, Susceptibility, Pathogenicity, Virulence, Pathogenesis, Lab diagnosis, Epidemic, Sporadic, Endemic, Pandemic	2
2	**Study of following pathogens with respect to** Classification, Morphological, Cultural and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy: **Bacteria:** a) *Escherichia coli* b) *Staphylococcus aureus* **Fungi:** a) *Candida* b) *Dermatophytes*	8
2	**Introduction to Chemotherapy** i. Selective toxicity, Bioavailability, MIC, MBC, LD50 ii. Antagonism and synergism in drug administration iii. Antibiotic sensitivity iv. Antibiotic misuse/antibiotic overuse v. Concept of drug resistance (e.g. MRSA, ESBL)	5
Unit II	**Immunology**	**(15)**
1	**Immunity** Definition, Types (Innate and acquired, active and passive, humoral and cell mediated)	2
1	**Formation of blood cells (Hematopoiesis)** Myeloid and lymphoid lineages and differentiation process Lymphocyte types	3
3	**Antigens and antibodies: Definition and Concept**	2
4	**Immunohematology** i. ABO and Rh blood group systems ii. Bombay blood group iii. Biochemistry of blood group substances iv. Inheritance of ABH antigens v. Medico legal applications of blood groups	5
5	**Active and Passive Immunization** i. Active Immunization -Whole organism vaccines a) Attenuated vaccines b) Inactivated Vaccines ii. Passive Immunization	3

	Transfer of preformed antibodies iii. Latest Immunization schedule in India	

References

1. Kanungo Reba. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. Tenth edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251

2. Collins C. H., Lyne P. M., Grange J. M. and Falkinham J. O. III. (Editors). (2004). Collins and Lyne's Microbiological Methods. 8th edition. Arnold, London; Oxford

3. Finch R., Greenwood D., Whitley R. and Norrby S. R. (2010) Antibiotic and Chemotherapy. 9th Edition. Elsevier. ISBN: 9780702040641

4. Dulbecco R., Eisen H. N. and Davis B. D. (1990). Microbiology. United States: Publisher -Lippincott. ISBN: 9780608072432

5. Dey N. C., Dey T. K. and Sinha D. (2013). Medical Bacteriology Including Medical Mycology and AIDS. 17th Edition. New Central Book Agency (P) Ltd (Publisher). India
6. Kindt T. J., Goldsby R. A. and Osborne B. A. (2007). Kuby Immunology. 6th Ed.

W. H. Freeman and Co., New York.
7. MacFaddin J. F. (1985). Media for Isolation-Cultivation-Identification –Maintenance of Medical Bacteria. Vol. I. Williams and Wilkins, Baltimore
8. MacFaddin J. F. (2000). Oxidation- Fermentation Test. Biochemical Tests for Identification of

Medical Bacteria. 3rd ed. Philadelphia: Lippincott Wilkins and Williams. 379-387. B, III
9. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257

10. Mukred A. M., Hamid A. A., Hamzah A. and Wan Mohtar Wan Yusoff W. M. W. (2008). Growth Enhancement of Effective Microorganisms for Bioremediation of Crude Oil Contaminated Waters. Pakistan Journal of Biological Sciences.11: 1708-1712.

11. Pathak S. S. and Palan V. (1997). Immunology-Essential and Fundamental, Pareen Publications Bombay.

12. Public Health England. (2019). Oxidation/fermentation of glucose test. UK Standards for Microbiology Investigations. TP 27 Issue 4. https://www.gov.uk/uk-standards- formicrobiology-investigations-smi-quality-and-consistency-in-clinical-laboratories

13. Roitt Evan, Brostoff J., Male D. (1993) Immunology. 6th Edition. Mosby and Co. London.

14. Roitt I. M. (1988). Essentials of Immunology, ELBS, London.

15. Roitt M. (1984). Essentials of Immunology. P. G. Publishers Private Limited, New Delhi.

16. Roth J. A., Bolin C., Brogden K. A., Chris Minion K. F. and Wannemuehler M. J. (1995). Virulence mechanisms of bacterial pathogens. Second edition. American Society for Microbiology. ISBN-13: 978-1555810856

17. Schuenke S. (1997). Medical Microbiology. Fourth edition. University of Texas Medical Branch of Galvesion. Samuel Baron (Editor). ASIN: B008UYPLIO

18. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4th edition. Ryan K. J. and Ray C.

19. G. (Editors). McGraw-Hill Companies. DOI: 10.1036/0838585299

20. Shrivastava M., Navaid S., Peethambarakshan A., Agrawal K. and Khan A. (2015). Detection of rare blood group, Bombay (Oh) phenotype patients and management by acute normovolemic hemodilution. Asian journal of transfusion science. 9(1):74–77

21. Standards Unit. National Infection Service. PHE Bacteriology – Test Procedures.TP. 27(4): Issue date: 16.01.19. 1-14

22. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V. (1982). Basic and Clinical Immunology. 4th Edition. Lange Medical Publications, Maruzen Asia Pvt. Ltd., Singapore.

23. Gangal S. and Sontakke S. (2013). Textbook of Basic and Clinical Immunology. Universities Press Private limited. Available also at Orientblackswan, India. ISBN: 9788173718298

24. Talwar G. P. (1983). Handbook of Immunology. Vikas Publishing Pvt. Ltd. NewDelhi.

25. Paul W. E. (2003): Fundamental Immunology. 5th edition. Lippincott Williams and Wilkins Publishers. ISBN: 9780781735148

26. Joklik W. K., Willett H. P., Amos D. B. and Wilfert C. M. 1995). Zinsser's Microbiology. 20th Edition. Appleton and Lange Publisher. ISBN-13: 978- 0838599839

27. Zajic J. E. and Supplisson B. (1972). Emulsification and degradation of "Bunker C" fuel oil by microorganisms. Biotechnol. Bioeng. 14: 331-343.

Minor

MIC35209: Practical based on Medical Microbiology and immunology 2(Cr) (P)

Expt. No.	Topics	No. of Practicals
1.	Isolation and identification of pathogens from clinical samples: (*Escherichia coli*, *Staphylococcus aureus* and ***Proteus***) by a. Gram staining & motility, b. Cultural and Biochemical characteristics i. Sugar utilization test, ii. Sugar fermentation test, iii. Triple Sugar iron agar, iv. IMViC test v. Enzyme detection – Gelatinase, Catalase, Oxidase, Coagulase (free and bound) vi. Oxidative-fermentative test [Baird Parker's modification of Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram Positive and Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram negative; Public Health England, 2019]	6
2	Sterility Testing of pharmaceuticals (non-biocidal injectables): Direct inoculation method, membrane filtration method (Demonstration), using control test cultures as per IP guidelines (availability at the center).	2
3.	Minimum inhibitory concentration and minimum bactericidal concentration of antibacterial compounds (MIC and MBC)	3
4.	Antibiotic and growth factor assay (agar gel diffusion technique)	2
5.	Blood grouping: ABO, Rh and Bombay blood group (anti H Lectin test)	2
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

Isolation and identification of pathogens from clinical samples:

1. Mac Faddin J. F. (2000). Biochemical Tests for Identification of Medical Bacteria. United
2. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology. Second Edition. Elsevier (A Division of Reed Elsevier India Pvt. Limited).
3. Verhaegen J. and Heuck C. C .(Editors). (2003). Basic Laboratory Procedures in Clinical Bacteriology. Second Edition. Switzerland: World Health Organization.

Sugar utilization test: Minimal salt Medium (MSM with 1% sugar):

1. Mukred A. M., Hamid A. A., Hamzah A. and Wan Yusoff W. M. (2008). Enhancement of Biodegradation of Crude Petroleum-Oil in Contaminated Water by the Addition of Nitrogen Sources. Pakistan Journal of Biological Sciences, 11: 2122-2127.
2. Mahalingam B. L., Karuppan M. and Manickam V. (2013). Optimization of Minimal Salt Medium for Efficient Phenanthrene Biodegradation by Mycoplana sp. MVMB2 Isolated from Petroleum Contaminated Soil Using Factorial Design Experiments. CLEAN - Soil, Air, Water. 41(1): 51–59. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim

Sugar fermentation test:- Phenol Red Broth Base:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Mac Faddin J. F. (2000). Biochemical Tests for Identification of Medical Bacteria. United Kingdom: Lippincott Williams and Wilkins.

Triple sugar Iron Agar:

1. Jain A., Agarwal J. and Venkatesh V. (2018). Microbiology Practical Manual. 1st Edition. E- Book. Elsevier Health Sciences, India.
2. Mac Faddin J. F.(2000). Biochemical Tests for Identification of Medical Bacteria.United Kingdom:Lippincott Williams and Wilkins.
3. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology. Second Edition. Elsevier (A Division of Reed Elsevier India Pvt. Limited).

IMViC test:

1. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
2. Jain A., Agarwal J. and Venkatesh V. (2018). Microbiology Practical Manual. 1st Edition. E- Book. Elsevier Health Sciences, India.
3. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology. Second Edition. Elsevier (A Division of Reed Elsevier India Pvt. Limited).
4. Verma A. S., Das S., and Singh A. (2014). Laboratory Manual for Biotechnology. S Chand and Company Limited, New Delhi, India

Enzyme detection:

1. Carroll K.C., Pfaller M. A., Landry M. L., McAdam A. J., Patel R., Richter S. S. and Warnock
Wiley, USA
2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Goldman E. and Green L. H. (2008). Practical Handbook of Microbiology. United States: CRC Press.
4. Leber A. L. (2020). Clinical Microbiology Procedures Handbook. United States: Wiley.
5. Verhaegen J. and Heuck C. C . (Editors). (2003). Basic Laboratory Procedures in Clinical Bacteriology. Second Edition. Switzerland:World Health Organization.

Sterility testing

https://www.who.int/medicines/publications/pharmacopoeia/TestForSterility-RevGenMethod_QAS11-413FINALMarch2012.pdf.

Microbiological assay of antibiotics: https://apps.who.int/phint/pdf/b/7.3.1.3.1-Microbiologicalassay-of-antibiotics.pdf

USA Clinical Laboratory Standards Institute(CLSI) Guidelines 2021 on https://clsi.org/

Microbiological assay of vitamins:

https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=14117andcontext=rtd.
https://www.pharmaguideline.com/2011/09/microbiological-assay-ofcyanocobalamin.
html.

Blood grouping:

2. Godkar D. P. (2003). Textbook of Medical Laboratory Technology. Bhalani Publishing House, New Delhi, India.
3. Mukherjee K. L. (2013). Medical Laboratory Technology. Second Edtion. Volume III. McGraw-Hill Companies, India. D. W. (Editors). (2019). Manual of Clinical Microbiology. 2 Volume Set. 12th Edition. John

Semester V

VSEC

MIC35410: Practicals based on Bioprocess technology 2(Cr)(P)

Sr. No	Title of the Practical	No. of Practical
1.	Sterility Testing of pharmaceuticals (non-biocidal injectables): Direct inoculation method, membrane filtration method, using control test cultures as per IP guidelines (availability at the center).	**2**
2.	Minimum inhibitory concentration and minimum bactericidal concentration of antibacterial compounds (MIC and MBC)	**2**
3.	Antibiotic and growth factor assay (agar gel diffusion technique)	**2**
4.	Study of SOPs for pharmaceutical industry a. disinfectant efficacy testing b. Physical monitoring of microbiology section c. Handling of biological indicators d. Microbiological testing of vials e. Identification of contaminant in sterile area	**1**
5.	Lab Scale production of the fermentation products: a. Ethanol (fermentation, recovery by simple distillation, estimationof end product by CAN method and fermentation efficiency) b. Citric acid (fermentation, recovery by acid base precipitation andestimation of product by titrimetry)	**4**
6.	Solid state fermentation for production of any one fermentation product (*Trichoderma sp.* / mushrooms / enzymes)	**2**
7.	Isolation and identification of Probiotic microflora from natural sources or any commercial formulation.	**2**
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. British Pharmacopeia. (2021). The Stationery Office Ltd (TSO), PO Box 29, Norwich,NR3 1PD. https://www.pharmacopoeia.com/Catalogue/Products
2. Indian Pharmacopeia. (2018 Addendum 2021). https://www.indianpharmacopoeia.in/index.php

3. USA Clinical Laboratory Standards Institute(CLSI) Guidelines 2021 on https://clsi.org/
4. Sterility Testing:
https://www.who.int/medicines/publications/pharmacopoeia/TestForSterility-RevGenMethod_QAS11-413FINALMarch2012.pdf.
5. Microbiological assay of antibiotics: https://apps.who.int/phint/pdf/b/7.3.1.3.1-Microbiological-assay-of-antibiotics.pdf, http://www.uspbpep.com/usp29/v29240/usp29nf24s0_c81.html.
6. Microbiological assay of vitamins:
https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=14117andcontext=rtd.
https://www.pharmaguideline.com/2011/09/microbiological-assay-of-cyanocobalamin.html.
7. Study of SOPs:
https://www.pharmaguideline.com/2012/01/sop-for-physical-monitoring-of.html
http://biomanufacturing.org/uploads/files/989767618742858542-sop-visual-inspection-process.pdf.
8. Lab scale fermentations:
Casida L. E., Jr. (2019). Industrial Microbiology, New Age International Publishers, New Delhi. ISBN- 9788122438024
Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-9789385750267
https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1541-4329.2005.tb00060.x
9. Solid state fermentation:
https://iopscience.iop.org/article/10.1088/1757-899X/612/2/022111/pdf.
https://www.scielo.br/j/babt/a/vDHdsFscjRYsW6jkRfKQCDM/?lang=en.
Meshram S. U. and Shinde G. B. (2009). Applied Biotechnology. I.K. International Publishing House Pvt. Ltd., New Delhi.
10. Isolation of Probiotic bacteria:
https://www.frontiersin.org/articles/10.3389/fmicb.2019.01382/full.
https://www.hindawi.com/journals/ijmicro/2020/8865456/.

Semester VI

Disciplinary Major Mandatory course

MIC36101: Microbial diseases and Chemotherapy 2(Cr) (T)

Course Outcomes:

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

CO1: Explain principles of chemotherapy of microbial diseases and development of drug

CO2: Develop identification systems for microbial disease diagnosis, disease treatment and prevention measures.

Unit No.	Topics	No. of lectures
Unit I	**Chemotherapy-Introduction**	**16**
	1. Chemotherapeutic agents & their characteristics **2.** Routes of drug administration. **3.** Mode of action of antimicrobial agents on: a. Bacteria: i. Cell wall: Beta lactams:1st to 6th Generation- e.g. Meropenem, Imipenem, Piperacillin, Tazobactam ii. Cell membrane: Polymyxin iii. Protein synthesis: Streptomycin, Tetracycline iv. Nucleic acids: Fluroquinolones, Rifamycin v. Enzyme inhibitors: Trimethoprim, Sulfomethaxazole **b.** Fungi: Griseofulvin, Amphotericin B, Anidulafungin, Vericonazole **c.** Viruses: Acyclovir, Oseltamivir, Remdecivir **d.** Protozoa: Metronidazole, Chloroquine	2 10
	3. Mechanisms of drug resistance and its genetic basis **a. Mechanisms of drug resistance by:** i. Limiting uptake of a drug.	2

	ii. Modification of a drug target. iii. Inactivation of a drug. iv. Active efflux of a drug. **b. Genetic basis:** i. Mutations in gene(s) ii. Acquisition of foreign DNA coding for resistance determinants through horizontal gene transfer.	2

Unit II	**Human and Animal Viruses, Fungal and Protozoal Pathogens**	**14**
	1.Introduction to cultivation of viruses	2
	2.Study of following groups of viral pathogens:	
	a. **Human viruses** (with respect to – Virion, Characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):	
	i. Respiratory Viruses: Influenza Virus, Corona Virus	2
	ii. Hemorrhagic Virus: Dengue	2
	iii. Hepatic Virus: Hepatitis A Virus	1
	iv. Gastrointestinal Virus: Rotavirus	1
	v. Cutaneous Viruses: Human papillomavirus	1
	vi. Neurological Viruses: Japanese Encephalitis Virus	1
	b. **Animal Viruses:** FMD Virus and Rinderpest Virus	2
	3. Study of following groups of parasites (with respect to Classification, Lifecycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (Serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy):	
	a. Plasmodium	2
	b. Entamoeba	1
	4. Study of following groups of yeast and fungal pathogens (With respect to – Morphological and cultural characteristics, Classification, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy)	
	a) *Aspergillus* species (Pathogenic)	1
	b) Cryptococcus neoformans	1
	c) Histoplasma capsulatum	1

References: MIC36101 Microbial diseases and chemotherapy

1. Chakraborty P. (2013). A Textbook of Microbiology. 3rd edition. New Central Book Agency. India. ISBN-13: 978-8173818769
2. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4th edition. Ryan K. J. and Ray C. **G.** (editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
3. Dey N. C., Dey T. K. and Sinha D. (2013). Medical Bacteriology Including Medical Mycology and AIDS. 17th Edition. New Central Book Agency (P) Ltd (Publisher). India
4. Dulbecco R., Eisen H. N. and Davis B. D. (1990). Microbiology. United States: Publisher - Lippincott. ISBN: 9780608072432
5. Finch R., Greenwood D., Whitley R. and Norrby S. R. (2010) Antibiotic and Chemotherapy. 9th Edition. Elsevier. ISBN: 9780702040641
6. Franklin T.J and Snow G. A. (1989). Biochemistry of Antimicrobial Action. Springer. First Edition. ISBN: 978-94-009-0825-3
7. Goering R., Dockrell H., Zuckerman M., Roitt I. and Chiodini P. L. (2018). Mims' Medical Microbiology and Immunology. 6th Edition. Elsevier. ISBN: 9780702071546
8. Greer D. L., Kane J., Summerbell R., Sigler L., Krajden S. and G. Land (Editors).(1999). Laboratory Handbook of Dermatophytes: a clinical guide and laboratory manual of dermatophytes and other filamentous fungi from skin, hair, and nails. Mycopathologia. 147: 113–114
9. Joklik W. K., Willett H. P., Amos D. B. and Wilfert C. M. (1995). Zinsser's Microbiology. 20th Edition. Appleton and Lange Publisher. ISBN-13: 978- 0838599839
10. Kanungo Reba. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. Tenth edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251
11. Kaslow R. A., Stanberry L. R. and Le Duc J. W. (2014). Viral Infections of Humans: Epidemiology and Control. 5th edition. Springer. ISBN 978-1-4899-7448-8
12. Mayers D. L., Sobel J.D., Ouellette M., Kaye K.S. and Marchaim D. (Eds.) (2017). Antimicrobial Drug Resistance: Mechanisms of Drug Resistance. Volume 1. Edition 2. Springer. ISBN 978-3-319-46718-4
13. Mayers D. L., Sobel J.D., Ouellette M., Kaye K.S. and Marchaim D. (Eds.) (2017). Antimicrobial Drug Resistance: Clinical and Epidemiological Aspects. Volume 2. Edition 2. Springer. ISBN 978-3-319-47266-9
14. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
15. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education

(India) Private Limited. ISBN-13: 978-1259061240

16. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
17. Park K. (2019). Park's Preventive and Social medicine. 25th Edition. Banarsidas Bhanot Publisher, Jabalpur. ISBN-13: 978-9382219156
18. Roth J. A., Bolin C., Brogden K. A., Chris Minion K. F. and Wannemuehler M. J.(1995). Virulence mechanisms of bacterial pathogens. Second edition. American Society for Microbiology. ISBN-13: 978-1555810856
19. Sastry G. A. and Rama Rao P. (2001). Veterinary Pathology. Seventh Edition. CBS Publishers, Delhi. ISBN: 9788123907389
20. Schuenke S. (1997). Medical Microbiology. Fourth edition. University of Texas Medical Branch of Galvesion. Samuel Baron (Editor). ASIN: B008UYPLIO
21. Tiwari S., Singh R. K., Tiwari R. and Dhole T. N. (2012). Japanese encephalitis: a review of the Indian perspective. The Brazilian Journal of Infectious Diseases. 16(6): 564-573. https://doi.org/10.1016/j.bjid.2012.10.004
22. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An introduction 12th Edition, Pearson. ISBN-13: 9780321929150

Links:

1. https://www.who.int/travel-advice/disease-information
2. https://Microbenotes.Com/Remdesivir/#Mechanism-Of-Action-Of-Remdesivir
3. *Aspergillus* https://www.cdc.gov/fungal/diseases/aspergillosis/index.html
4. *Histoplasma cap*sulatum https://www.cdc.gov/fungal/diseases/histoplasmosis/
5. *Cryptococcus neoformans* www.cdc.gov/fungal/diseases/cryptococcosis-neoformans/

Semester VI

Disciplinary Major Mandatory course

MIC36102: Advanced immunology and immunological techniques 2(Cr) (T)

COURSE OUTCOMES:

Students will be able to

CO1: Describe the processes and mechanisms of adaptive immunity.
CO2: Classify hypersensitivity reactions with examples
CO3: Understand various autoimmune disease and deficiencies.
CO4: Explain the mechanisms underlying transplantation of organs and tissues.
CO5: Give principles of immunological techniques and their applications.

UNIT No.	Topics	No. of Lectures
Unit I	**Advanced Immunology, Autoimmune diseases and immunodefeciencies**	**30**
	A. Advanced Immunology: Third line of defense: **1. Humoral Immune Response** a. Primary and secondary response kinetics, significance in vaccination programs b. Response of secondary lymphoid organs to antigen c. role of cytokines in activation and differentiation of B-cells **2. Cell Mediated Immune Response** a. Activation and differentiation of T cells, role of cytokines in activation b. Mechanism of Cytotoxic T lymphocytes (CTL) mediated cytotoxicity c. Antibody-dependent cellular cytotoxicity (ADCC) d. Significance of Cell Mediated Immune Response (CMI) Antigen processing and presentation (Major Histocompability class I and class II restriction pathways	**8**
	B. Hypersensitivity a. General principles of different types of hypersensitivity reactions b. Gell and Coomb's classification of hypersensitivity – mechanism with examples for type I (Immediate), II, III and IV (delayed)	3
	C .Immunohematology 1. ABO and Rh Blood Group system, 2. Bombay Blood group, **3.** Biochemistry of blood groups	2

	E. Transplantation and Immunity; a. Types of Grafts, b. Allograft rejection mechanisms **c.** Prevention of allograft rejection	2
	F. Active & Passive Immunization and Types of vaccines	2
	E.Autoimmunity and Autoimmune diseases: a. Immunological tolerance b. Types of autoimmune diseases c. Factors contributing development of autoimmune diseases d. Immunopathological mechanisms e. Diagnosis and treatment of autoimmune diseases: Myasthenia gravisand Rheumatoid arthritis f. Therapeutic immunosuppression for autoimmunity	**4**
	G .Immunodeficiency: a. Complement deficiencies b. Introduction to congenital immunodeficiency disorders: Common Variable Immune Deficiency (CVID) and acquired immunodeficiency: Immune mechanisms in AIDS	3
Unit II	**Antigen- Antibody Interactions**: 1. Principles of interactions: Antibody affinity and avidity, ratio of antigenantibody 2. Lattice hypothesis and two stage theory, antigen-antibody reactionkinetics (dialysis equilibrium experiment) 3. Visualization of antigen antibody complexes: a. Precipitation reactions: in fluid and in gel, immunoelectrophoresis b. Agglutination reactions:hemagglutination,,bacterial agglutination, passive agglutination and agglutination-inhibition c. Immunofluorescence techniques: direct and indirect, d. Enzyme-linked immunosorbent assay (ELISA) e. Radioimmunoassay RIA	**6**

References: MIC36102- Advanced Immunology And Immunlogical Techniques

1. Abbas A. K. and Lichtman A. H. (2004). Basic Immunology- Functions and Disorders of Immune System. 2nd Ed. Saunders. Elsevier Inc. PA. USA.
2. Aderem A., and Underhill D. M. (1999). Mechanisms of phagocytosis in macrophages. Annu. Rev. Immunol. 17: 593-623.
3. Austin J. M. and Wood K. J. (1993). Principles of Molecular and Cellular Immunology. Oxford University Press, London
4. Barret J. D. (1983). Text Book of Immunology. 4th edition, C. V. Mosby and Co. London.
5. Bendelac A. Savage P. B. and Teyton L. (2007). The biology of NKT cells. Annu Rev

Immunol. 25: 297-336.

6. BIOTOL Series. (1993). Biotechnology by open learning series. Defense Mechanisms. Butterworth and Heinemann Ltd., Oxford
7. Fathman G., Soares L., Cha S. M. and Utz P. J. (2005). An array of possibilities for the study of autoimmunity. Nature Rev. 435(2):605-611
8. Ganz T. (2003). Defensins: antimicrobial peptides of innate immunity. Nat. Rev. Immunol., 3:710–720.
9. Guyton A. C. and Hall J. E. (1996) Text Book of Medical Physiology, Goel Book Agency, Bangalore.
10. Kindt T. J., Goldsby R. A. and Osborne B. A. (2007). Kuby Immunology. 6th Ed. W. H. Freeman and Co., New York
11. Kuby J. (1996) Immunology. 3rd Ed. W. H. Freeman and Co, New York
12. Roitt E., Brostoff J. and Male D. (1993) Immunology. 6th Ed. Mosby and Co. London.
13. Roitt I. M. (1988). Essentials of Immunology. ELBS, London.
14. Roitt M. (1984). Essentials of Immunology. P. G. Publishers Pvt. Ltd., New Delhi.
15. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V. (1982). Basic and Clinical . Immunology. 14th Ed. Lange Medical Publications. Maruzen Asia Pvt. Ltd., Singapore
16. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. NewDelhi.

Semester VI

Disciplinary Major Mandatory course

MIC36103: Metabolism 2(Cr) (T)

Course Outcome:

After completion of this course students would be able to

CO1: Describe the mechanisms of transport of solutes across the membrane.

CO2: Discuss the synthesis and role of high energy compounds.

CO3: Explain with mechanism of biosynthesis and degradation of biomolecules.

CO4; Explain the basic concept of autotrophic modes of metabolism of prokaryotes.

Unit No.	Topics	No of lectures
Unit I	**Membrane transport and Bioenergetics**	15
	1. Membrane transport mechanisms: i. Passive transport - Diffusion, Osmosis, Facilitated transport ii. Active transport - Active transport systems in bacteria iii. Group translocation of sugars in bacteria iv. Ionophores: Mechanism and examples	5
	2. Bioenergetics: i. Laws of thermodynamics- first and second law ii. Concepts of free energy, entropy, high energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds iii. Mitochondrial electron transport chain: components, arrangement of different components in the inner membrane, structure and function of ATP synthatase, inhibitors and uncouplers of ETC and oxidative phosphorylation, energetics of mitochondrial electron transport chain	10
Unit	**Metabolic pathways and Autotrophy**	**15**
	3. Biosynthesis and Degradation: a. Chemistry, concept of polymerization of macromolecules: Polysaccharides. (Starch, and peptidoglycan) and Lipids (Fatty acids, triglycerides and phospholipids) b. Degradation of macromolecules – Polysaccharides (starch), Lipids (fatty acids oxidation e.g. β oxidation), Proteins (urea cycle)	11

II	**4. Bacterial Photosynthesis: Photosynthetic bacteria with reference to photosynthetic apparatus, energy generation, and CO_2 fixation** a. Cyanobacteria, b. Purple bacteria	3
	5 Chemolithotrophy: Concept and one example, Iron oxidizing bacteria	1

References: MB 363 Metabolism

1. Berg J. M., Stryer L., Tymoczko J. and Gatto G. (2019). Biochemistry. 9th Edition. Palgrave Macmillan. ISBN-978-1319114657.
2. Conn E. E., Stumpf P. K., Bruening G. and Doi R. H. (1987). Outlines of Biochemistry. 5th Edition. John Wiley and Sons. ISBN-13: 9780471052883
3. Hall D. A. and Krishna Rao K. (1994). Photosynthesis (Studies in Biology). 6thEdition. Cambridge University Press, London. ISBN-13: 978-1-133-10629-6
4. Garrett R. H. and Grisham C. M. (2013). Biochemistry. 5th Edition. Brooks/Cole, Publishing Company, California. ISBN-13: 978-1-133-10629-6
5. Katoch R. (2011). Analytical Techniques in Biochemistry and Molecular Biology. SpringerNew York. ISBN 978-1-4419-9785-2.
6. Nelson D. L. and Cox M. M. (2021). Lehninger's Principles of Biochemistry.8th Edition.Mac Millan Worth Pub. Co. New Delhi. ISBN:9781319228002
7. Palmer T. (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry.Horwood Pub. Co. Chinchester, England. ISBN-9781898563785
8. Segel I. H. (2010). Biochemical Calculations. 2nd Ed. Wiley India Pvt. Limited. ISBN: 9788126526437
9. Stanier R. Y., Adelberg E. A. and Ingraham J. L. (1985). General microbiology. 4th Edition. London: Macmillan**.**
10. Wilson K. and Walker J. (Editors). (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press, New York. ISBN-13: 978-0521731676

Semester VI

Disciplinary Major Mandatory course

MIC36104: Practicals based on Microbial diseases and chemotherapy, Advanced immunology and immunological techniques 2 (Cr) (P)

Sr. No.	Title of the Practical	No. of Practicals
1.	**Study of permanent slides/ of following microbial pathogens:** *a)* *Entamoeba histolytica* *b)* *Giardia* spp. *c)* *Plasmodium* spp. *d)* *Mycobacterium* (tuberculosis or leprae) *e)* *Epidermophyton* spp.	**1**
2.	**Isolation and identification of following:** a. Isolation and characterization of *Candida* from skin/mouth. b. Identification of *Candida* (Slide CultureTechnique) c. 1.Isolation and identification of Aspergillus niger from onion/ vegetable samples 2 .Determination of Koch's Postulates using Aspergillus niger. 3. Total fungal spore count by Neubauer's chamber	**4**
3.	**Antibiotic sensitivity testing (Disc diffusion technique) of:** a**.** Gram negative and b. Gram positive bacterial pathogens	**2**
4.	**Immunohematology:** a. Determination of titre of Anti-A / Anti-B antibodies in human serum b. Cross-matching (Major and Minor reactions)	**2**
5.	Qualitative and semi-quantitative detection of: a. Rheumatoid factor (RA factor) and b. Anti Streptolysin O using Slide test.	**2**
6.	**Immunoprecipitation:** Double diffusion (Ouchterlony) technique	**1**
7.	**Virtual Demonstrations of:** a. ELISA (Antigen/ Antibody detection) b. Egg inoculation technique	**2**
8.	**Visit to blood bank and preparation of visit report**	**1**
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Abramson J. and Abramson Z. H. (2011). Research Methods in Community Medicine: Surveys, Epidemiological Research, Programme Evaluation, Clinical Trials. Sixth Edition. Wiley. ISBN: 978-0-470-98661-5
2. Baveja C. P. and Baveja V. (2019). Text and Practical Microbiology for MLT. 3rd Edition. Arya Publishing Company. ISBN-13: 9788178558387
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0-387-24143-2
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., andStaley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
6. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9
7. Cappuccino, J.G. and Sherman, N. (2013) Microbiology: A Laboratory Manual. 10th Edition, Pearson Education Limited, London.
8. Godkar P. B. (2020). Textbook of Medical Laboratory Technology Volume 1 and 2. 3rd edition Bhalani Publishing House. ASIN: 9381496196. ISBN-13: 978- 9381496190
9. Greer D. L., Kane J., Summerbell R., Sigler L., Krajden S. and G. Land (Editors). (1999). Laboratory handbook of dermatophytes: a clinical guide and laboratory manual of dermatophytes and other filamentous fungi from skin, hair, and nails. Mycopathologia. 147: 113–114
10. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978- 9386261182
11. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
12. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240
13. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III:

Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257

14. Rosana Y., Matsuzawa T., Gonoi T. and Karuniawati A. (2014). Modified slide culture method for faster and easier identification of dermatophytes. Microbiology Indonesia.8(3): 135-139 https://doi.org/10.5454/mi.8.3.7
15. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

MIC36105 Practicals based Metabolism and Molecular Biology 2(Cr)(P)

12 Practicals x 5 lectures = 60 Lectures

Sr. No.	Title of the Practical	No. of Practical
1.	Clinical Biochemistry - Estimations of i. Blood sugar ii. Blood urea iii. Serum cholesterol iv. Serum proteins and albumin	**4**
2.	Enzyme production, purification, quantification : i. Precipitation of amylase enzyme. (salt/solvent) ii. Determination of specific activity of crude and purified amylase. iii. Preparation of purification chart. iv. Immobilization of amylase and activity determination	**5**
3.	Enrichment, Isolation and Enumeration of Bacteriophages (Principle, Methodology and Calculations of phage titer in PFU/ml)	**2**
4.	Isolation of Plasmid DNA and Agarose Gel Electrophoresis (Demonstration/hands on as per infrastructure availability)	**2**
5.	Study of Mitotic cell division from onion root tips	**1**
6.	Visit to a Biotechnology/ Biochemistry institute	**1**
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References: MB 368 Metabolism and Molecular Biology

1. Ausubel F. M., Brent R., Kingston R. E., Moore D. D., Seidman J.G., Smith J. A. and Struhl K. (Editors.). (2003). Current Protocols in Molecular Biology. Copyright © John Wiley and Sons, Inc. ISBN: 047150338X
2. Bhatta P. and Sakya S. R. (2008). Study of mitotic activity and chromosomal behaviour in root meristem of *Allium cepa* L. treated with magnesium sulphate. Ecoprint. 15: 83-88. ISSN 1024-8668. Ecological Society (ECOS), Nepal. www.ecosnepal.com.
3. Birnboim H. C. and Doly J. (1979). A rapid alkaline extraction procedure for screening of recombinant plasmid DNA. Nucleic acid Research. 7(6):1513-1523.
4. Clokie M. R. J. and Kropinski A. M. (editors): Bacteriophage: Methods and Protocols. Volume 1. Isolation, Characterization and Interactions. Series Volume 501. Humana Press, New York

5. Freitas A.R., Novais C., Peixe L. and Coque T.M. (2020). Isolation and Visualization of Plasmids from Gram-Positive Bacteria of Interest in Public Health. In: de la Cruz F. (editors). Horizontal Gene Transfer. Methods in Molecular Biology. Volume-2075. Humana, New York, NY. https://doi.org/10.1007/978-1-4939-9877-7_2
6. Hyman P. and Abedon S.T. (2009). Practical methods for determining Phage growth parameters. Methods Mol Biol. 501:175-202. doi: 10.1007/978-1-60327-164-6_18. PMID: 19066822
7. Katoch R. (2011). Analytical Techniques in Biochemistry and Molecular Biology. Springer New York Dordrecht Heidelberg London. ISBN: 978-1-4419-9784-5
8. Kusumaningrum H. P., Lunggani A. T. and Nurhakim M. A. (2012). Chromosomes and Mitotic Cell Division Phase in Onion Roots After 24 Hours Acetoorcein Soaking Time. Bioma: Berkala Ilmiah Biologi. 14 (2): 46-48. https://doi.org/10.14710/bioma.14.2.46-48
9. Wilson K. and Walker J. (Editors). (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press, New York. ISBN-13: 978-0521731676

Discipline Specific Elective

MIC36106: Molecular Biology 2 Cr (T)

Course Outcomes:

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

CO1: Explain the mechanisms of recombination amongst eukaryotes

CO2: Map the genes for fungi using data from tetrads generated or Parasexual cycle

CO3: Describe the basics of bacteriophage genetics

CO4: Explain DNA damage and repair mechanisms

CO5: Describe molecular techniques involved in and methodology of Recombinant DNA Technology.

Credit No	Topics	No. of lectures
Credit I	**Genetic Recombination and Bacteriophage Genetics.**	**15**
	1. Gene linkage and crossing over a. Mendel's laws: Eukaryotic Cell cycle, Mitosis, Meiosis b. Holliday model for Homologous recombination, Role of Rec and Ruv proteins c. Genetic mapping by Tetrad analysis in *N. crassa* (Numerical Calculations using PD, TT and NPD) d. Genetic Mapping by Parasexual cycle in *A. nidulans*	7
	2. Bacteriophage Genetics a. Lytic cycle: Virulent phages, T-series phages, Concept and formation of plaque, Lysogenic cycle: Temperate phage (□phage) b. Bacteriophage mutants: Plaque morphology (r type), Host range, Conditional lethal mutants (Ts and Am) c. Concept of Genetic Complementation and Cis-trans test of genetic function. (Intergenic- rII locus of T4 phage, Mechanism of Intragenic complementation.) d. Fine structure mapping of rII locus of T4 phage using Benzer's spot tests and deletion mapping	8
	DNA damage and repair mechanisms, Recombinant DNA technology	**15**

Credit II	**3. DNA damage and Repair mechanisms** a. DNA damage by hydrolysis, deamination, alkylation, oxidation, Radiation (X rays and UV rays) b. DNA repair by Photo reactivation c. DNA repair by Mismatch repair mechanism d. DNA repair by Excision repair mechanisms (BER/NER)	4
	4. Recombinant DNA Technology Tools and basics of recombinant DNA technology a. Introduction to recombinant DNA technology b. Restriction enzymes: Concept, Nomenclature, properties and types with examples (*Eco* R1, *Sma* I, *Pst* I). c. Vectors: Features of an ideal vector i. Plasmids: pBR322 ii. Bacteriophage vectors: Lambda iii. Cosmids iv. High capacity vectors: YACs, BACs v. Expression vectors d. Joining of DNA molecules- DNA Ligases (*E. coli* and T4 phage), Use of Linker / Adaptor / Homopolymer tailing e. Methods to transfer recombinant DNA into bacterial host cells (Physical – Electroporation, Gene gun, Chemical –$CaCl_2$ mediated, liposome mediated) f. Methods of screening recombinants using selective markers and Blue-White screening	8
	5. Molecular techniques used in RDT a. Isolation of genomic DNA b. Principle and methodology of Agarose gel electrophoresis and its applications c. Concept, Methodology and applications of Southern, Northern and Western blotting and hybridization.	3

References:

1. Birge E. A. (2013). Bacterial and Bacteriophage Genetics. Springer, New York. ISBN: 9781475732580
2. Brooker R. J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw- Hill Publication.
3. Brown T. A. (2006). Gene Cloning and DNA Analysis. Blackwell Publication. 5th Edition. ISBN: 1405111216
4. Brown T.A. (2016). Gene Cloning and DNA Analysis: An Introduction. 7thEd. Wiley Blackwell Publication, U.S.A. ISBN: 978-1-119-07254-6
5. Clokie M. R. J. and Kropinski A. M. (editors): Bacteriophage: Methods and Protocols. Volume 1. Isolation, Characterisation and Interactions. Series Volume 501. Humana Press, New York
6. Clutterbuck A. J. (1996). Parasexual recombination in fungi. J. Genet. 75(3): 281-286, @ Indian Academy of Sciences
7. Dubey R. C. (2014). Advanced Biotechnology. S. Chand Publishing. ISBN: 9788121942904
8. Freifelder D. (2005). Molecular Biology. 2nd Edition. Narosa Publishing House Pvt. Limited, India.
9. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics. 8th Edition. .John Wiley and Sons Publication. ISBN-13: 9788126510436
10. Goodenough U. (2016). Genetics. Publisher: Holt, Rinehart and Winston. ISBN-13: 978-0030197161
11. Gupta P. K. (2020). Elements of biotechnology. 4th Reprint (2nd Edition). Product Code: BC-22. Rastogi Publications. Meerut, India. ISBN: 978-81-7133-937
12. Hartwell L., Goldberg M., Fischer J. and Hood L. (2018). Genetics: from genes togenomes. McGraw-Hill. ISBN13: 9781259700903
13. Hayes W. (1968). Genetics of Bacteria and their Viruses. 2nd Edition. Oxford-Edinburgh: Blackwcll Scientific Publications.
14. Hyman P. and Abedon S.T. (2009). Practical methods for determining Phage growth parameters. Methods Mol Biol. 501:175-202. doi: 10.1007/978-1-60327-164-6_18. PMID: 19066822.
15. Kemp W. (2011). Organic Spectroscopy. 3rd edition. Publisher: Red Globe Press. Macmillan Fsterility
16. Klug W. S., Cummings M. R., Spencer C. A., Michael A. and Palladino M. (2019). Genetics. Pearson Publisher. ISBN 13: 978-0-134-60471-8

17. Kohli D. V. and Vyas S. P. (2009). Pharmaceutical Biochemistry. Published by CBS Publishers and Distributors CBS. ISBN 13: 9788123916903

18. Lewin's GENES X (2011). Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). 10th Edition. Sudbury, Mass.: Jones and Bartlett, c2011.

19. Lodish H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., Martin K. C., Yaffe M. and Amon A. (2021). Molecular Cell Biology, 9th Edn. Macmillan Learning. ISBN: 9781319208523

20. Pal J. K. and Ghaskadabi S. (2009). Fundamentals of Molecular Biology. Oxford UniversityPress. ISBN: 9780195697810

21. Primrose S. B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics, 7thEd. Blackwell Publishing: U.S.A.

22. Russel P. J. (2000). Fundamentals of Genetics. Publisher: Benjamin/Cummings. ISBN: 9780321036261

23. Russel P. J. (2010). iGenetics: A Molecular Approach. 3rd Edition. Benjamin Cummings. ISBN: 9780321569769

24. Sambrook J. F. and Russel D. W. (Editors). (2001). Molecular cloning, A laboratory manual (3rd Edition.). Volumes 1, 2, and 3. Cold Spring Harbor Laboratory Press. ISBN- 978-0- 87969-577-4

25. Sharma. B. K. (2011). Instrumental Methods of Chemical Analysis. 27th Edition. Goel Publishing House, Meerut. India

26. Singh B. D. (2007). Biotechnology Expanding Horizon. Kalyani Publishers, India

27. Singh B. D. (2016). Biotechnology. 5th Edition. Reprint. Kalyani Publishers, India.

28. Stanier R. Y. (1999). General Microbiology. 5th Edition. Palgrave Macmillan

29. Strickberger M.W. (2012). Genetics. 3rd Edition. New Delhi: PHI Learning Gardner.

30. Tamarin R. H. (2002). Principles of Genetics. Publisher: McGraw-Hill Education (India) Pvt Limited. ISBN:9780070486676

31. van Sinderen D. and Mc Grath S.(Editors). (2007). Bacteriophage: Genetics and Molecular Biology. Caister Academic Press

32. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014). Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436

Reference-Links:

1. Potential biohazards of recombinant DNA molecules: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC388511/?page=1
2. National Academies Press: Introduction of Recombinant DNA-Engineered Organisms Into theEnvironment: Key Issues: https://www.nap.edu/download/18907#

3. Guidelines and Handbook for Institutional Biosafety Committees (DBT, Govt. of India and BCIL):https://thsti.res.in/pdf/IBG.pdf

4. University of North Carolina's Biosafety Guidelines (Principles, Risk assessment, Biosafety levels,Guidelines): https://ehs.unca.edu/laboratory-safety/biological-safety/

5. http://www.informatics.jax.org/silver/chapters/7-1.shtml

Semester VI

Discipline Specific Elective
MIC36107: Practicals based on Applied Microbiology

Sr. No	Title of the practical	No. of Practicals
1.	Isolation and identification of *Xanthomonas* spp. from Citrus canker	**1**
2.	Isolation of any two plant pathogenic fungus *e.g. Fusarium/Rhizoctonia/Alternaria* from infected plant specimen.	**2**
3.	Collection of plant disease specimens and study of symptoms/ Project based ondigital record of plant diseases (Group Activity)	**1**
4.	Isolation of PGPR with phosphate solubilization potential/Vesicular Arbuscular Mycorrhiza (VAM), Preparation of liquid bioinoculants	**2**
5.	Validation of commercial formulations of bioinoculants based on BIS standards, Pot studies to check effect of bioinoculants on plant growth	**1**
6.	Detection of aflatoxin	**1**
7.	Determination of TDP and TDT value	**2**
8.	Isolation and characterization of food spoilage organisms	**2**
9.	HACCP guidelines for food industry (activity based)	**1**
10.	Visit to any food industry or a fermentation industry	**1**
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

2. Isolation of *Xanthomonas citri* from citrus canker: https://www.plantbiosecuritydiagnostics.net.au/app/uploads/2018/11/NDP-9-Asiatic-citrus- canker-Xanthomonas-V1.2.pdf. https://assets.ippc.int/static/media/files/publication/en/2016/01/DP_06_2014_En_2015-12-22_PostCPM10_InkAmReformatted.pdf. http://www.asianjournalofchemistry.co.in/User/ViewFreeArticle.aspx?ArticleID=23_1_67.

3. Plant disease study based on symptoms:

- Dube H. C. and Bilgrami K.S.1976 Text book of modern pathology. Vikas PublishingHouse. New Delhi.
- Mehrotra R. S. (1994). Plant Pathology. Tata McGraw-Hill Limited.
- Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall

of IndiaPvt. Ltd., New Delhi.

4. Validation of standards ofbiofertilizers:
   - Manual - https://law.resource.org/pub/in/bis/S06/is.6092.3.2.2004.pdf
   - Rhizobial and azotobacterial biofertilizers: https://bio-fit.eu/q8/lo6-quality-control-of- biofertilizers?start=4.
   - Organic Farming: Organic Inputs and Techniques: http://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html.
   - Borkar S. G. (2015). Microbes as Biofertilizers and their Production Technology.Woodhead Publishing India Private Limited., New Delhi.
   - Yadav A. K. and Chandra K. (2014). Mass Production and Quality Control ofMicrobial Inoculants.Proc Indian Natn Sci Acad. 80 (2): 483-489.
5. Isolation of PGPR with PSB:
   - https://www.ijnpnd.com/article.asp?issn=2231-0738;year=2013;volume=3;issue=1;spage=29;epage=33;aulast=Ranjan.
   - https://scielo.conicyt.cl/pdf/jsspn/v16n2/aop4316.pdf

1. Detection of aflatoxin:
   - https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/MYCOTOXIN.pdf.
   - https://journals.sagepub.com/doi/pdf/10.1177/156482659902000411.
   - https://www.diva-portal.org/smash/get/diva2:799266/FULLTEXT01.pdf.
2. Determination of TDT, TDP, TDR, D value.
   - Frazier W. C., Westhoff D. C. and Vanitha N. M. (2013). Food Microbiology. 5th edition. McGraw Hill education, India.
   - Jay J. M. and Loessner M. J. (2005). Modern Food Microbiology. 7th edition. Springer. ISBN 978-0-387-23413-7.
3. HACCP: https://www.fsai.ie/food_businesses/haccp/principles_of_haccp.html.

Semester VI
Minor
MIC36208: **Nano-biotechnology Theory 2(Cr) (T)**

Course Outcomes:

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

CO1: Explain design, development and application of Nanomaterials and their applications in Nano devices.
CO2:Describe fundamentals of nanotechnology as to Synthesis and characterization techniques of nanoparticles.
CO3:Articulate the applications of nanomaterials in different disciplines of human life.
CO4:Compare the merits of using nanotechnology with existing technologies.

Sr. No.	Topic	No. of Lectures
Unit 1	**Introduction to Nano-biotechnology:** a. Introduction to nanoscale, nanomaterials, nanoscience and nanotechnology b. Nanoscale bio-assemblies: Liposomes, viruses, DNA, polysaccharides and proteins (Proteinnanotubes, nanofibers, peptide nanoparticles). c. Biomedical applications of bio-assemblies: Cell targeting, drug delivery, bio-imaging and vaccine development.	7
Unit 2	**Nanoparticle biosynthesis** **A.Microbial mediated metallic nanoparticles synthesis:** a. Gold nanoparticles (AuNPs) b. Silver nanoparticles (AgNPs) c. Au-Ag alloy nanoparticles d. Oxide nanoparticles e. Magnetic nanoparticles f. Non-magnetic oxide nanoparticles g. Sulfide nanoparticles etc. **B. Plant mediated silver nanoparticle synthesis:** Mechanism of phytofabrication Factors affecting on phytofabrication of NPs and Application of Ag NPs.	10
Unit 3	**Characterization techniques for nanomaterials:** UV-visual spectroscopy, Fourier transform infrared (FTIR), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and dynamic light scattering (DLS).	8
Unit 4	**Applications of nanoparticles:** Antibacterial agent, drug delivery, biosensor, animal industry and nanotechnology in wastewater treatment.	5

References: Nano-biotechnology.

1. Bujold K. E., Lacroix A., and Sleiman H. F. (2018). DNA Nanostructures at the Interface with Biology. Chem. 4: 495–521. Elsevier Inc.
2. Chokriwal A., Sharma M. M. and Singh A. (2014). Biological synthesis of nanoparticles

using bacteria and their applications. American Journal of PharmTechResearch. 4(6):38-61.

3. Das R. K., Pachapur V. L., Lonappan L., Naghdi M., Pulicharla R., Maiti S. and Brar S. K. (2017). Biological synthesis of metallic nanoparticles: plants, animals andmicrobial aspects. Nanotechnology for Environmental Engineering. 2(1): 1-21.
4. Doll T. A. P. F., Raman S., Dey R. and Burkhard P. (2013). Nanoscale assembliesand their biomedical applications. J R Soc Interface.10: 20120740. http://dx.doi.org/10.1098/rsif.2012.0740
5. Gurunathan S., Kalishwaralal K., Vaidyanathan R., Venkataraman D., Pandian S. R. K., Muniyandi J., Hariharan N. amd Soo Hyun Eom. (2009). Biosynthesis, purification and characterization of silver nanoparticles using *Escherichia coli*. Colloids and Surfaces B. 74(1): 328–335.
6. Fariq A., Khan T. and Yasmin, A. (2017). Microbial synthesis of nanoparticles and their potential applications in biomedicine. J. Appl. Biomed. 15: 241–248
7. Li X., Xu H., Chen Z. S. and Chen G. (2011). Biosynthesis of nanoparticles by microorganisms and their applications. Journal of Nanomaterials. 2011.

Minor

MIC36209: Practicals based on Nano-biotechnology 2(Cr) (P)

Unit	Practical	No. of Practicals
	1. Microbial synthesis of metallic nanoparticle: copper, chromium and cobalt 2. Synthesis of metallic nanoparticle zinc,chromium and cobalt using a green synthesis (plant mediated) method	**6**
	3. Detection and Characterization of metallic nanoparticles (silver, chromium and cobalt) by UV-Spectrophotometer and FTIR analysis	**4**
	4. Application of nanoparticles- Study the antibacterial effect of metallic nanoparticles (silver,chromium and cobalt) on *Escherichia coli* (*E. coli*) and Staphylococcus culture.	**4**
	5. Demonstration of characterization of nanoparticles using XRD on VLabs.	1
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References: Nano-biotechnology.

8. Bujold K. E., Lacroix A., and Sleiman H. F. (2018). DNA Nanostructures at the Interface with Biology. Chem. 4: 495–521. Elsevier Inc.
9. Chokriwal A., Sharma M. M. and Singh A. (2014). Biological synthesis of nanoparticles using bacteria and their applications. American Journal of PharmTechResearch. 4(6):38-61.
10. Das R. K., Pachapur V. L., Lonappan L., Naghdi M., Pulicharla R., Maiti S. and Brar S. K. (2017). Biological synthesis of metallic nanoparticles: plants, animals andmicrobial aspects. Nanotechnology for Environmental Engineering. 2(1): 1-21.
11. Doll T. A. P. F., Raman S., Dey R. and Burkhard P. (2013). Nanoscale assembliesand their biomedical applications. J R Soc Interface.10: 20120740. http://dx.doi.org/10.1098/rsif.2012.0740
12. Gurunathan S., Kalishwaralal K., Vaidyanathan R., Venkataraman D., Pandian S. R. K., Muniyandi J., Hariharan N. amd Soo Hyun Eom. (2009). Biosynthesis, purification and characterization of silver nanoparticles using *Escherichia coli*. Colloids and Surfaces B. 74(1): 328–335.
13. Fariq A., Khan T. and Yasmin, A. (2017). Microbial synthesis of nanoparticles and their

potential applications in biomedicine. J. Appl. Biomed. 15: 241–248

14. Li X., Xu H., Chen Z. S. and Chen G. (2011). Biosynthesis of nanoparticles by microorganisms and their applications. Journal of Nanomaterials. 2011.
15. Madkour L. H. (2019) Introduction to Nanotechnology (NT) and Nanomaterials (NMs). In: Nanoelectronic Materials. Advanced Structured Materials, vol 116. Springer, Cham. https://doi.org/10.1007/978-3-030-21621-4_1
16. Mohd Yusof H., Mohamad R., Zaidan U. H. and Rahman N. A. A. (2019). Microbial synthesis of zinc oxide nanoparticles and their potential application as an antimicrobial agent and a feed supplement in animal industry: a review. J Animal SciBiotechnol. 10(57): https://doi.org/10.1186/s40104-019-0368-z
17. Rajput N. and Bankar A. (2017). Bio-inspired gold nanoparticles synthesis and their anti-biofilm efficacy. J. Pharm. Investig. 47: 521–530.
18. Rattan R., Shukla S., Sharma B. and Bhat M. (2021). A mini review on lichen-based nanoparticles and their applications as antimicrobial agents. Front. Microbiol. https://doi: 10.3389/fmicb.2021.633090
19. Salame P. H., Pawade V. B. and Bhanvase B. A. (2018). Characterization tools and techniques for nanomaterials. Nanomaterials for Green Energy: 83–111. doi:10.1016/b978-0-12-813731-4.00003-5
20. Shukla M. and Shukla P. (2020) Microbial nanotechnology for bioremediation of industrial wastewater. Front. Microbiol. 590631. https://doi.org/10.3389/fmicb.2020.
21. Tiquia-Arashiro S. and Rodrigues D. (2016). Nanoparticles Synthesized by Microorganisms. In Extremophiles: Applications in Nanotechnology. 1-51. Springer,Cham.
22. Xiangqian Li, Huizhong Xu, Zhe-Sheng Chen, and Guofang Chen. (2011). Biosynthesis of nanoparticles by microorganisms and their applications nanostructures for medicine and pharmaceuticals Volume 2011 |Article ID 270974 | https://doi.org/10.1155/2011/270974
23. Yan S., He W., Sun C., Zhang X., Zhao H., Li Z., Zhou W., Tian X., Sun X., Han X. (2009). The biomimetic synthesis of zinc phosphate nanoparticles. Dyes and Pigments. 80(2): 254–258.

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Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)

Ganeshkhind, Pune – 411 016

Affiliated to SPPU

B.Sc. (Physics)
(Three Years Integrated Degree Program)

T. Y. B. Sc. Physics

From Academic year 2025-26

Board of Studies in Physics
Modern College of Arts, Science and Commerce, (Autonomous)
Ganeshkhind, Pune – 16

Structure of T. Y. B. Sc. Physics

(NEP Version 1)

NEP I- T.Y.B.Sc. (Physics) (SEM-V and SEM VI)

Subject Code	Subject	Subject Type	Credits	Th	Pr	Total Workload
Semester V						
PHY35201	Basics of Nano-materials and Technology	Minor- Th	2	2	-	**2**
PHY35202	Practical Based on Basics of Nano-materials and Technology	Practical	2	-	4	**3**
		Total for SEM V		2	4	**06**
Semester VI						
PHY36201	Solar PV Systems: Installation, Repairing and Maintenance	Minor- Th	2	2	-	**2**
PHY36202	Practical based on Solar PV Systems: Installation, Repairing and Maintenance	Practical	2	-	4	**4**
		Total for SEM VI				**06**

T.Y.B.Sc. (Physics) (Sem-V)
Minor (Theory)
PHY35101: Basics of Nano materials and technology

Lectures: 30 **(Credits-02)**

1: Fundamentals of material Science (9L)

1.1 Types of materials
1.2 introduction to material properties
1.3 Study of Solid solution and impurities
1.4 Introduction to single phase metals and alloys.
1.5 Deformation in single phase materials

2: Introduction and synthesis of nanomaterials (8L)

2.1 Introduction to Nano-sized materials and Structures
2.2 Significance of Nano-size
2.3 Properties of Nanomaterials: Mechanical, Electrical, Thermal and Optical properties
2.4 Classification of nanostructured materials
2.5 Bottom-up and Top-down approaches
2.6 Classification of Synthesis Techniques: Vapour phase and Liquid phase approach.
2.7 Synthesis Methods: Sol-gel Method, Chemical Vapour deposition and Electrochemical Deposition.

3: Introduction and characterization techniques: (08L)

3.1 Over view of structural characterization of nanomaterials by XRD using Debye Scherer Method
3.2 Optical characterization of nanomaterials using UV- visible spectroscopy
3.3 Introduction to Scanning electron microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and Transmission electron microscopy (TEM) for microstructural characterization and elemental analysis of nanomaterials.

4: Applications of nanomaterials: (5L)

6.1 Nanomaterials for application in Nano-electronics, Cosmetics, Medical, Biosensors Automobiles, Space, Sports, Cloth industry etc.
6.2 Nanomaterials for environmental pollution monitoring and reduction etc.
6.3 Nanomaterials for energy generation and storage

Reference books :

1. Elements of Materials Science and Engineering I. H. Vanvlach (4th Edition)
2. Materials Science and Engineering - V. Raghavan
3. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
4. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
5. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
6. Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials CollegePress, London.
7. The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K.Cheetham (Eds) Wiley VCH Verlag Gmbh& Co, Weinheim, 2004.

T.Y.B.Sc. (Physics) (Sem-V)
Minor (Practical)
PHY35102: Practical based on basics of nano- materials and technology

Lectures: 60 **(Credits-02)**

List of experiments: (Any 8)

1. To determine the dipole moment of a given liquid
2. To determine magnetic susceptibility of $FeCl_3$
3. To determine the specific heat of graphite
4. Determination of the yield point and the breaking point of an elastic material
5. Ionic conductivity of NaCl/ NaI.
6. Grain size and grain boundary measurement using SEM images.
7. Synthesis of metallic nanoparticles by wet chemical method.
8. Synthesis of Metal Oxide Nanoparticle using different techniques.
9. Synthesis of silver nanoparticles from silver nitrate by colloidal solution method.
10. Study of optical absorption of nanoparticles.
11. Determination of crystallite size from X-ray diffraction spectra.

T.Y.B.Sc. (Physics) (Sem-VI)
Minor (Th)

PHY36101: Solar PV System: Installation, Repairing and Maintenance

Lectures: 30 **(Credits-02)**

Introduction: A PV solar system syllabus typically covers the fundamental principles of solar energy conversion, the design and installation of PV systems, and the operation and maintenance of these systems. It will include topics like solar cell and module technology, PV system design, and practical skills related to installation and troubleshooting

Objectives:

1. In this skill oriented course, student will study basics of solar photovoltaic (PV) cells, modules and system components.
2. Design and sizing of off-grid PV system for homes, apartments as well as commercial offices.
3. Understanding energy conversion from sunlight to electricity and working with solar conversion equipment.
4. This course will give hands on experience needed to become self-employed.

Outcomes:

1. Learn basics conversion of light into electricity.
2. Hands on training will motivate students to use Solar PV system.
3. Become entrepreneur / self-employed.
4. Students can know about the analysis of MSEB electricity bill
5. To understand design and sizing of off-grid PV system
6. Participants will learn about solar PV module and batteries used in solar PV plant.

Syllabus:

Unit 1: Basics of Electricity **(3L)**

1. Voltage, Current, DC Power, AC Power
2. Energy
3. Harmonics
4. Net Metering
5. Measurement of Electrical and Non-Electrical Quantities

Unit-2: Introduction to Solar Systems **(6L)**

1. The Sun, Earth and Renewable Energy
2. Solar radiation at the earth surface
3. Solar constant
4. Solar Cell- Working- Photovoltaic Effect
5. Types of solar cell
6. PVModules and Arrays
7. Module Parameters
8. Tracking mechanism- Sunshine and Shadow
9. Aligning the Array

Unit-3: Solar Radiations and Measurement **(6L)**

1. Introduction
2. Solar constant
3. Solar radiation at the earth surface

4. Need of solar radiation measurement
5. Instruments for the measurement of solar Radiation
6. Pyrheliometer
7. Pyranometer
8. Sunshine Recorder
9. Sun Meter or Lux Meter

Unit-3: Basics of Solar PV Systems (6/8 L)

1. Basics types of PV Systems on grid and off grid
2. DC to AC conversion
3. Building-integrated Photovoltaic
4. Engineering and Architecture
5. Balancing of PV system
6. Hybrid systems,
7. System sizing
8. Applications of off grid PV System

Unit 4: Solar System Components: **(5L)**

1. Inverters: Different types of inverters (string, central, off-grid), selection criteria and sizing.
2. Charge Controllers: Understanding MPPT (Maximum Power Point Tracking) and its importance.
3. Batteries: Types of batteries, battery sizing and charging/discharging considerations.
4. Other components: Junction boxes, cables, mounting structures and protective devices.

Unit 5: Electrical Wiring (4L)

1. Types of Wire,
2. Wire Sizing,
3. Junction Box,
4. DC cabling,
5. AC cabling,
6. Array Combiner Box,
7. AC Distribution Box,
8. Energy Metering,
9. Electrical Grounding,
10. Earth Resistance and Insulation Resistance Measurements

Unit 4: Safety in PV Systems (2 L)

1. Understanding electrical hazards and safety regulations
2. Safe handling of PV equipment and tools
3. Emergency procedures and fire prevention
4. Project Management and Economics

Reference books:

1. Solar Energy, S.P. Sukhatme (second edition), Tata Mc.Graw Hill Ltd, New Delhi.

2. Solar Energy Utilisation, G. D. RAI (5th edition), Khanna Publishers, Delhi.
3. Electricity from Sunlight, An Introduction to Photovoltaics, Paul A. Lynn, John Wiley & Sons, Ltd.
4. Solar Electricity, 2nd edition, T. Markvart, John Wiley & Sons, Ltd.
5. Solar Photovoltaic Basics, White Sean, Taylor & Francis Ltd.

Online Resources:

1. https://dgt.gov.in/sites/default/files/2024-08/Rooftop_book.pdf
   "Rooftop Solar PV (Installation & Maintenance)" - Directorate General of Training (DGT)
2. "Solar Photovoltaic Systems" - B.Tech program at CET, Department of Electrical Engineering

T.Y.B.Sc. (Physics) (Sem-VI)
Practical (Minor)
PHY36102: Practical based on Solar PV System

Credits:2 **Lectures:60**

List of experiments: (Any 8)

1. Estimation of the value of the Solar Constant.
2. Study of intensity variation on the performance of PV module.
3. Study of series and parallel combination of the PV modules.
4. Analysis of MSEB electricity bill.
5. Energy Farm/PV Plant visit report.
6. Study of intensity variation using Sun Meter or Lux Meter.
7. Study of I-V characteristics and working of solar cell.
8. Study of different types of solar cell.
9. Study of Hybrid systems.
10. Writing a small survey article on Status of Solar energy utilization in India
11. Book Review

MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE GANESHKHIND, PUNE-16 (AUTONOMOUS)

SYLLABUS OF THIRD YEAR B.Sc ZOOLOGY

T.Y.B.Sc (SEMESTER V AND VI)

To be implemented from

Academic Year 2025-2026

FRAMED BY

BOARD OF STUDIES IN ZOOLOGY

Progressive Education Society's
MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE,
GANESHKHIND,
PUNE- 16
(AUTONOMOUS)

PREAMBLE:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a substantial component of what is needed from a zoologist as a skilled career and what zoologists needs to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology with the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC**] have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language & communication, English / Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field visits, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

The new course will be effective from the academic year 2025- 2026 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of

B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing pre requisites of the students. This graduate program has been introduced with 144 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, co-curricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students.

The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills. The Syllabus has been revised with the following aims -

• To foster curiosity in the students for Zoology,

• To create awareness amongst students for the basic and applied areas of Zoology,

• To orient students about the importance of abiotic and biotic factors of environment and their conservation,

• To provide an insight to the aspects of animal diversity,

• To inculcate good laboratory practices in students and to train them about proper handling of lab instruments.

Instructions for the Students:

The students seeking admission to T.Y.B.Sc Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.
3. The students opting for dissertation course shall follow the rules framed for the same.

4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

Examination

[A] Pattern of Examination Evaluation of Students:

1) The In-semester and End-Semester examinations will be of 20 marks each for 2 credits and 40 marks for 4 credits and for End-semester 30 marks for 2 credits and 60 marks for 4 credits.

2) Student has to obtain minimum of 40 % passing separately in both the In-Semester and End- Semester.

3) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.

5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i. In-semester Examination:

Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) Theory Courses:

Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

a) Multiple choice questions

b) Combination of objective and subjective questions.

c) Open book test (concerned teacher will decide the allowed books)

d) Tutorial

e) Surprise test specified topics in a given notified period

f) Oral

g) Assignments

h) Review of research paper

i) Seminar presentation

j) Journal/Lecture/Library notes Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) Practical Courses:

It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).

i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.

ii. Project on Research Methodology

iii. Industrial/Institution Visit report

iv. Field visit report/ study tour report.

The student strength of practical batch should be 12

Project Course: Project will be evaluated by the examiner/s in consent with the project guide if required.

ii. End-Semester Examination:

The End-semester examination program will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

[B] Standard of Passing

Student has to obtain 40% marks separately in In-Semester and End-Semester assessment.

Program outcomes (POs):

After successfully completing the T.Y.B.Sc Zoology program students will be able to:

PO1. Zoology knowledge: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

PO2. Problem analysis: Identify, review research literature, and analyse complex situations of living forms.

PO3. Design/development of solutions: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources,and ICT tools for understanding of the subject.

Programme Specific outcomes

PSO1: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PSO2: Apply ethical principles and commit to professional ethics and responsibilities andnorms of the work/research practice.

PSO3: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Structure: **Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology- B.Sc. in Zoology**

T.Y. B.Sc.

Course Type	Course Code	SEMESTER V	Course Code	SEMESTER VI	Credits
Mandatory Major	ZOO35101	Biological chemistry (2C) (T)	ZOO36101	Molecular Biology (2C) (T)	2+2
Mandatory Major	ZOO35102	Entomology (2C) (T)	ZOO36102	Parasitology (2C) (T)	2+2
Mandatory Major	ZOO35103	Environmental Resource Management (2C) (T)	ZOO36103	Developmental Biology (2C) (T)	2+2
Mandatory Major	ZOO35104	Practical in Biological Chemistry (2C)(P)	ZOO36104	Practical in Molecular Biology (2C)(P)	2+2
Mandatory Major	ZOO35105	Practical in Environmental Resource Management (2C)(P)	ZOO36105	Practicals in Parasitology & Developmental Biology (2C)(P)	2+2
Major Elective	ZOO35106	Bioinstrumentation and Bioinformatics (2C)(T)	ZOO36106	Medical and Forensic Zoology (2C) (T)	2+2
Major Elective	ZOO35107	Practical in Bioinstrumentation and Bioinformatics (2C)(P)	ZOO36107	Practical in Medical and Forensic Zoology (2C)(P)	2+2
Minor	ZOO35208	Biodiversity, Conservation and sustainable development (2C) (T)	ZOO36208	Museology and Taxidermy of Invertebrates and Vertebrates (2C) (T)	2+2
Minor	ZOO35209	Practical in Biodiversity, Conservation and sustainable development(2C) (P)	ZOO36209	Practical in Museology and Taxidermy of Invertebrates and Vertebrates (2C) (P)	2+2
VSEC	ZOO35410	Practical in Entomology (2C) (P)		--	2
FP	ZOO35611	Field project (2C)	ZOO36610	OJT (4C)	2+4
				Total credits	44

Subject Code: - ZOO35101 Subject Name -: Biological Chemistry No. of credits: 02						
Year : III				Semester : V		
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

CO1: To understand the basic concepts and significance of biochemistry.

CO2: To know the basic concepts pH and Buffers.

CO3: To learn the chemical structures of carbohydrates, their biological and clinical significance.

CO4: To analyse the structure and importance of proteins and lipids.

CO5: To understand the variations in enzyme activity and kinetics.

Sr. No	Name of the Topic	Lectures allotted
1	**Unit 1:- Introduction of Biochemistry:** Importance of Biochemistry in Life Sciences	(01L)
2	**Unit 2 :- pH and Buffers** 2.1 Concept of pH. 2.2 Concept of pH scale, biological significance of pH 2.3 Concept of acid and base, Ionization of acids and bases. 2.4 Derivation of Henderson-Hassel Balch equation & its applications.	(03L)

	Buffer - Definition, Concept, Functions, Types of buffer and Buffering Capacity.	
3	**Unit 3 :- Carbohydrates** 3.1 Definition, Classification & Biological importance of Carbohydrates. 3.2 Isomerism in carbohydrates - Structural and Stereoisomerism. 3.3 Significance of Gluconeogenesis, Glycogenolysis and Glycogenesis. 3.4 Clinical significance- hyperglycaemia and hypoglycaemia	(06L)
4	**Unit 4 :- Amino acids and Proteins** 4.1 General Structure of amino acids and Peptide bond. 4.2 Essential, non-essential and conditionally essential amino acids. 4.3 Types of proteins, protein structures (primary, secondary, tertiary and quaternary structures with suitable example) 4.4 Biological importance of proteins – Biocatalysts, Carrier proteins Contractile proteins, Hormonal role of proteins.	(06L)
5	**Unit 5:- Enzymes** 5.1 Nomenclature, Types and properties of enzymes. 5.2 Regulatory and non-regulatory enzymes. 5.3 Enzyme inhibition. 5.4 Factors influencing enzyme activity (pH, temperature, substrate concentration). 5.5 Introduction of isoenzymes and cofactor. 5.6 Clinical significance of enzymes - PKU and AKU. 5.7 Industrial applications of enzymes	(07L)
6	**Unit 6:- Lipids** 6.1 Introduction.	(03L)

	6.2. Fatty acids - Types and nomenclature (saturated and unsaturated). 6.3 Clinical significance (obesity, atherosclerosis, myocardial infarction). 6.4 Biological importance of lipids.	
7	**Unit 7:- Vitamins** 7.1 Fat soluble and water soluble 7.2 Dietary Sources and Deficiency disorders 7.3 Biological functions	(04L)
	Total Lectures	30

REFERENCES:

1.Principles of Biochemistry, 1993, Lehninger A. L. Nelson D. L. & Cox M. M. W. H. Freeman Company, USA.

2.Biochemistry, 1995 5th Edn. Zuby G. W, C. Brown Communications USA.

3.Harpers Biochemistry, 1996 26th Edn. p Murray R. K., Granner D. K., Mayes P. A. & Rodwell V. W. Prentice Hall international USA.

4.Outline of Biochemistry, 1995 5th Edn, Conn E. E., Stumph P. K. Bruening G & Doi R. H. John Wiley & Sons, USA.

5.Principals of Biochemistry, 1993, 1st Edn., Pattabhiraman T. N. Gajanan Book publishers and distributors Bangalore.

6. Clinical Biochemistry, 1994, B. P. Godkar, Bhalini Publishing House, Mumbai.

7. Biochemistry, 1995 5th Edn., Stryer San Francisco, W. H. Freeman & Co.

8. Biochemistry, 1990, 8th Edn., D. Voet & J. Voet, John Willey, New York

9. David T. Plummer: An Introduction to Practical Biochemistry, IIIrd edition (1988)

Subject Code: - ZOO35102 Subject Name -: Entomology No. of credits: 02						
Year : III			Semester : V			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

CO1: The students will understand the basic concepts in Entomology and its scope.

CO2: The students will be able to Learn morphology and anatomy of Insects.

CO3: The students will Understand the concept of social organization in Insects.

Sr.No.	Name of the Topic	Lectures allotted
1	**Unit 1:- Fundamentals of Entomology:** 1.1 Definition and scope of Entomology. 1.2 General Classification of Insect. 1.3 General Characters of Insects.	(02L)
2	**Unit 2:- Insect Morphology** 2.1 Insect head, Head Orientations, Head articulations, Insect antennae and Mouth parts. 2.2 Insect Thorax, Insect Wing and modifications, Insect Leg and Modifications – a) Cursorial – Cockroach. b) Fossorial – Mole cricket. c) Saltorial – Grasshopper. d) Raptorial – Praying mantis,. e) Pollen basket – Honey bee.	(05L)

	2.3 Insect Abdomen, Genital and Pre – genital appendages of Cockroach.	
3	**Unit 3: l Insect Anatomy (Cockroach)** 3.1 Digestive System. 3.2 Circulatory System. 3.3 Nervous System. 3.4 Respiratory System. 3.5 Reproductive System.	(06L)
4	**Unit 4 :- Insect Ecology:** 4.1 Definition of Insect Ecology. 4.2 Abiotic Factors (Photoperiod, Temperature and Humidity) and Biotic Factors (Food, Foraging and Nesting). 4.3 Mimicry in insects with suitable examples.	(04L)
5	**Unit 5:- Insect Metamorphosis** 5.1 Definition, Types and examples of Metamorphosis. 5.2 Hormonal control of metamorphosis.	(03L)
6	**Unit 6:- Insects as social groups** 6.1 Definition & significance of Eusociality. 6.2 Intraspecific and Interspecific relationships among insects. 6.3 Social organization in Wasps and Termites.	(05L)
7	**Unit 7:- Economic Importance of Insects** 7.1 Insects as food. 7.2 Insects as Vectors. 7.3 Insects in Research 7.4 Insects in Medicines and Cosmetics.	(05L)

REFERENCES:

1. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.
2. Modern Entomology, 2nd edition - By D. B. Tembhare, Himalaya Publication House, Bombay.
3. Principles of Insect Morphology - By R. E. Snodgrass, Tata Mc-Graw Hill Bombay.

4. The Insect: Structure & Function - By R. F. Chapman, E. L. B. S., & E. U. P. London.
5. General Entomology, 2nd edition - By M. S. Mani Oxford & IBH Publishing Company, New Delhi.
6. A Text book of Entomology - By H. H. Ross, John Wiley and Sons, Ins. New York.
7. An Introduction to Entomology - By J. H. Comstock, Ithaca, New York.
8. General & Applied Entomology - By K. K. Nayar, T. N. Anathakrishnan & B.V. David, Tata McGraw-Hill, New Delhi.

Subject Code: - ZOO35103
Subject Name -: Environmental Resource Management
No. of credits: 02

Year : III			Semester : V			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Environmental Resource Management Course Outcomes:

CO1: Describe the branches and scope of Environmental biology, emphasizing its environmental importance.

CO2: Understand Ecosystem and its Interactions.

CO3: Understand Energy flow in the Ecosystem Environmental Pollution.

CO4: Students understand Natural Resources and Conservation and wildlife management and acquainted with Environmental Education.

Sr. No.	Name of the Topic	Lectures allotted
1	**Unit 1: Environmental Biology** 1.1 Introduction of Environmental Biology 1.2 Scope of Environmental Biology 1.3 Concept of Biosphere, lithosphere, Atmosphere Hydrosphere.	(02L)
2	**Unit 2: The Ecosystem** 2.1 Definition, abiotic and biotic components and their interrelationship. 2.2 Nutrient cycles in ecosystem. atmospheric cycles & edaphic nutrient cycles. 2.3 Energy flow in ecosystem and flow models. 2.4. Major Ecosystems Natural ecosystem: fresh water e.g. Pond water, Forest ecosystem, Artificial ecosystem: crop land. 2.5 Food chain in ecosystem and food web. 2.6 Ecological pyramids.	(06L)
3	**Unit 3: Environmental Pollution** 3.1 Definition and types of pollution. 3.2 Pollutants, types of pollutants. (metallic, gaseous, acids, alkalis, biocides) 3.3 Air pollution: Definition, sources of air pollutants, their effects.(biodegradable, non-biodegradable) 3.4 Air pollution and its relation with the following. 3.5 Acid rain Greenhouse effect Ozone layer. 3.6 Water pollution: definition, sources of water pollutants, their effects on ecosystem.	(05L)
4	**Unit 4: Environment and Development.** 4.1 Bioindicators and environmental monitoring. 4.2 Environmental challenges in India: land degradation, population explosion, urbanization and industrialization. 4.3 Efforts to meet the environmental challenges.	(05L)

5	**Unit 5: Natural Resources and Conservation** 5.1 Renewable and non-renewable resources. 5.2 Soil conservation 5.3 Forest conservation. 5.4 Energy sources: conventional and non-conventional.	(05L)
6	**Unit 6: Wildlife Management** 6.1 Definition, causes of wildlife depletion. 6.2 Importance of wildlife, management in India. 6.3 Endangered species, vulnerable species, rare species , threatened species 6.4 Wildlife conservation. 6.5 Use of technology in Wildlife conservation 6.6 Conservation strategy-Cheetah reintroduction, Project Tiger.	(05L)
7	**Unit 7: Environmental Education** 7.1 Goals and objectives. 7.2 Role of environmental organizations & agencies.	(02L)

REFERENCE:

1. Fundamentals of Ecology - M C Dash, Tata Mcgraw-Hill Publishing Co. Ltd.1998

2. Concepts of Ecology - Edward J. Kormondy, Prentice-Hall Of India Pvt. Ltd.1996

3. Ecology - Mohan P. Arora, Himalaya Publishing House, 2004

4. Environmental Biology-Biswarup Mukherjee, Tata Mcgraw-Hill Publishing Co.Ltd,1996

5. Fundamentals of Ecology-Eugene P. Odum, Natraj Publishers, 199.

6 Environmental Education - Nagarajan and Sivakumar. P, Ram Publishers, Chennai, (2002). 7. A text book of Environment - Agarwal. K. M. Sikdar. P. K. and Deb. S. C, Mac Miller India Ltd., Calcutta, (2002).

Subject Code: - ZOO35104 Subject Name -: Practicals in Biological Chemistry No. of credits: 02						
Year : III			Semester : V			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Practical per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO 1: To understand the basic concepts and significance of biochemistry.
CO2: To study the basic concepts pH and Buffers.
CO3: To know the structure and importance of proteins.
CO4: To evaluate the variations in enzyme activity and kinetics.

Sr. No.	Name of the Practical	Practical allotted
1	Preparation of Acid, Alkali & it's standardization	1P
2	Isolation of starch from potato and digestion of starch by salivary amylase	1P
3	Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests.	1P
4	Principle, Working & Measurement of pH of any three samples.	1P
5	Preparation of buffer of desired pH and molarity	1P
6	Protein estimation by Bradford method.	1P
7	To study the principle and working of colorimeter and spectrophotometer.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO35104 : Practicals in Biological chemistry (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES :

1. Principles of Biochemistry, 1993, Lehninger A. L. Nelson D. L. & Cox M. M. W. H. Freeman Company, USA.
2. Biochemistry, 1995 5th Edn. Zuby G. W, C. Brown Communications USA.
3. Harpers Biochemistry, 1996 26th Edn. p Murray R. K., Granner D. K., Mayes P. A. & Rodwell V.

   W. Prentice Hall international USA.
4. Outline of Biochemistry, 1995 5th Edn, Conn E. E., Stumph P. K. Bruening G & Doi R.

   H. John Wiley & Sons, USA.
5. Principals of Biochemistry, 1993, 1st Edn., Pattabhiraman T. N. Gajanan Book publishers and distributors Bangalore.

Subject Code: - ZOO35105

Subject Name -: Practicals in Environment Resource Management

No. of credits: 02

Year : III			**Semester : V**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Practical per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO1: To understand the abiotic and biotic factors of environment.

CO2: To study the various ecosystems.

CO3: To study and identify freshwater Zooplanktons

CO4: To study the water parameters of fresh-water ecosystems.

CO5: To study biodiversity indices.

Sr. No.	Name of the Practical	Practical allotted
1	Study of environmental pollutants	1P
2	Study of alkalinity from water sample.	1P
3	Study of hardness of water sample.	1P
4	Study of salinity of water sample.	1P
5	Study and identification of freshwater Zooplanktons.	1P
6	To study population dynamics of fresh-water ecosystem	1P
7	Study of biodiversity indices.	1P
8	Compulsory field visit to effluent/sewage treatment plant	2P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO35105 : Practicals in Environment Resource Management (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. Fundamentals of Ecology - M C Dash, Tata Mcgraw-Hill Publishing Co. Ltd.1998

2. Concepts of Ecology - Edward J. Kormondy, Prentice-Hall Of India Pvt. Ltd.1996

3. Ecology - Mohan P. Arora, Himalaya Publishing House, 2004

4. Environmental Biology-Biswarup Mukherjee, Tata Mcgraw-Hill Publishing Co.Ltd,1996

5. Fundamentals of Ecology-Eugene P. Odum, Natraj Publishers, 199.

Subject Code: - ZOO35106 Subject Name -: Bioinstrumentation and Bioinformatics No. of credits: 02						
Year : III			Semester : V			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Major Elective	**02**	**30**	**02**	**20**	**30**	**50**

Course outcomes:

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

CO1 : Understand the principle, significance and applications of biological techniques.

CO2: Apply the knowledge of different Separation and Microscopic techniques.

CO3: Analyse and comprehend the good laboratory practices and safety measures.

CO4 : Illustrate the database tools with their significance.

CO5 : Apply the knowledge of different bioinformatics web resources, tools and databases.

Sr. No.	Name of the Topic	Lectures allotted
1	**Unit 1: Introduction to Good Laboratory Practices** 1.1 Laboratory safety and etiquettes. 1.2 Hazardous and Toxic substances. 1.3 Risk groups and Biosafety Levels.	(02 L)
2	**Unit 2: Microscopy** 2.1 Construction, principle and applications of Bright and Dark Field Microscopy 2.2 Types of microscopes (Compound, Phase contrast and fluorescent microscope) and their uses.	(03 L)

3	**Unit 3: 3. pH** 3.1 Sorenson's pH scale. 3.2 pH meter – principle and applications.	(02 L)
4	**Unit 4: Colorimetry and Spectrophotometry** 4.1 Beer – Lambert's Law and its derivation. 4.2 Principle, working and Applications of colorimeter and spectrophotometer.	(02 L)
5	**Unit 5: Separation techniques** **5**.1 Centrifugation – principle, working and applications**,** Types of Centrifuges used in Biology. 5.2 Chromatography- principle, working and applications of Thin Layer, Column, Gas chromatography and HPLC. 5.3 Electrophoresis- Support media used in electrophoresis, Types- Native, Agarose and SDS- PAGE.	(06 L)
6	**Unit 6: Introduction to Bioinformatics** 6.1 Scope and Application of Bioinformatics. 6.2 Bioinformatics web resources (NCBI, EBI, OMIM, PubMed). 6.3 Different Search engines and computer programs useful in Biology.	(03 L)
7	**Unit 7: Biological databases and tools** 7.1 Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBL- EBI) 7.2 Protein sequence databases (UniProtKB,) 7.3 Secondary sequence databases 7.4 Derived databases – PROSITE.	(05 L)
8	**Unit 8: Sequence alignment methods** 8.1 BLAST, FASTA. 8.2 Types of sequence alignment (Pairwise & Multiple sequence alignment). 8.3 Significance of sequence alignment.	(04 L)
9	**Unit 9: Predictive applications using DNA and protein sequences**	(03 L)

	1.1 Concept of phylogenetic tree. 1.2 Introduction to the Era of Omics- Proteomics, Pharmacogenomics and Metabolomics (Significance and Applications).	

REFERENCES:

1. Introduction of Medical Laboratory Technique,1998, 7th Edn., Baker F. J., Silverton R. E., Pallister C. J., Butterworth-Heinemann, UK.
2. Basic Separation Techniques in Biochemistry, 1998, Okotore R. O., New Age International, New Delhi.
3. Cytological techniques: The Principles Underlying Routine Methods, 1963,Baker J. R., Methuen & Co., London.
5. Microscope and microscopic life, 1979, 2nd Edn., Peter Healey, Hamlyn, UK.
6. Biological Instrumentation and methodology, 2008, 2nd Revised Edition, P. K. Bajpai, S. Chand and Co. Ltd., New Delhi.
7. Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003.

Subject Code: - ZOO35107

Subject Name -: Practicals in Bioinstrumentation and Bioinformatics

No. of credits: 02

Year : III **Semester : V**

Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Major Elective	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO1: To understand various evidences of evolution.

CO2: To study the various adaptations in animals.

CO3: To understand successive stages of evolution of man.

CO4: To study and understand zoogeographical distribution of animals in different zoogeographical realms.

Sr. No.	Name of the Practical	Practical allotted
1	To study the working and principle of different types of microscopes.	1P
2	To study the separation of dyes using Thin Layer chromatography.	1P
3	To study of blood and its constituents using Centrifuge.	1P
4	To measure the optical density of colored compounds using colorimeter.	1P
5	Isolation and Quantification of DNA using Nanodrop method.	1P
6	Study of bioinformatics and Biological databases	1P
7	Study of Bioinformatics tools and web resources.	1P
8	Retrieval of Nucleotide sequence from GenBank.	1P
9	Retrieval of Protein sequence from GenBank.	1P
10	Sequence Similarity Search using BLASTN.	1P
11	Sequence Similarity Search using BLASTP.	1P
12	To browse genomic resources for prokaryotic and eukaryotic genomes.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO35107 : Practicals in Bioinstrumentation and Bioinformatics (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. Basic Separation Techniques in Biochemistry, 1998, Okotore R. O., New Age International, New Delhi.
2. Cytological techniques: The Principles Underlying Routine Methods, 1963,Baker J. R., Methuen & Co., London.
3. Microscope and microscopic life, 1979, 2nd Edn., Peter Healey, Hamlyn, UK.
4. Biological Instrumentation and methodology, 2008, 2nd Revised Edition, P. K. Bajpai, S. Chand and Co. Ltd., New
5. Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi& others; CBS Publishing; 2003.
7. Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry- Smith; Pearson Education, 11th Reprint; 2005

Subject Code: ZOO35208 Subject Name -: Biodiversity conservation and sustainable development No. of credits: 02						
Year: III			Semester: V			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Minor	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

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

CO1: To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.

CO2: To introduce about ecosystems, biodiversity and to make aware for the need of conservation.

CO3: To sensitize students towards environmental concerns, issues, and impacts of human population.

CO4: To prepare students for successful career in environmental departments, research institutes, industries, consultancy, and NGOs, etc.

Sr. No	Name of the Topic	Lectures allotted
1.	**Unit 1**: **Biodiversity** 1.1 Definition and Types of Biodiversity (Genetic, Species and ecological).	(02L)
2.	**Unit 2**: **Levels of biological diversity** 2.1 Genetic, species and ecosystem diversity.	(04L)

	2.2 Biodiversity Hotspots.	
3.	**Unit 3**: **Biogeographic zones of India** (Trans-Himalayan Region, Himalayan Zone, Indian Desert Zone, Semi-arid Zone, Western ghats, Deccan Plateau, Gangetic plain, North East Region, Islands, Costal region)	(04L)
4.	**Unit 4**: **India as a mega-biodiversity nation** 4.1 The International Union for Conservation of Nature (IUCN) 4.2 Categories of wildlife (Endangered, Endemic, Extinct species of India and IUCN Red list)	(04L)
5.	**Unit 5**: **Threats to biodiversity** 5.1 Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions. 5.2 Neothreats-Environmental contaminants, particulate matter, gases, industrialization.	(04L)
6.	**Unit 6**: **Conservation of biodiversity** 6.1 In-situ conservation of biodiversity. 6.2 Ex-situ conservation of biodiversity.	(04L)
7.	**Unit 7**: **Natural Resources and Sustainable Development** 7.1 Overview of natural resources: Definition of resource; 7.2 Classification of natural resources- Biotic and abiotic, Renewable and non-renewable.	(04L)
8.	**Unit 8: Sustainable development**	(04L)

	8.1 Sustainable Development Goals (SDGs) 8.2 Targets, indicators, challenges and strategies for SDGs	
	Total Lectures	30

REFERENCES:

1. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.

2. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

3. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

4. Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.

5. John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS)

6. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications https://sdgs.un.org/goals

7. Down to Earth, Centre of Science and Environment ®.

Subject Code: ZOO35209 **Subject Name -: Practicals in Biodiversity conservation and sustainable development** **No. of credits: 02**	
Year : III	**Semester : V**
Teaching Scheme	**Evaluation Scheme**

Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
Minor	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

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

CO1: To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.

CO2: To introduce about ecosystems, biodiversity and to make aware for the need of conservation.

CO3: To sensitize students towards environmental concerns, issues, and impacts of human population.

CO4: To prepare students for successful career in environmental departments, research institutes, industries, consultancy, and NGOs, etc.

Sr. No.	Title of the Practical	No. of Practicals
1.	Study of soil fauna: collection, sampling, preservation and analysis.	2P
2.	Study of water quality and dissolved oxygen content in water samples of an ecosystem.	1P
3.	Collection, identification and preservation of various insect orders and arthropod groups (including study of permanent specimens).	1P
4.	Museum preservation techniques of selected vertebrates and invertebrates.	1P
5.	Using photographs / paintings / coloured drawings identify and study ecological role of characteristic animal species (major representative species only) of various Biomes.	2P
6.	Using photographs / paintings / coloured drawings identify and	2P

	study ecological role of characteristic plant species (predominant trees / shrubs only) of various biomes.	
7.	Study of animal architecture (photographs / diagram / abandoned specimen); Hive of honey bee, nest of paper wasp, nest of potter wasp, mount of termite, nests of weaver bird and tailor bird).	2P
8.	Sampling of plant and animal biodiversity of the College campus	2P
9.	Visit to ZSI Pune and other places.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO35209 : Practicals in Biodiversity conservation and sustainable development (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. Standard Methods For The Examination Of Water And Waste Water (E.D. 17) by American Public Health Association & Others
2. Chemistry For Environmental Engineering (E.D. 3) by Sawyer Clairn& McCarthy Perry L
3. Laboratory Manual For The Examination Of Water, Waste Water & Soil by Rump H. H. &Krist H.
4. Brusseau, M.L., Pepper, I.L., and Gerba, C.P. (2019). Environmental and Pollution Science, 3rd Edition. Academic Press, USA. (pp. 1-520).
5. Divan, S. and Rosencranz, A. (2002). Environmental Law and Policy in India: Cases,

Material & Statutes, 2nd Edition. Oxford University Press, India. (pp. 1-837).

6. Gadgil, M., and Guha, R. (1993). This Fissured Land: An Ecological History of India. University of California Press, Berkeley, USA. (pp. 1-245).
7. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). Environment, 8th Edition. Wiley Publishing, USA. (pp. 1-472).

Subject Code: - ZOO35410

Subject Name -: Practical in Entomology

No. of credits: 02

Year : III			Semester : V			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Practical per week**	**Internal Assessment**	**Semester End Exam**	**Total**
VSEC	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO1: To understand the external characters of Cockroach.
CO2: To study the various digestive system of Cockroach.
CO3: To prepare temporary mounting of mouthparts, antennae, legs and wings of Cockroach.
CO4: To study the social organization in social insects.
CO5: Study of insect vectors.
CO6: Identification of gut parasites from the cockroach.

Sr. No.	Name of the Practical	Practical allotted
1	Study of external characters of any Insect- Cockroach.	1P
2	Study of Insect Head, its articulations and types of mouthparts and their modifications.	1P
3	Study of insect legs, wings and their modification.	1P

4	Study of Digestive system of any locally available insect pest.	1P
5	Temporary mountings of Mouthparts, Antennae, Legs and Wings of Cockroach.	1P
6	Study of Digestive system of Cockroach.	1P
7	Study of Reproductive System of Cockroach.	1P
8	Study of insect egg, larva, pupa and their types.	1P
9	Study of Insect vectors - Mosquito, House fly, Cockroaches, Bugs.	1P
10	Study of Social organization in Wasps and Termites.	1P
11	Compulsory field visit to wildlife sanctuary/National parks/to study the insect diversity.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO35410 : Practicals in Entomology (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.
2. Modern Entomology, 2nd edition - By D. B. Tembhare, Himalaya Publication House, Bombay.
3. Principles of Insect Morphology - By R. E. Snodgrass, Tata Mc-Graw Hill Bombay.
4. The Insect: Structure & Function - By R. F. Chapman, E. L. B. S., & E. U. P. London.
5. Social Insects: Their Origin and Evolution, 2006, W. M. Wheeler, Discovery Publishing House, Delhi.

SEMESTER VI

Subject Code: - ZOO36101 Subject Name -: Molecular Biology No. of credits: 02						
Year : III			Semester : VI			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

CO1: Understand Nucleic acid types and structure.

CO2: Understand the Structure of DNA and RNA, DNA and RNA as genetic material.

CO3: Understand the Central Dogma of Molecular Biology.

CO4: Understand the concept of gene regulation, and application of DNA fingerprinting and PCR.

Sr. No.	Name of the Topic	Lectures allotted
1	**Unit 1: Nucleic Acids** 1.1 Structure of DNA and RNA 1.2 Types of DNA and RNA 1.3 DNA as genetic material - evidences (Griffith's, Avery et al., Hershey and Chase experiment	(06L)
2	**Unit 2: Central Dogma of Molecular Biology** 2.1 DNA Replication: Basic mechanism of replication in prokaryotes and eukaryotes. 2.2 Transcription -Basic mechanism of transcription in prokaryotes and eukaryotes. 2.3 Role of RNA polymerase enzyme in prokaryotes. 2.4 Inhibitors of Transcription	(12L)

	2.5 RNA modifications and processing (splicing - mRNA, modifications at 3'and 5' end). 2.6 Translation - Basic mechanism of Translation in prokaryotic and eukaryotic cells. 2.7 Genetic code, properties of genetic code.	
3	**Unit 3: Gene Regulation** 3.1 Inducible- Lac operon, Regulatory Gene, Promotor, Operator gene. 3.2 Repressible -Trp Operon	(04L)
4	**Unit 4: Recombinant DNA Technology** 4.1 Restriction enzymes and its types. 4.2 Types of Cloning vector. 4.3 Steps of Recombinant DNA technology.	(06L)
5	**Unit 5: Application of Molecular Biology** 5.1 Concept of PCR and RTPCR and its Mechanism. 5.2 DNA finger printing. 5.3 Molecular Markers and its Importance.	(02L)
	Total Lectures	30

REFERENCES:

1. Molecular biology of cell, 3rd and 4th edition, Albert's B. D. Lewis J. Raff M. Roberts K. and Watson.
2. Gene, Vol. V, VI, VII, VIII and IX, Lewin B., Oxford University Press, Oxford.
3. Molecular biology of the Gene, 1993, Watson J. Hopkins, Roberts Steitz & Weiner, Benjamin Cummings.
4. Text Book of Molecular Biology, 1994, K. Sivrama Sastry G. Padmanabhan and C. Subramanyam : MacMillan, India.
5. Cell and Molecular biology, 1996, G. Karp, John Willey & Sons, U.S.A. CBCS: 2021-

2022.

6. Principles of Genetics, 1997, P. D. Snustad, M. L. Smmons, J. B. & Jenkins, John Willey & Sons, U.S.A.

7. Cell and Molecular biology, De Robertis and De Robertis, 8th & 9th Edition, Saunders Publications.

Subject Code: - ZOO36102 Subject Name -: Parasitology No. of credits: 02						
Year : III			**Semester : VI**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

CO1: To learn about the basics and scope of parasitology.

CO2: To know the types of host and parasite with examples.

CO3: To learn about host -parasite relationships and their effects on host body.

CO4: To understand about the morphology, life cycle, pathogenicity and treatment of common parasites (Protists, Parasitic worms and Arthropods).

CO5: To understand causative agents, modes of transmission of zoonotic diseases.

Sr. No.	Name of the Topic	Lectures allotted
1	**Unit 1: Introduction, Scope and Branches of Parasitology.** 1.1. Definition: host, parasite, vector, commensalisms, mutualism and parasitism. 1.2. Branches of parasitology. 1.3 Scope of parasitology.	(02L)
2	**Unit 2: Types of Parasites and Hosts** 2.1 Ectoparasites.	(03L)

	2.2 Endoparasites and its subtypes. 2.3 Types of hosts - Intermediate, definitive, paratenic and reservoir.	
3	**Unit 3: Host - Parasite relationship** 3.1 Host specificity. 3.2 Types of host specificity: structural specificity, physiological specificity and ecological specificity. 3.3 Effects of parasite on the host.	(03L)
4	**Unit 4: Study of Parasitic Protists** 4.1 *Entamoeba histolytica* - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment. 4.2 *Plasmodium vivax* - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.	(07L)
5	**Unit 5: Study of Parasitic worms:** 5.1 *Ascaris lumbricoides* - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment. 5.2 *Taenia solium* (Tapeworm) - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.	(06L)
6	**Unit 6: Study of Parasitic Arthropoda** Morphology, pathogenicity and control measures of – 6.1 Soft and Hard tick. 6.2 Head louse. 6.3 Rat flea. 6.4 Bed bug.	(04L)
7	**Unit 7: Zoonotic diseases.** 7.1 Definition and types of zoonotic diseases. 7.3 Causative agents and modes of transmission.	(02L)
8	**Unit 8: Tools and techniques used in the diagnosis of parasites** 8.1 Microscopic and macroscopic examination. 8.2 Indirect method of examination-antigen and antibody based.	(03L)
	Total Lectures	30

REFERENCES:

1. Parasitology: K. D. Chatterjee.

2. Parasites: ecology, diseases, and management (2013).

3. Parasitic Helminths: Targets, Screens, Drugs, and Vaccines, 201.

4. Parasitism: The Diversity and Ecology of Animal Parasites (2014) Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press.

5. Principles of Veterinary Parasitology (2016), 1st Edn, Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons.

6. Veterinary Parasitology (2013), Hany M. Elsheikha, Jon S. Patterson, CRC Press Taylor & Francis Group

7. Textbook of medical parasitology – C. K. Jayaram Panikar.

8. Textbook of medical parasitology – Arora & Arora.

Subject Code: ZOO36103 **Subject Name -: Developmental Biology** **No. of credits: 02**						
Year : III			**Semester : VI**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

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

CO1: Define basic terms, concepts and theories of developmental biology.

CO2: Explain the process of gamete formation and fertilization.

CO3: Explain the cleavage, blastulation and gastrulation events in fertilized egg.

CO4: Explain the various events in chick embryology.

Sr. No.	Name of the Topic	Lectures allotted
1.	**Unit 1: - Fundamentals of Developmental Biology:** 1.1 Definition and scope. 1.2 Concepts in Developmental Biology: Growth, Differentiation, Dedifferentiation, Cell determination, Cell Specification, Cell communication, Morphogenesis, Induction, Competence and Regeneration.	(03L)
2.	**Unit 2: - Theories of Developmental Biology** 2.1 Preformation. 2.2 Pangenesis. 2.3 Epigenesis. 2.4 Axial gradient. 2.5 Germplasm.	(04L)
3.	**Unit 3: - Gametogenesis** 3.1 Structure of T.S. of Testis; Spermatogenesis & Structure of sperm with respect to human. 3.2 Structure of T.S. of Ovary; Oogenesis & Structure of ovum with respect to human. 3.3 Types of eggs	(05L)
4.	**Unit 4: - Fertilization:** 4.1 Concept and types. 4.2 Chemotaxis. 4.3 Sperm penetration: Acrosome reaction, Capacitation & Decapacitation.	(05L)

	4.4 Activation of ovum: Fertilization cone. 4.5 Prevention of polyspermy: Fast block & Slow block. 4.6 Significance of fertilization.	
5.	**Unit 5: - Cleavage and Blastula** 5.1 Definition and concept. 5.2 Planes and symmetry of cleavage. 5.3 Types of cleavage. 5.4 Significance of cleavage. 5.5 Definition and types of Blastula.	(04L)
6.	**Unit 6: - Gastrulation** 6.1 Definition and Concept. 6.2 Basic cell movements in gastrulation: Epiboly, Emboly, Invagination & Involution with reference to frog. Concept of Organizer: Primary, Secondary and Tertiary.	(05L)
7.	**Unit 7: - Chick Embryology** 7.1 Structure of Hen's egg. 7.2 Fertilization and cleavage in Chick. 7.3 Blastulation and Gastrulation in chick (Formation of primitive endoderm, Primitive streak development, Head process and regression of Primitive streak).	(04L)
	Total Lectures	**30**

REFERENCES:

1. An Introduction to Embryology (2012), 5th Edition., Balinsky B. L., Fabian B. C. Brooks

Cole Pub. Co., USA

2. Developmental Biology (2013), 10th Edn. Gilbert S. F., Sinauer Associates Inc.

3. Developmental Biology: Patterns, Principle and Problems (1982), Saunders J. W., Prentice Hall Coll Div.

4. Principles of Development (2007), 3rd edition, Lewis Wolpert, Oxford University Press Publisher.

Subject Code: - ZOO36104

Subject Name -: Practical in Molecular Biology

No. of credits: 02

Year : III			**Semester : VI**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Practical per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO1: Students will be able to learn laboratory safety techniques and sterilization methods.

CO2: The students will be able to prepare DNA paper model and understand its characteristics.

CO3: The students will able to isolate prokaryotic and eukaryotic DNA.

CO4: The students will be able to understand the principle and working of spectrophotometer and PCR.

Sr. No.	**Name of the Practical**	**Practicals allotted**
	Practicals in Molecular Biology	1P
1	Lab safety techniques and sterilization.	1P
2	Staining of DNA and RNA by methyl green- pyronin.	1P
3	Estimation of DNA by diphenylamine method	1P
4	Isolation of DNA from bacteria.	1P

5	Absorption spectra of DNA isolated from bacteria.	1P
6	Isolation of eukaryotic DNA from chicken liver.	1P
7	Principle and Application of Spectrophotometer.	1P
8	Principle and working of thermal cycler.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO36104 : Practical's in Molecular Biology (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. Molecular biology of cell, 3rd and 4th edition, Albert's B. D. Lewis J. Raff M. Roberts K. and Watson.
2. Gene, Vol. V, VI, VII, VIII and IX, Lewin B., Oxford University Press, Oxford.
3. Molecular biology of the Gene, 1993, Watson J. Hopkins, Roberts Steitz & Weiner, Benjamin Cummings.
4. Text Book of Molecular Biology, 1994, K. Sivrama Sastry G. Padmanabhan and C. Subramanyam : MacMillan, India.
5. Cell and Molecular biology, 1996, G. Karp, John Willey & Sons, U.S.A. CBCS: 2021-2022.
6. Principles of Genetics, 1997, P. D. Snustad, M. L. Smmons, J. B. & Jenkins, John Willey & Sons, U.S.A.
7. Cell and Molecular biology, De Robertis and De Robertis, 8th & 9th Edition, Saunders Publications.

Subject Code: - ZOO36105 Subject Name -: Practical in Parasitology & Developmental Biology No. of credits: 02						
Year : III			Semester : VI			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	**02**	**30**	**01**	**20**	**30**	**50**

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Course Outcomes:

CO1: Students will be able to explain various pathologies in humans.

CO2: The students will be able to understand the life cycle, pathogenicity, diagnosis and treatment of various parasites through permanent slides or microphotographs.

CO3: The students will able to understand the role of parasites as vector.

CO4: The students will be able to identify gut parasites in cockroach.

CO5: The students will be able to understand the ultrastructure of sperm and ovum of humans.

CO6: The students will be able to understand the cleavage, blastula and gastrula in Amphioxus, Frog and Hen.

CO7: The students will be able to understand the whole mount developmental stages of chick embryo.

CO8: The students will be able to understand to prepare temporary mounting of chick embryo.

Sr. No.	Name of the Practical	Practicals allotted
	Practical in Parasitology	
1	Study of parasitic association with their example - a) Commensalism. b) Parasitism	1P
2	To study the life cycle, pathogenecity, diagnosis and treatment of *Entamoeba histolytica* and *Plasmodium vivax* through permanent slides or microphotographs	1P

3	To study the life cycle, pathogenecity, diagnosis and treatment of *Ascaris lumbricoides* and *Taenia solium* through specimen, permanent slides or microphotographs	1P
4	Study of following parasites with its role as vector – soft tick and hard tick, Mite (*Sarcoptes scabiei*), *Pediculus humanus, Xenopsylla cheopis* and *Cimex lectularius* through permanent slides or photographs	1P
5	Study of parasites from the gut of cockroach	1P
	Practical in Developmental Biology	1P
1	Study of ultrastructure of sperm and Ovum of mammal.	1P
2	Study of different types of eggs with the help of slide/Photograph/Chart/Model (Insect, Amphioxus, Frog and Hen).	1P
3	Study of cleavage and its types with the help of slide/Photograph/Chart/Model	1P
4	Study of blastula and gastrulae (Amphioxus, Frog and Hen).	1P
5	Study of whole mounts of developmental stages of chick through permanent slides: 18 hrs upto 72, and 96 hours of incubation.	1P
6	Temporary mounting of chick embryos	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO36105 : practical's in Parasitology & Developmental Biology (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. 1. Parasitology: K. D. Chatterjee.

2. Parasites: ecology, diseases, and management (2013).

3. Parasitic Helminths: Targets, Screens, Drugs, and Vaccines, 201.

4. Parasitism: The Diversity and Ecology of Animal Parasites (2014) Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press.

5. Principles of Veterinary Parasitology (2016), 1st Edn, Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons.

6. Veterinary Parasitology (2013), Hany M. Elsheikha, Jon S. Patterson, CRC Press Taylor & Francis Group

7. An Introduction to Embryology (2012), 5th Edition., Balinsky B. L., Fabian B. C. Brooks Cole Pub. Co., USA.

8. Developmental Biology (2013), 10th Edn. Gilbert S. F., Sinauer Associates Inc.

9. Developmental Biology: Patterns, Principle and Problems (1982), Saunders J. W., Prentice Hall Coll Div.

10. Principles of Development (2007), 3rd edition, Lewis Wolpert, Oxford University Press Publisher.

Subject Code: - ZOO36106 **Subject Name -: Medical & Forensic Zoology** **No. of credits: 02**						
Year : III			**Semester : V**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Major Elective	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

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

CO1: To understand the basics of Medical and Forensic Zoology.

CO2: To know the scientific methods in crime detection.

CO3: To evaluate the advancements in the field of Medical and Forensic Zoology.

CO4: To analyze the fundamental principles and functions of forensic science and its

significance to human society.

Sr. No.	Name of the Topic	Lectures allotted
1	**Unit 1:- Introduction to Medical and Forensic Zoology and its importance:** 1.1 Definition, significance and scope. 1.2 Basic Principles of Forensic Science with Examples. 1.3 Different branches of Forensic Science. 1.4 Forensic Laboratories in India.	(04L)
2	**Unit 2 :- Medico-legal Autopsy:** 2.1 Death and its Causes- External examination of deceased body – Internal Examination - Determination of time since death and cause of death. 2.2 Injuries – Classification - Medico-legal aspects of injuries. 2.3 Post-mortem changes - collection of post-mortem samples and Preservation.	(05L)
3	**Unit 3: Diseases and their control** **3.1 Infectious diseases:** Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Tuberculosis and Hepatiti **3.2 Non infectious Diseases:** Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Diabetes (Type I and II), Hypertension, Hypotension, Obesity, Atherosclerosis, Myocardial Infraction.	(04L)
4	**Unit 4 :- Forensic Medicine** 4.1 Introduction to Forensic Medicine: Definitions of Forensic Medicine. 4.2 Medical Jurisprudence. 4.3 Medical evidence documentations.	(04L)

5	**Unit 5 :- Forensic analysis** 5.1 Examination of biological materials: Examination of Hair, Fibers, Diatoms, plants materials, human tissues. 5.2 Examination of Body Fluids: Blood, Semen and Saliva. 5.3 DNA Fingerprinting Technique and Examination of Biological Traces: Liquid blood, blood stains, & swabs, semen, Seminal stains, tissues, Bones, Hairs, Teeth, Saliva, Skeletal remains.	(05L)
6	**Unit 6:- Insects of forensic importance** 6.1 Forensic Importance of Insect 6.2 Insects of forensic importance - indicators of time of death stages of insect development & comparative decomposition of human body - colonization – 6.3 Evidence collection of insects – Territorial & Aquatic Insects.	(03L)
7	**Unit 7: Toxicological Investigations** 7.1 Poisons – Definition 7.2 Forms of Poison – Physical, Chemical & Mechanical state. 7.3 Introduction with examples of – Neurotoxic Poisons – Cerebral & Spinal, Cardiovascular Poisons, Asphyxiants.	(05L)
	Total Lectures	30

REFRENCES:

1. Godkar P. B and Godkar D. P, Textbook of Medical Laboratory Technology, II Edition, Bhalani Publications
2. Textbook of Microbiology: R. Ananthanarayan, C. K. Jayaram Panikar, University Press.
3. A textbook of Microbiology: P. Chakraborty
4. Text book of pathology: Robbins & Cotran, Vol. 1 & 2, Tenth Edition, Elsevier Publication.

5. Pathologic basis of disease: M. K. Singh & Vinay Kumar, Vol. 1 & 2, 10th edition, Elsevier.

6. Text book of General pathology: Bhende & Deodhare Part I & II.

7. Pathologic basis of Disease: Robbins & Cotran, Vol. 1 & 2, 10th edition, Elsevier publications.

8. Essentials of medical pharmacology: K. D. Tripathi, 8th edition, Jaypee brother's publishers.

9. Review of pharmacology: K. D. Tripathi, Jaypee brothers' publishers.

Subject Code: - ZOO36107

Subject Name -: Practical in Medical and Forensic Zoology

No. of credits: 02

Year : III			**Semester : VI**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Major Elective	**02**	**30**	**01**	**20**	**30**	**50**

Course Outcomes:

CO1: Students will be able to explain various pathologies in humans.

CO2: The students will be able to perform urine analysis.

CO3: The students will be able to determine urea/uric acid/creatinine and calcium in human blood.

CO4: The students will be able to understand morphology, scale pattern of human hair.

CO5: The students will able to understand various types of fingerprints.

CO6: The students will be able to identify blood stains and determine blood group from fresh blood and blood stains.

CO7: The students will be able to understand modern tools, techniques and skills in forensic investigations.

Sr. No.	Name of the Practical	practical's allotted
1	To carry out routine analysis of given urine sample i. Physical Properties: Volume, Colour, odour, pH, Turbidity, Specific gravity. ii. Chemical Properties: Sugars, Protein, Bile salts & bile pigments, Ketone bodies, Blood. (C	2P
2	Determination of serum urea/uric aci	1P
3	Determination of serum creatinine.	1P
4	Determination of serum Calcium.	1P
5	To examine human hair for cortex and medulla.	1P
6	To prepare slides of scale pattern of human hair.	1P
7	To examine hair morphology and determine the species to which the hair belongs.	1P
8	To Identify and differentiate various types of Finger prints.	1P
9	To carry out ten digit classification of fingerprints.	1P
10	To prepare a case report on forensic entomology with respect to insect's succession and its relationship to determine time since death.	1P
11	To Visit a Forensic Laboratory and submission of the report.	2P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO36107 : practical's in Medical and Forensic Zoology (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

REFERENCES:

1. W. G. Eckert and S. H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).

2. A textbook of Clinical pharmacology: Roger H. J., Spector R. G., Trounce J. R., Hodder & Stoughton publishers.

3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).

4. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton (1983)

5. D.A. Ashbaugh, Quantitative-Qualitative Friction Ridge Analysis, CRC Press, Boca Raton (2000).

6. C. Champod, C. Lennard, P. Margot an M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton (2004).

7. Lee and Gaensleen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press, Boca Raton (2013).

Subject Code: - ZOO36208
Subject Name -: Museology and Taxidermy of Invertebrates and Vertebrates
No. of credits: 02

Year : III			Semester : VI			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Minor	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

CO1: Understand the importance of Environment.

CO2: Learn the impact of Pollution on Human health, natural resources.

CO3: Understand Environmental Protection acts and concepts sustainable development.

CO4: Understand types of Environmental Impact Assessment (EIA) and stakeholders in EIA Process.

Sr. No.	Name of the Topic	No of Lectures allotted
1	**Unit 1: Establishment of an Animal Museum** 1.1 Concept, Development and Types of Museums. 1.2 Definition, History, Scope and Significance of Museum. 1.3 Characteristic features of Ideal Museum.	(03L)
2	**Unit 2: Collection and Preservation Techniques for Invertebrate Animals** 2.1 Protozoans, Sponges, Coelenterates, Worms. 2.2 Annelids, Arthropods, Molluscans and Echinoderms.	(03L)
3	**Unit 3: Collection and Preservation Techniques for Vertebrate Animals** 3.1 Amphibians, Reptiles, Aves and Mammals.	(03L)
4	**Unit 4: Collection, Preservation and Embalming** 4.1 Collection and Preservation of Insects: Collecting Net, Sieve, Aspirator, Traps, Berlese Funnel, Killing Bottles. 4.2 Relaxing, Pinning, Spreading, Insect Box.	(04L)
5	**Unit 5: Collection and Preservation of Fishes** 5.1 Collection Methods: Fishing without any gear and only by hands. 5.2 Line fish (Angling), By fish screen, Fish trap. 5.3 Dipnet or Lift net, Cast net, Purse net , Gill net, Drag net. 5.4. Preservation Techniques: Cleaning, Gutting, Drying, Refrigeration, Deep freezing, Chemical Preservation. 5.5. Embalming. 5.6. Injecting.	(04L)

6	**Unit 6: Taxidermy** 6.1 Definition, History, Scope and Significance of Taxidermy. 6.2 Protection and Storage of Animal before Taxidermy. 6.3 Types and Process of Taxidermy. 6.4 Anthropomorphic Taxidermy. 6.5 Conservation and Restoration of Taxidermy. 6.6 Taxidermy of Birds/Mammals.	(06L)
7	**Unit 7: Preparation of Skeleton and Fixatives, Stains and Reagents** 7.1 Preparation of Skeleton. 7.2 Steps: Skinning, Removal of soft organs, Removal of muscles, Disarticulation, Cleaning, Bleaching, Curing, Polishing and Preservation. 7.3 Maceration: A bone preparation technique. 7.4 Conservation and Restoration of Bone, Horn and Antler objects. 7.5 Labelling: Labelling and Marking kit. 7.6 Cataloging: Purpose of Cataloging. 7.7 Display: Arrangement of specimens and slides. 7.8 Fixatives, Stains and Reagents: Alizarin Skeletal Staining.	(07)
	Total lectures	30

REFERENCES:

1. Alexis Turner: "Taxidermy": Thames and Hudson.
2. Dalela R.C. & Sharma R.S. "Animal Taxonomy & Museology" JP Nath & Company Meerut Nadine H. Roberts : "A Complete Handbook of Taxidermy": Tab books.
3. Roger J. Lincoth & J Gordon Sheals, "Invertebrate Animals Collection & Preservation"; Cambridge university Press.
4. Anderson Rudolph "Methods of collecting & Preserving vertebrate Animals"; Read Books.
5. Azhagu Madhavan; "Collection & Preservation of Insects;" Notion Press.
6. Swarup N., Arora S. and Pathak S.C, "laboratory techniques in Modern Biology" Kalyani Publication New Delhi.

Subject Code: - ZOO36209 Subject Name -: Practical in Museology and Taxidermy of Invertebrates and Vertebrates No. of credits: 02						
Year : III			Semester : VI			
Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Minor	**02**	**30**	**01**	**20**	**30**	**50**

Sr. No.	Name of the Practical	practical's allotted
1	Collection, Preservation, Curation and Identification of animals.	2P
2	Preparation and Identification of Nets and Gears.	1P
3	Identification and Labelling of Collected animals (locally available)	1P
4	Preparation of permanent slide - Locally available small organisms (Invertebrates).	1P
5	Preparation of basic and acidic fixatives, stains and reagents.	2P
6	Observation of the procedure of Taxidermy through YouTube /videography.	2P
7	Observation of Bird Skeleton / Mammal Skeleton Preparation through YouTube/videography.	1P
8	Alizarin Skeletal Staining.	2P
9	Preparation of Insect Box with Preserved Insects, 5 Permanent Slides and 5 Preserved.	2P

	Specimens.	
10	Physical/Virtual visit to Animal Museum.	1P

REFERENCES:

1. Alexis Turner: "Taxidermy": Thames and Hudson.

2. Dalela R.C. & Sharma R.S. "Animal Taxonomy & Museology" JP Nath & Company Meerut Nadine H. Roberts : "A Complete Handbook of Taxidermy": Tab books.

3. Roger J. Lincoth & J Gordon Sheals, "Invertebrate Animals Collection & Preservation"; Cambridge university Press.

4. Anderson Rudolph "Methods of collecting & Preserving vertebrate Animals"; Read Books.

5. Azhagu Madhavan; "Collection & Preservation of Insects;" Notion Press.

6. Swarup N., Arora S. and Pathak S.C, "laboratory techniques in Modern Biology" Kalyani Publication New Delhi.

ZOO36610 On Job Training OJT (4C)

Subject Code: ZOO36610 Subject Name -: On Job Training (4C) No. of credits: 04						
Year : III			**Semester : VI**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
OJT	**04**	**60**	**02**	**40**	**60**	**100**

Chairman, BOS **Principal**