Maharani Lakshmi Ammanni College for Women **Autonomous**

Affiliated to Bengaluru Central University
Re-accredited by NAAC with "A" grade, Recognised by UGC
under Section 2(f) and 12(b) of the UGC Act 1956
Conferred the Status of 'College with Potential for Excellence' by UGC

MAHARANI LAKSHMI AMMANNI COLLEGE FOR WOMEN (AUTONOMOUS)

Affiliated to Bengaluru Central University (BCU)

SYLLABUS

BACHELOR OF SCIENCE

B.Sc CBBT

CHEMISTRY BOTANY BIOTECHNOLOGY

Choice Based Credit System (Semester Scheme)

(w.e.f.2016)

Chemistry

BOS Members:

S. No	Name and Address	Panel of Experts
1.	Dr.Nagalaxmi.B.N mLAC Autonomous	Chairperson (Department Name)
2.	Dr. Gayathri. V, Dept of Chemistry, Bangalore University	University Nominee
3.	Dr. K. Natarajan Vijayalakshmi Polymers International Ltd.	Industry Expert
4.	Dr. Shashikala Devi K Maharani Science College ,Bangalore	External Subject Expert
5.	Dr. N C Subramanyam APS College of Arts and Science, Bangalore	External Subject Expert
6.	Ms. Lakshmi Devi V GFGC Ramnagar	Alumni Representatives
7.	Dr. N Radhakrishna mLAC Autonomous	Member
8.	Ms. Nussarath Zareen mLAC Autonomous	Member
9.	Muralidhara.M mLAC Autonomous	Member

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Board of Studies (BOS)
Department of Chemistry (UG)
Maharani Lakshmi Ammanni College
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Malleswaram, Bangalore - 560012

Program Outcome:

After successful completion of three year degree program in Chemistry students are prepared to;

- Demonstrate, solve and to understand major concepts in all disciplines of chemistry.
- Solve the problem and also think methodically, independently and draw a logical conclusion.
- Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of chemical reactions.
- Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.
- Find out the green route for chemical reaction for sustainable development.
- Use modern techniques, equipments and Chemistry softwares.
- Take up Specific competitive exams conducted by service commission.

Program Specific Outcome:

- To create, select and apply appropriate techniques, resources and modern technology in multidisciplinary environment.

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B.Sc I SEMESTER

Chemistry Paper-I [CHE.P1-1]

Objectives:

- To provide a deep understanding of the various concepts and to build a strong foundation in all branches of chemistry.
- To strengthen the fundamentals of theoretical chemistry.
- To make understand the modern periodic table which stand the backbone in understanding Chemistry and to study the periodic properties in detail

Skills to be developed:

- The use of an analytical balance for mass measurement
- Calibration of Glass wares and preparation of solutions of varied concentrations
- Estimation of concentration of solutions by volumetric analysis.

Outcomes:

- Students will be acquainted with the basic concepts of mathematics required for efficient learning and application in chemistry.
- Students will be equipped with basic concepts of atomic structure, periodic table and analytical chemistry
- Students will be acquainted with the basic concepts of organic reactions

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	**2**	**4**	**30**	**70**	**100**

UNIT-I 13hours

Chapter 1: Mathematical concepts for Chemistry: 4hrs

Logarithmic relations: Definition, some important relations like log (m+n), log(m/n), $\log m^n$, change of base $\log_e 2 \rightarrow \log_e x$. Application in the calculation of p^H. Curve sketching: How a cure is sketched with a set of points: linear and non-linear (asymptotic) with a set of points.. Calculation of slope in case of linear curve. Extrapolation of linear curve and arriving at a limiting value. Differentiation: Meaning and derivative of functions like e^x, log x, sin x, cos x, 1/x, x^2 and $x^{x.}$ Rules of differentiation for y = u + v, y = uv, y = u/v and y = ku, where k is constant. Partial differentiation: Explanation, applications using the equation, H = U + PV and G = H − TS. Integration: Meaning and integrals of functions like x, dx, x^2 , 1/x , $1/x^2$, $1/x^3$, x^n, e^x , sin x and cos x. Simple problems from I and II order kinetics. Exact and inexact differentials: Examples from internal energy and enthalpy. Definite integrals. Probability: some definitions, examples from atomic orbitals, wave functions and entropy.

Chapter 2: Gaseous state: 9hrs

Introduction**:** Need for Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule-explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity, relationships between them. Problems.

Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c, P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c. Amagat's mean density method for V_c. Problems on the calculation of T_c, P_c and V_c, a and b.

Law of corresponding states-statements, reduced equation of state and explanation, JouleThomson effect-explanation. Joule-Thomson co-efficient, inversion

temperature-definition (no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

UNIT-I I **13hours**

Chapter3: Analytical Chemistry-I **4hrs**

Errors**:** Classification, minimisation of determinate errors, accuracy and precision. Significant figures and their computations.

Equivalent weights of acids, bases, salts, oxidising and reducing agents. Calculations of equivalent weights of acids(Acetic acid, Oxalic acid,Sulphuric acid and Phosphoric acid), bases (sodium hydroxide and calcium hydroxide), salts (sodium carbonate and sodium oxalate), oxidising agents (Potassium permanganate and Potassium dichromate), reducing agents (Sodium thiosulphate and FAS). Methods of expressing concentration of solutions in terms of Normality and Molarity. Numerical problems.

Chapter 4: Periodic Table and Periodic properties: **9hrs**

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodic properties: Atomic and ionic radii, ionisation energy, electron affinity and electronegativity. Trends in the periodic properties-applications in predicting and explaining chemical behaviour. Factors affecting the values of ionisation energy. Determination of electronegativity by Pauling's method. Diagonal relationship between beryllium and aluminium. Comparitive study of elements of alkali and alkaline earth metals, chalcogens and halogens with respect to electronic configuration, atomic and ionic radii, ionisation energy and elecronegativity. Halides, oxides and carbonates of alkali and alkaline earth metals. Hydrides of chalcogens and halogens.

UNIT-III 13hours

Chapter 5: Quantum Mechanics and Atomic Structure: 13hrs

Review of Bohr's atomic model. Bohr's theory-postulates and limitations. Derivation of expressions for radius, energy and calculation of ionisation energies of hydrogen like atoms. Numerical problems.

Limitations of classical mechanics: Wave particle duality-De-Broglie equation and its significance. Numerical problems. Heisenberg's uncertainty principle-mathematical expression.

New quantum mechanics-Sinusoidal wave equation-explanation based on classical wave mechanics. Schrodinger wave equation- derivation. Postulates of quantum mechanics. Explanation of terms- (i) Hamiltonian operator (ii) eigen function Ψ and significance of ψ^2 (iii) eigen values. Application of Schrodinger equation: (i) to particle in one dimensional box (derivation required) (ii) to the hydrogen atom (detailed solution not required) Expressing the solution as a product of $\psi_{n,\,l,\,m}\,(r,\,\theta,\,\phi) = \psi_{n,\,l,\,(r)}\psi_{l,m(\theta,\,\phi)}$

Radial and Angular wave function and Probability distribution curves. Shapes of 1s, 2s, 2p and 3s orbitals. Quantum numbers –Significance (with reference to shells, subshells and number of orbitals). Rules for filling electrons in various orbitals-Aufbau principle, Pauli's exclusion principle and Hund's rule. Electronic configuration of 3d orbitals-Stability of half-filled and completely filled orbitals based on exchange energy concept.

UNIT-IV 13hours

Chapter 6: Basic concepts in Organic chemistry: 4hrs

Bond cleavage – homolytic and heterolytic (meaning with examples). Types of reagents – electrophilic and nucleophilic reagents with examples. Reactive intermediates – carbocation, carbanion, carbon free radicals and carbenes-generation with examples and their relative stabilities based on inductive, resonance and hyperconjugation effects. Types of reactions - addition, substitution and elimination with examples.

Concept of isomerism – structural isomerism, stereo isomerism, geometrical and optical isomerism, chiral center - definition and examples. Tautomerism (keto-enol): explanation with an example.

Chapter 7: Aliphatic Hydrocarbons: 9hrs

Alkanes: Sources. Nomenclature of branched chain alkanes. Preparation of alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits. Conformational analysis of ethane and n-butane - Sawhorse and Newman projection formulae to be used . Energy profile diagram.

Cycloalkanes: Nomenclature. Methods of preparation of cyclopropane, cyclobutane, cyclopentane and cyclohexane. Stability of cycloalkanes based on heat of hydrogenation data. Baeyer's strain theory and its limitation. Sachse - Mohr theory of strain-less ring system. Axial and equatorial bonds. cyclopropane ring - banana bonds.

Alkenes: Preparation by dehydrohalogenation of alkyl halides-Saytzeff's rule with examples Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene (HI and propene as example) - Markownikov's rule and Antimarkownikov's rule with mechanism.

Reactions: Hydroboration- oxidation, reduction, oxymercuration – demercuration and epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4.Ozonolysis- mechanism and importance.

Dienes: Classification- isolated, conjugated and cumulated. Structure of allene and Butadiene-1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.

Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with $KMnO_4$, acidic nature of terminal alkynes- ammoniacal $AgNO_3$ and ammoniacal cuprous chloride reactions.

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TEXT BOOKS

1. Y R Sharma and L Gomati Devi, College Chemistry-1
2. Bahl and Arun Bahl, Advanced Organic Chemistry
3. Dr. R L Madan, Chemistry for Degree Students

REFERENCE BOOKS

1. Gopalan et al., Analytical Chemistry
2. R.D. Madan, Modern Inorganic Chemistry
3. Puri and Sharma, Principles of Physical Chemistry
4. Raj K Bansal, The Text Book of Organic Chemistry

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B.Sc I-SEMESTER

CHEMISTRY PRACTICAL-I

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

1. Calibration of glass wares: (i) Pipette (ii) Burette (iii) Volumetric flask.
2. Preparation of standard solutions. (Oxalic acid, potassium dichromate and FAS)
   a. Normal solution (1N, 0.1N & 0.05N)
   b. Molar solution (1M, 0.1M & 0.05M)
   c. Molal solution (1, 0.1& 0.05molal solution)
3. Determination of the percentage of available chlorine in the given sample of bleaching powder.
4. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).
5. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with diphenyl amine as an internal indicator. (Change to ferroin indicator)
6. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with potassium ferricyanide as an external indicator.
7. Estimation of sodium thiosulphate using standard potassium dichromate solution.
8. Estimation of potassium permanganate using standard sodium oxalate solution.
9. Determination of percentage of manganese dioxide from pyrolusite ore.
10. Estimation of ferrous and ferric iron in a given mixture using standard Potassium dichromate solution.
11. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.

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B.Sc II SEMESTER

Chemistry Paper II [CHE.P2-2]

Objectives:

- To provide a deep understanding of the various concepts and to build a strong foundation in all branches of chemistry.
- To learn the formation of different types of bonding and hybridization concept.
- To understand the preparation methods for alkenes, alkynes, alkyl halides.

Skills to be developed:

- Students will be well equipped with the methods of determining the physical parameters of liquids and solutions

Outcomes:

- The students will be able to predict the geometries of simple molecules
- Students will be acquainted with the organic reaction mechanism.
- The students will be able to apply the concepts of photochemistry in the environmental issues

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
52	2	4	30	70	100

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UNIT-I 13hours

Chapter 1: Liquids and Solutions: 9hrs

Properties of liquids- Viscosity- Definition, mathematical expression, coefficient of viscosity, effect of temperature, size, mol weight and shape of molecules.

Surface Tension- Definition, mathematical expression, effect of temperature and solute on it. Parachor-Definition. Sugen equation- calculation and applications. Numerical problems.

Liquid Mixture- Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation- Tc curves for all the three types, azeotropic mixtures– definition, types and examples. Partially miscible liquids-Critical solution temperature (Three types) and examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-statement, partition coefficient and its limitation. Application-solvent extraction.

Dilute solutions- Colligative properties –Definition, type and their relationship with molecular weight. Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (π) (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems.

Chapter 2: Photochemistry: 4hr

Laws of Photochemistry, Grotthus-Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene. Photosensitization, Photostationary equilibrium. Singlet and triplet states-Jablonski diagram. Fluorescence, Phosphorescence, Luminescence, bioluminescence and chemical sensors. Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.

UNIT-II 13hours

Chapter 3: Chemical bonding: 13hrs

Ionic bond: Lattice energy, Born-Haber cycle, Born-Lande equation (derivation not required), problems on Born-Lande equation. Calculation of lattice energies of NaCl and MgO. Effect of lattice energy on solubility of ionic compounds.

Covalent bond: Valence bond approach- hybridization and directional characteristics of sp, sp^2 , sp^3 , sp^2d, sp^3d^2. Shapes of $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6.VSEPR theory-postulates and shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3, $ICl^{2.}$ Molecular orbital theory-postulates and molecular orbital diagrams of H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-} , O_2^+ and CO (bond order, stability and magnetic properties to be discussed). Polarization concept- Fazan's rule, bond length, bond angle and bond energy. Polar and non-polar molecules- dipole moment. Weak interactions: i) Hydrogen bond- Intra molecular and Intermolecular types, anomalous properties of HF, H_2O, NH_3, alcohols, carboxylic acids, nitro phenols and bio molecules. ii) van der Waal's forces- Noble gases and molecular crystals (dry ice, Iodine and solid SO_2). Metallic bond- Band theory, electrical properties of metals, semiconductors and insulators. Superconductors- Definition and example.

UNIT-III 13hours

Chapter 4: Silicates: 2hrs

Structure of SiO_4^{4-}. Classification of silicates based on the structure. Zeolites- their structure and applications-ion exchange, molecular sieves of zeolites in water treatment process.

Chapter 5: Noble gases: 3hrs

Introduction. Isolation of Helium from Natural gas and applications of Noble gases. Preparation, properties and structures of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

Chapter 6: General study of d and f block elements. 8hrs

Transition elements- electronic configuration, atomic and ionic radii, ionisation energy, oxidation states, spectral and magnetic properties, catalytic activity and

interstitial compound formation. Lanthanides and Actinides- Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences, oxidation states, spectral and magnetic properties. Comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion exchange method for separation of Lanthanides

UNIT-IV **13hours**

Chapter 7: Aromatic hydrocarbons: **9hrs**

Nomenclature. Structure of benzene - using molecular orbital theory. Criteria for aromaticity. Huckel's rule (Examples: cyclopentadienyl anion, cycloheptatrieneyl cation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity with example. General mechanism of aromatic electrophilic substitution.Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol. Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene. Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene.

Alkenyl benzenes- Styrene, cis- and trans-stilbenes and their preparations. Biphenyl- Preparation-Ullmann reaction.

Chapter 8: Organic Halides: **4hrs**

Alkyl halides- Nomenclature. Nucleophilic substitution reactions - S_N1 and S_N2 mechanisms with energy profile diagrams. Differences between S_N1 and S_N2 reactions. Effect of (i) nature of alkyl groups (ii) nature of leaving groups (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms. Elimination reactions - E^1 and E^2 mechanisms. Hofmann and Saytzeff eliminations with mechanism.

Aryl halides and aralkyl halides- Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution reaction**.**

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2. Bahl and Arun Bahl Advanced Organic Chemistry
3. Dr. R L Madan, Chemistry for Degree Students

REFERENCE BOOKS

1. Lee J D, Concise Inorganic Chemistry ELBS 1991
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007)
3. MorrisonR N & Boyd, R N Organic Chemistry, dorling Kindersley (India) Pvt. Ltd.

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BSc II-SEMESTER

CHEMISTRY PRACTICAL-II

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.

2. Determination of percentage composition of a binary liquid mixture by viscosity method.

3. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.

4. Determination of transition temperature of a salt hydrate by thermometric method.

5. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.

6. Determination of degree of dissociation of an electrolyte by ebullioscopic method.

7. Determination of distribution coefficient of benzoic acid between water and toluene.

8. Determination of distribution coefficient of acetic acid between water and butanol.

9. To study the adsorption of oxalic acid on activated charcoal.

10. Effect of surfactants on the surface tension of water (Stock solution to be given)

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B.Sc III SEMESTER

Chemistry Paper III [CHE.P3-3]

Objectives:

- To understand the concepts of thermodynamics and kinetic forces involved in chemical reactions which
- To describe a reaction rate in terms of a change in concentration divided by a change in time and a general form of a differential rate law
- To explain the role of catalysts in surface reactions

Skills to be developed:

- Synthesis and purification of organic compounds
- Learn to handle the high end equipments
- Separation techniques

Outcomes:

- Students will be able to determine the rate and extent of chemical reactions
- Students will be introduced to advanced materials like organic and inorganic polymers
- The students will gain knowledge about the different chemical industries and concepts needed for transforming raw materials and precursors into useful commercial products for society.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	**2**	**4**	**30**	**70**	**100**

UNIT-I 13 hours

1. Thermodynamics-I 8hrs

Exact and inexact differentials-definition with examples.

I law of Thermodynamics – statement. Mathematical expression with explanation of the terms. Derivation of expressions for work done in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used). Numerical problems.

Heat capacity of a gas at constant pressure and constant volume, derivation of the relationship between Cp and Cv. Relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems on Kirchoff' equation, Cp and Cv.

Spontaneous and non-spontaneous processes definitions with suitable examples.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance- illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency based on entropy concept. Problems based on efficiency equation. II law in terms of efficiency (η).Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problems on Phase transitions.

2. Thermodynamics-II 5hrs

Gibb's free energy: Work function, Chemical potential definitions, and physical significance. Relationship between free energy and work function.

Criteria for equilibrium, spontaneous and nonspontaneous processes based on free energy. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G^o = -RT \ln K_p$ – Problems.

Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. The applications of Clausius-Clapeyron equation to ΔT_b and ΔT_f determination (thermodynamic derivation not required).

Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

UNIT-II 13 hours

3 .Chemical Kinetics 8hrs

Rate, Rate constant, Order and Molecularity. Pseudo first order, pseudo second order –definition with examples. II order reactions, definition with examples. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Half-life period. Definition and derivation for the expression for half-life of a second order reaction with $a = b$. Mean life period of a reaction - definition, expression for mean life period of a II order reaction ($a=b$). Problems on rate constant ($a=b$); half-life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction – temperature coefficient and probability distribution curve of effective molecules with rise in temperature of 10^o, Arrhenius equation-indication of the terms involved, concept of activation energy, threshold energy definitions with energy profile diagram. Problems on Arrhenius equation in calculating energy of activation and rate constants.

Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Limitations of collision theory. Steady state approximation statement and Lindemann's hypothesis-postulates. Explanation of the hypothesis using concentration dependence in deciding the order of a reaction.

Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

4. Surface chemistry 5hrs

Theories of adsorption : Adsorption isotherms- Freundlich adsorption isotherm-equation and limitations. Langmuir adsorption isotherm and BET equation and its terms. Its significance in the evaluation of surface area of adsorbent. Adsorption indicators- examples. Theory of adsorption indicator in argentometric titrations. Catalysis –i) Homogeneous Catalysis: Mechanism of enzyme catalysis, factors influencing enzyme activity, measurement of optimum pH and optimum temperature with examples, industrial applications.

Heterogeneous catalysis- surface reactions- Mechanism for unimolecular and bi-molecular surface reactions. Parallel reactions, Consecutive reactions-definition with examples.

UNIT-III 13 hours

5. Organic and Inorganic Polymers 4 hrs

Differences between inorganic and organic polymers.

Polymerisation– definiton, types and examples- addition and condensation polymerization. Molecular weight of polymers: Expression for weight average and number average-problems

Preparation and applications of the following types of polymers

1. Plastics: i) thermo plastics-polystyrene, polyethylene, PVC and Teflon.
   ii) thermosetting plastics-phenol-formaldehyde resin and epoxides.
2. Fibres: Acrylic, polyamide, polyester types: one example for each.
3. Elastomers: Natural rubber-polyisoprene.
   Synthetic rubber-neoprene .
4. Silicones (adhesives).
5. Fluoro carbons- Teflon.

6. Fertilisers 3hrs

Introduction (need of fertilizers), functions of essential plant nutrients (NPK)

Classification of fertilizers - Nitrogeneous, Phosphatic and Mixed fertilizers with suitable examples. Manufacture of Urea and Super phosphate of lime and their uses. Fertilizer industries in India.

7. Non-aqueous solvents **2hrs**

Physical properties of solvents, types of solvents and their characteristics.

Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

8. Environmental Chemistry **4hrs**

Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Principles of green chemistry and its application to the synthesis of ibuprofen (with using principles of green chemistry), Acid rain, photochemical smog-causes, consequences and remedial measures. Treatment of sewage- primary and secondary processes, industrial effluents-from paper industry and sugar industries. Disposal of radioactive wastes-solid, liquid and gaseous wastes, harmful effects.

Rain water harvesting-definition and applications-groundwater recharge and reusability

UNIT-IV **13 hours**

9. Alcohols and Thiols **8 hrs**

Introduction and classification: monohydric, dihydric and trihydric alcohols with an example each. 1^o, 2^o and 3^o alcohols with an example each. Methods of preparation: (i) from carbonyl compounds –by the reduction of aldehydes and ketones (by Meerwin-Pondorff-Verley reaction) (ii) from acids and esters (by reduction with $LiAlH_4$) (iii) hydroboration-oxidation of alkenes and (iv) hydration of alkenes. Reactions of alcohols: acidic nature-reaction with sodium, esterification, oxidation of alcohols with $KMnO_4$. Comparison of the reactivity of 1^o, 2^o and 3^o alcohols-Lucas test and oxidation with $K_2Cr_2O_7$-with equations.

Glycols: Preparation from alkenes using OsO_4, $KMnO_4$ and from epoxides. Oxidation of glycols by periodic acid and lead tetraacetate with mechanisms, uses. Pinacol-pinacolone re-arrangement.

Glycerol: Preparation from propene and manufacture from oils/fats. Reactions of glycerol (i) nitration (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid. Uses of glycerol.

Thiols: Nomenclature. Methods of preparation (Ex: methane thiol). Chemical reactions of methane thiol with (i) sodium (ii) NaOH (iii) metal oxides (iv) formation

of thioesters and (v) oxidation with mild oxidizing agent (H_2O_2) and strong oxidising agent (HNO_3 or HIO_4). Uses of dithanes.
Introduction of umpolung character (reversal of polarity) in carbonyl compounds taking 1,3-dithane as an example.
Comparison of reactivity of alcohols and thiols**.**

10. Phenols 3 hrs

Methods of preparation and classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing group (NO_2) and electron donating group (CH_3) on acidity of phenols at o-, m-, p- positions. Pechmann reaction. Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin (ii) methyl salicylate (iii) salol (iv) salicyl salicylic acid - reactions with conditions

11. Organometallic compounds 2 hrs

Preparation and synthetic applications of Grignard reagents. Preparation of methyl magnesium iodide. Applications in the synthesis of ethanol, acetic acid, acetaldehyde and acetone from methyl magnesium iodide. Organolithium compounds - preparation from methyl iodide and synthetic applications-preparation of methane and ethanoic acid. Lithium dialkylcuprates- preparation from methyl iodide.

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Maharani Lakshmi Ammanni College
for Women, Autonomous
Malleswaram, Bangalore - 560012

TEXT BOOKS

1. L Indira and G R Chatwal, College Chemistry-III
2. R P Rastogi and R R Misra, An Introduction to Chemical thermodynamics
3. Gurdeep Raj, Advanced Physical Chemistry, 35th Edition, Goel Publishing House, Meerut, 2009.

REFERENCE BOOKS

1. Peter A & Paula, J. de physical Chemistry 9Th Ed. Oxford University Press (2011).
2. McQuarrie, D A & Simon, J. D. molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004)
3. Finar I. L. Organic Chemistry (Volume 1),, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

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B.Sc III-SEMESTER

CHEMISTRY PRACTICAL-III

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Preparation and purification of organic compounds

1. Recrystallization and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.

One stage preparation

(Preparation, recrystallization and melting point determination of the unknown sample)

3. Preparation of aspirin from salicylic acid.
   (*Note: Acetic anhydride is to be prepared freshly by distilling acetyl chloride and sodium acetate mixture*).
4. Preparation of paracetamol from *p*-aminophenol.'
5. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
6. Preparation of *p*-aminobenzoic acid from *p*-nitrobenzoic acid.
7. Preparation of *m*-dintrobenzene from nitrobenzene.
8. Preparation of benzoic acid from benzaldehyde.
9. Preparation of Benzene azo beta naphthol from aniline
10. Preparation of phenolphthalein from phenol.

Two stage preparations (Procedure writing experiments)

11. Preparation of *p*-bromoaniline from acetanilide.
12. Preparation of *p*-nitroaniline from acetanilide.
13. Preparation of *m*-nitrobenzoic acid from methyl benzoate.
14 Preparation of methyl orange/methyl red by diazotization and coupling.

Chromatography (Demonstration experiments)

15. **Thin layer chromatography**: Separation of a mixture of two organic compounds.
16. **Column chromatography**: Separation of a mixture of two organic compounds

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B.Sc IV SEMESTER

Chemistry Paper IV [CHE.P4-4]

Objectives:

- To Study the Chemical Equilibrium, Ionic Equilibria
- To Study the Solid State and X-ray diffraction studies.
- To understand the reactivity of different carbonyl compounds towards nucleophillic reaction.

Skills to be developed:

- Analysis of inorganic salt mixtures
- Water treatment process

Outcomes:

- Students are able to recognize mechanism of different reactions related to carbonyl compounds.
  Students will be able to recognize the symmetry elements of simple compounds
- Thorough knowledge about fission, fusion and nuclear reactors. Disposal of nuclear wastes

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	**2**	**4**	**30**	**70**	**100**

UNIT-I 13 hours

1. Phase Equilibria 7 hrs

Explanation of the terms with examples: phase (P), component (C) and degree of freedom (F). Phase rule - statement, significance and derivation. Applications of phase rule: one component systems - water and sulphur systems - phase diagram and explanation of the curves, areas, triple point, transition equilibria. Effect of pressure on freezing point of water, melting point of monoclinic sulphur and transition temperature of rhombic sulphur; calculation of degree of freedom.

Two component systems – types, condensed phase rule, temperature - composition phase diagrams for simple eutectic systems such as water–potassium-iodide and lead-silver systems; explanation of effect of mixing of two solids on melting point of a component, eutectic point ,eutectic mixtures, effect of temperature on the solubility of KI. Desilverisation of lead by Pattinson's process. Freezing mixtures - preparation and examples.

2. Solid state 6 hrs

Types of crystalline solids, space lattice and unit cell. Laws of crystallography – law of rational indices, law of constancy of interfacial angles, law of constancy of symmetry elements. Symmetry elements in crystals: plane of symmetry- rectangular and diagonal planes. Axis of symmetry: two fold, three fold and four fold axes. Centre of symmetry; illustration using a simple cubic crystal. Crystal systems – introduction of crystal parameters –a, b, c and α, β, γ; classification into seven systems (an example each, no diagrams required); Bravais lattices- explanation using cubic system (diagrams of primitive, face centered and body centered cubes with an example each). Weiss and Miller indices – calculation and use of h k l symbols; sketching of 100, 110, 111 planes in a cubic crystal; calculation of inter planar spacings in a simple cubic crystal, problems.

X-ray diffraction of crystals - derivation of Bragg's equation and determination of crystal structures of NaCl, KCl and CsCl.

Liquid crystals: explanation of the liquid crystalline state; types –smectic, nematic and cholesteric; examples and applications.

Superconducting solids: explanation of the phenomenon of superconductivity using mercury as an example; Tc high temperature superconductors – example and applications.

UNIT-II 13 hours

3. Water Technology: 4 hrs

Types of impurities present in water- soluble and insoluble (organic, inorganic and biological) with examples. Hardness of water- Types, hardness causing constituents. Potability of water- TDS, hardness and pH . COD and BOD-definition and distinction. Treatment of water for domestic and industrial purposes by the following methods- Principle and process

1. Demineralization of water by ion exchange method
2. By reverse Osmosis method.

4. Nuclear and Radiochemistry. 9hrs

Nucleus – nucleons, nuclear force, nuclear density, stability - explanation using n/p ratio, n versus p graph. Mass defect; Binding energy - definition, graph, calculation of binding energy to show that 1 amu=931MeV. Explanation of the instability of the nuclei. Problems.

Radioactive decay law, derivation of $N=N_0\ e^{-\lambda t}$, half-life period of a radioisotope, relationship between half-life and decay constant, numerical problems.

Radioactive equilibrium - explanation, introduction of the terms parent and daughter elements. Group displacement law - statement and explanation taking examples; radioactive series - U, Th, Ac and Np series (mention the first and last stable elements, number of α and β particles. Type of series namely 4n, (4n+1), (4n+2) and (4n+3).

Artificial radioactivity: Rutherford's first artificial transmutation, induced radioactivity; nuclear reactions – differences between chemical and nuclear reactions; reason for the large amount of Q value; symbolic representation of a nuclear reaction, introduction of the term projectile, comparison of neutron, proton, α, γ and deuteron as projectiles. Examples of nuclear reaction induced by γ-radiation, α, n, p and deuteron.

Nuclear fission - explanation with an example, chain reaction, principle of atomic bomb, calculation of energy liberated, fissionable isotopes.

Nuclear fusion- explanation with an example, thermonuclear reaction, advantages and disadvantages of fusion over fission, principle of hydrogen bomb.
Nuclear reactors - principle, working of a thermal reactor, diagram, explanation of the terms like nuclear fuel, control rods, moderators and coolant.
Breeder reactors- Brief explanation of the functioning. Atomic energy programme in India. Use of radio isotopes in tracer technique - agriculture (phosphorous in agriculture research), medicine (phosphorous to check cracks in bones, sodium/iodine to detect clots in blood vessels), food preservation.
Carbon dating - formation of radioactive carbon in the atmosphere. Explanation of the determination of age of wood or peat or fossil. Problems on carbon dating. Ionization and working principle of G.M. Counter,√-ray counter, neutron activation analysis and isotopic dilution analysis.

UNIT-III **13 hours**

5. Ethers and Epoxides: **4 hrs**

Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis- advantages and disadvantages. Reactions – Ethers as Lewis ases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.
Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1,2- disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

6. Aldehydes and Ketones: **9 hrs**

Nomenclature. Preparation of aldehydes: from acid chlorides (Rosenmund reaction), Gattermann-Koch aldehyde synthesis. Preparation of Ketones: From nitriles, from carboxylic acids with alkyl lithium, from acid chlorides with metal alkyls. Mechanisms of: Aldol condensation, Perkin condensation, Knoevenagel condensation, Benzoin condensation, Acetal formation and Cannizaro reaction. Condensation with ammonia and its derivatives (NH_2-R; R = $-NH_2$,$-OH$, $-NH-CO-NH_2$). Reduction: Reduction by $LiAlH_4$ and $NaBH_4$. Mannich reaction. Mechanisms of Clemmensen and Wolff Kishner reductions.

Industrial applications of formaldehyde and acetophenone.

UNIT-IV 13 hours

7. Carboxylic acids and their derivatives: 5 hrs

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidic strength (pK_a values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid)

Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Decarboxylation and reduction (using $LiAlH_4$).

Di and tri carboxylic acids: Action of heat on dicarboxylic acids (Oxalic to Adipic acids) Reactions of tartaric acid and citric acid. (action of heat, reduction with HI). Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates) .Acid anhydrides (hydrolysis, reaction with alcohol, ammonia). Esters (alkaline hydrolysis, ammonolysis and alcoholysis). Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: $B_{AC}2$, $A_{AC}2$; alkyl O-cleavage: $A_{AL}1$ mechanisms).

8. Tautomerism and Enolates: 5 hrs

Tautomerism in carbonyl compounds – Keto-Enol tautomerism. Acidity of α-hydrogen atoms in aldehydes, ketones and active methylene compounds (example diethylmalonate, ethylacetoacetate and acetyl acetone).Preparation of diethylmalonate(from acetic acid) and synthetic applications of diethyl malonate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - Adipic acid, unsaturated acids - cinnamic acid, ketones - butanone, cyclic compounds - barbituric acid) Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications of ethyl acetoacetate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid –succinic acid, unsaturated acids - crotonic acid, ketones - butanone).

9. Steel **3hrs**

Ferro-alloys- Production of ferro-chrome, ferro-manganese and ferro-silicon and their applications.

Phase diagram of iron-carbon: explanation of the composition of austenite, ferrite, cementite and pearlite phases in the diagram.

Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of steel and their applications. Carbon steel: classification based on carbon content. Heat treatment of steels: hardening, case hardening, carbiding, nitriding, tempering and annealing - definition with applications of each type. Steel industries in India.

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TEXT BOOKS

1. Y. R Sharma and L. Gomathi Devi., New College Chemistry
2. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan limited,
   New York, 1966
3. P.W. Atkins, Physical Chemistry, 7th edition, Oxford university press, 2001.

REFERENCE BOOKS

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry 9th Ed., Oxford University Press.
2. Irving M. Klotz and Robert M. Rosenberg, Chemical Thermodynamics, John Wiley and sons, Inc. 1994.
3. J. Rajaram and J.C. Kuriacose, Thermodynamics, Shoban Lal Nagin Chand and CO. 1986.
4. K. L. Kapoor, A Textbook of Physical chemistry, (volume-2 and 3) Macmillan, India
   Ltd, 1994.

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B.Sc IV-SEMESTER

CHEMISTRY PRACTICAL-IV

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, $Co^{2+,}$ Ni^{2+}, Fe^{2+})using paper chromatography and calculation of Rf values (To be performed by the students)
3. Separation of Mg(II) and Fe(II) by solvent extraction technique.
4. Effluent analysis.

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B.Sc V SEMESTER

Chemistry Paper V [CHE.P5-5]

Organic Chemistry

Objectives:

- To study the stereochemistry of organic compounds in detail.
- To understand the basic principles of spectroscopy.
- To study the fundamental properties and reactivity of biologically important molecules (eg: carbohydrates, amines)

Skills to be developed:

- Analysis of mono-functional organic compounds
- Isolation of organic compounds from natural products

Outcomes:

- Students will gain an understanding of reactivity and stability of an organic molecule based on conformation and stereochemistry
- The students will be aware about most of drugs in the present market are the compounds containing various heterocyclic moieties in industries.
- Students will be able to determine the structure of organic compounds using spectroscopic techniques

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**6**	**30**	**70**	**100**

UNIT - I

Stereochemistry **8 hours**

Elements of symmetry (plane of symmetry: 2, 3-dichrolobutane, tartaric acid, center of symmetry: trans-2, 4-dimethyl-trans-1,3-cyclobutanedioic acid, axis of symmetry:1,2,3,4-tetramethylcyclobutane).Chiral molecules and achiral molecules (2-chloropropanol, 3-chloropentane).Chirality, stereogenic center (example: lactic acid, tartaric acid and 2, 3-dichlorobutane). Fischer projection formulae (lactic acid, 2-chlorobutane, tartaric acid and 2, 3-dichlorobutane).

Meso compounds: Explanation with examples of tartaric acid and 2,3-dichlorobutane.

Optical isomerism due to free rotation about single bonds**:** Enantiomers, optical activity (conditionsfor optically active compounds); absolute configuration of enantiomers (use of +/–, d/l, D/Lnotations (Examples: glyceraldehyde and lactic acid). Cahn-Ingold-Prelog sequence rules(R and S system) of nomenclature with suitable examples.Properties of enantiomers.

Diastereomers:Explanation with examples of tartaricacid,2-bromo-3-chlorobutane) and properties.Relative Configuration of threo and erythro nomenclature (using above examples).

Racemisation: Definition and explanation using lactic acid as an example.

Resolution of racemic mixture: definition, explanation of resolution of racemic mixture of tartaricacid by chemical method and biochemical method.

Optical isomerism due to restricted rotation about single bonds- diphenyl systems: Explanation using 6, 6'-dinitrodiphenic acid as an example.

Geometric isomerism in alkenes: Definition, conditions and explanation using 2-butene and 1,2-dichloroethene as examples. Determination of configuration of geometric isomers: cis and trans by (i) Physical methods (melting and boiling points, dipole moments, solubility) (ii)Spectroscopic methods (UV, IR evidences (iii) chemical methods (cyclisation method: Ex-maleic acid to maleic anhydride, pKa values: Ex maleic and fumaric acids).

E and Z system of nomenclature (rules with suitable examples).

Geometric isomerism in oximes: Nomenclature of syn and anti isomers in oximes using benzaldoxime and acetophenone oxime as examples.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes(1,2,1,3 and1,4 dimethylcyclohexanes as examples).

Bicylic systems: cis and trans- nomenclature and conformations of decalins and norbornane.

UNIT - II

Amines **5 hours**

Classification and nomenclature. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds (ethyl amine, isopropyl amine).

Gabriel phthalimde synthesis (ethyl amine).Reduction of nitrobenzene to aniline.

Basicity of amines in aqueous solution: Inductive, resonance,steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles(methylation and acylation). Formation of quaternary ammonium salts (reaction of tertiary amine and alkyl halide), Formation of quaternaryammonium hydroxide.

Hofmann elimination reaction with mechanism. Distinguishing reactions of 1^0, 2^0 and 3^0 amines (Reactions with equations for Hinsbergs test).

Diazotization: formation of benzenediazonium chloride.

Synthetic applications of benzenediazonium chloride in the preparation of

(i) chlorobenzene, bromobenzene and benzonitrile by Sandmeyer's reaction

(ii) phenol (iii) phenyl hydrazine and aniline by reduction reaction and

(iv) p-hydroxyazobenzene and 1- phenylazo-2-naphthol by coupling reaction.

Heterocyclic compounds **4 hours**

Introduction, classification (based on size of heterocyclic ring - 5 and 6 membered) with examples,orbital structures, resonance and aromatic character (Huckel's rule) of furan, pyrrole, thiophene and pyridine.

Methods of preparation of pyrrole (from acetylene and from ammonium mucate), furan (from mucicacid and furfural),thiophene (from acetylene and butane).

General mechanism of electrophilic substitution reactions and nitration reaction of pyrrole, furan and thiophene.Preparation of pyridine (from acetylene and from nicotinic acid) and reaction with sodamide (Chichibabin reaction). Comparison of basicity of pyrrole, pyridine and piperidine (pKb).

Fused heterocyclic compounds (i) Indole - preparation by Fischer synthesis and nitration reaction,(ii) Quinoline-preparation by Skraup synthesis and properties - nitration.

UNIT -III

Chemistry of Natural Products **8 hours**

Carbohydrates: Introduction and classification (based on number of monosaccharide units and sugars and non-sugars) with examples. Monosaccharides: Definition with examples, classification of mono saccharides (based on functional group).

Aldoses: Structures of D-aldohexoses (glucose, galactose and mannose). Open and Haworth structures.Epimers (Example: D-galactose and D-glucose, D-glucose and D-mannose). Elucidation of open chain structure of D-glucose. Limitations of open chain structure of glucose. Mechanism of mutarotation and anomeric effect.

Elucidation of ring structure and size of D-glucose by oxidation with
HIO_4 and HNO_3.

Ketoses: Structure of fructose-pyranose and furanose forms. Inter-conversion of glucose and fructose

Disaccharides: Definition with examples. Formation of glycosidic bond with examples.Haworth and conformational structures of maltose, lactose and sucrose.

Terpenes and terpenoids: Occurrence, isoprene rule and classification (on the basis of number of isoprene units, acyclic and cyclic). Elucidation of structure and synthesis of citral (from methyl heptenone) and zingiberene (from methyl heptenone and p-methoxy methyl magnesium bromide).

Structures of limonene, menthol, α-terpineol, camphor, β-carotene, Vitamin-A and their uses.

Alkaloids: Introduction, classification (based on heterocyclic ring present) and generalcharacteristics. Structural elucidation and synthesis of nicotine (from succinimde).Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

UNIT –IV

Spectroscopy of Organic compounds **8 hours**

Introduction: Electromagnetic radiation, electromagnetic spectrum, advantages of spectroscopic techniques, basic principle of spectroscopy, types of spectroscopic techniques (UV-Visiblespectroscopy, IR spectroscopy, NMR spectroscopy).

UV-Visible spectroscopy: Introduction - basic principles of UV-Visible spectroscopy. Types of electronic transitions with suitable examples.Chromophores and auxochormes (with suitable examples).Blue shift and red shift (with suitable examples). Influence of conjugation on λ max absorption in UV - Visible region. Comparison of UV spectra of acetone and methyl vinyl ketone.Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Advantages of UV-Visible spectroscopy.

IR spectroscopy: Introduction - Basic principles of IR spectroscopy. Conditions for IR active organiccompounds.Vibrational transitions: Stretching and bending modes of vibrations. Factors affecting onposition of IR absorption peak (atomic mass and force constant-electronic effects and hydrogenbonding). Types of IR region (functional group region and finger print region).

Explanation of Stretching frequencies of −OH (free and H-bonded), alkyl −C−H, C≡C, C=C, C−C, C=O and C−Ogroups (formaldehyde, acetaldehyde, acetone, ethanol, ethylene, benzene, acetylene, acetic acid andphenol). Graphical representation (interpretation) of IR spectra of benzoic acid and methyl benzoate in comparison with FTIR.Advantages of IR spectroscopy.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Nuclear magnetic resonance. Chemical shift (δ values), uses of TMS as reference.

Nuclear shielding and deshielding effects. Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values.

Spin-spin splitting and spin-spin coupling (qualitative treatment only).Graphical representation (interpretation) of NMR spectra of simple organic compounds (i) methane (ii) CH_3-Cl (iii) CH_2Cl_2 and (iv) $CHCl_3$ using shielding and deshielding effects, (iv) Cl_2CHCHO (v) 1,1,2-trichloroethane and (vi) CH_3CH_2Cl using spin-spinsplitting and spin-spin coupling.Applications of NMR in medical diagnostics.

Industrial Organic chemistry **7 hours**

Synthetic dyes: Introduction: Colour and constitution (modern theory). Classification of dyes: (based on methods of application to the fibre: direct dyes, vat dyes, mordant dyes, azoic dyes and dispersive dyes with examples). Synthesis of congo red (from benzidine), malachite green (from benzaldehyde), alizarin (from anthracene) and indigo (from aniline).

Medicinal Chemistry: Definition and examples-Pharamacodynamic agents, Pharmacophore, Metabolites and Anti-metabolites, Agonist, Anti-agonist, Lead compounds and Analogues, Generics, Prodrugs, Hard and Soft drugs, Isosterism and Biosterism. Theory of Drugs- Receptor interaction (i) Patons rate theory and (ii) Koshland's induced fit theory. Drugs Toxicity testing- Infectious dose-50, Inhibitory capacity-50, Lethal dose-50 and Effective dose-50.

Drugs: Chemotherapy, classification of drugs (i) drugs used for the treatment of diseases due to infection (antimalarial, sulpha drugs, anthelmentics, antileprotic, antitubercular, amoebicides, antibiotics and antiseptic drugs with examples)
(ii) drugs used for the treatment of diseases not due to infection (antipyretics, analgesics,anesthetics, tranquilizers and hypnotics, narcotics, anticonvulsants, cardiac or cardiovascular and diuretics drugs with examples**).**
Synthesis of paracetamol (from phenol), sulphanilamide (from acetanilide) and chloramphenicol (from 4-nitroacetophenone).Structure and uses of diclofenac and ranitidine.

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TEXT BOOKS

1. Y R Sharma and L. Gomathi Devi., New College Chemistry
2. Dr. R L Madan, Chemistry For Degree Students for B. Sc Third Year
3. S M Mukherji, S P Singh, R P Kapoor , Organic Chemistry Volume-III

REFERENCE BOOKS

1. Kalsi, P S Textbook of Organic chemistry 1st ed., New Age International (P) Ltd. Pub.
2. Finar, I L, Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural products), (Pearson Education)
3. Kemp W, Organic spectroscopy, Palgrave

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B. Sc- V Semester (CBCS)

CHEMISTRY PRACTICALS

P- V (Organic Chemistry)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

List of experiments:

1. Qualitative analysis of organic compounds through functional group analysis. Determination of physical constant. Preparation and characterization (m pt) of a suitable derivative.
2. Isolation of lycopene from tomatoes.
3. Isolation of caffeine from tea leaves.

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V SEMESTER B.Sc

Chemistry Paper VI [CHE.P6-5]

Physical Chemistry

Objectives:

- To learn the fundamental concepts of electrochemistry, to understand their importance and illustrate the varied applications.
- To enable the students to upgrade with the existing analytical technologies that helps to pursue further research.
- To study the principle involved in electroanalytical techniques

Skills to be developed:

- Calibration of pH meters, conductometer, potentiometer and simple spectrophotometer
- Instrumental methods of estimating the concentration of solutions

Outcomes:

- Able to prepare buffer solutions of suitable pH
- Able to recognize different regions for different spectroscopy
- Compare the advantages and disadvantages of the different electrochemical methods of analysis

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**6**	**30**	**70**	**100**

UNIT-I

Electrochemistry-I **10 hours**

Review of electrolytes and Conductance related terms

Definition of molar conductance, determination of molar conductance of an electrolyte ($NaNO_3$ or KCl) using Wheatstone's bridge. Conductometric titrations: Definition and advantages over other conventional titrations. Principles involved in conductometric titrations with graph for strong acid- strongbase, strong acid-weak base, weak acid-strong base and weak acid-weak base titrations.

Ionic mobility, absolute ionic mobility and transport number-definitions. Relationship between transport number and ionic mobility of an ion(noderivation). Determination of transport number of an ion (H+ ion in HCl) by moving boundary method. Abnormal transport numbers- definition with an example like Cd^{2+} in CdI_2. Causes for abnormal transport numbers in H^+ and H_2O.

Numerical problems on (i) transport number calculation by moving boundary method(ii) relationship between transport number and ionic mobility

(iii) molar conductance and specific conductance.

Kohlrausch's law: Statement and its applications (i) Evaluation of $\lambda\infty$ from $\lambda+$ and $\lambda-$ for CH_3COOH and NH_4OH (ii) evaluation of degree of dissociation of a weak electrolyte - monochloro acetic acid (iii) evaluation of $\lambda\infty$ a weak electrolyte

(iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Numerical problems based on these.

Limitations of Arrhenius theory. Qualitative account of Debye-Huckel theory - postulates, asymmetric effect (with diagram) and electrophoretic effect.

Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galavanic cell: Conventions of representing galvanic cells-reversible and irreversible cells,requirements and examples for reversible (Danielcell) and irreversible cells ,representation, cell reaction.

Electrode potential, Standard electrode potential, Derivation of Nernst equation for single electrode potential (free energy concept).

Numerical problems on single electrode potential of a metal and emf of cells.

UNIT-II

Electrochemistry- II **5 hours**

Weston-cadmium cell: Diagram involving the representation of anode, cathode and the electrolyte.Requirements to decide Weston cadmium cell as standard cell. Construction and working of Westoncell and its numerical value of emf. Determination of emf of a cell by compensation method.

Determination of Emf of Zn/Zn^{2+} and Cu/Cu^{2+} electrodes. Liquid junction potentials, elimination of liquid junction Potential using a salt bridge and conditions required for preparing a salt bridge.

Types of electrodes: (i) Metal and gas electrodes-Pt/H_2 and Pt/Cl_2 (ii) metal/metal insoluble salt electrodes-Ag/AgCl. (iii) redox electrodes-Pt/Fe^{2+}, Fe^{3+}.

Reference electrodes: Standard hydrogen electrode- representation and limitations. Calomel electrode: Representation, construction and working.

Quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems involving the calculation of pH using hydrogen and quinhydrone electrodes.

Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly solublesalt taking silver chloride as example. Numerical problems:

(i) calculation of emf (ii) solubility and solubility products. Redox electrodes: emf of redox electrodes. Potentiometric titration involving only redox systems. Example: Fe^{2+}/Fe^{3+}.

Ionic Equilibria **3 hours**

Hydrolysis of salts of weak acids and weak bases.Ionic product of water. Deriving the relation ship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis of salt of weak acid and weak base. pH expression for the salt of weak acid - bases. Numerical problems on the calculation of Kh, h and pH of salts of weak acid and weak bases only. Common ion effect: statement and example (ammonium hydroxide - ammonium chloride and acetic acid - sodium acetate).

Buffers: Types and examples. Buffer action and buffer capacity. pH of buffers Henderson's equation and its derivation for acidic buffer.

Problems in calculating the pH of buffers. Solubility product and ionic product definitions and their applications in the precipitation of II and IV group basic radicals in the qualitative analysis of simple salt mixtures. Analytical and biological applications of buffers.

Theories of indicators (Mentioning the different theories).Acid-base theory by taking phenolphthalein as an example.

UNIT-III

Photovoltaics **2 hours**

Solar cells- Principle, preparation and applications.

High Pressure Liquid Chromatography **3 hours**

Basic Principle and types

(i) Normal phase HPLC- Principle and Separation of the mixture containing Acetic acid, ethanol, ethyl amine, acetone, chloroform and carbon tetra chloride. (Stationary phase/Mobile phase- Silica gel/Hexane).

(ii) Reverse phase HPLC -Principle and separation of the mixture containing Acetic acid, ethanol, ethyl amine, acetone, chloroform and carbon tetra chloride. (Stationary phase/Mobile phase- C_{18} Alkylated silica gel/Water+Methanol).

(iii) Size Exclusion HPLC-Principle and determination of relative molecular weight of synthetic polymers.Stationary phase and mobile phase used.

(iv) Ion exchange HPLC- Principle and separation of a mixture of amino acids (acidic pH).(Stationary phase/Mobile phase- Charged surface (cation or anion)/Water, buffer.

Chemical Spectroscopy-I **5 hours**

The interaction of radiation with matter.Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular spectra:

Born Oppenheimer approximation.

Rotational spectra of diatomic molecules:Relationship between inter-nuclear distance and moment of inertia derivation.

Expression for rotational energy.Numerical problems involving moment of inertia and bond length. Rotational energy for different quantum levels- J=0, J=1, J=2 etc. Criterion for absorption of radiation- selection rule.

UNIT-IV

Chemical Spectroscopy- II **4 hours**

Vibrational spectroscopy: Introduction, degree of freedom of polyatomic molecules - calculating the number of modes of vibration for CO_2 and H_2O molecules, diagrammatic representations of these vibrations.

Hooke's law- Expression for the frequency and wave numbers of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy - definition, mathematical expression and its significance. Numerical problems based on (i) zero point energy(ii) wave number and (iii) force constant.

Raman spectroscopy and electronic spectroscopy **3 hours**

Concept of polarisability. Pure rotation, vibration - qualitative study.Stokes and anti-Stoke's lines selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Potential energy curves for bonding and antibonding molecular orbitals.Electronic transitions - qualitative description of non-bonding orbitals and transitions between them.

Selection rules and Franck-Condon principle, definitions and its diagramatic representations.

Electro analytical Methods **5 hours**

Voltametry at a dropping mercury electrodes (DME)- Types of current obtained at DME. Ilkovic equation and its applications. Current - potential relation for a cathodic process - half wave potential and its significance. Cyclic Voltametry: Principles- Experimental set up- Quantitative analysis,determination of diffusion coefficients and its significance.

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TEXT BOOKS

1. Y. R Sharma and L. Gomathi Devi., New College Chemistry
2. K K Sharma., Problems in Physical Chemistry
3. P L Soni, S Chand and Co., Textbook of Physical Chemistry, 1993.

REFERENCE BOOKS

1. Atkins P W & Paula J D, Physical Chemistry, 9th Ed., Oxford University Press(2011)
2. Rogers D, Concise Physical Chemistry, Wiley (2011)
3. Kakkar R, Atomic and Molecular Spectroscopy, Cambridge University Press (2015)
4. Banwell C N & McCash E M, Fundamentals of Molecular Spectroscopy 4th Ed. (2006)
5. Ditts R V, Analytical Chemistry-Methods of separation

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VI SEMESTER B.Sc

Chemistry Paper 7 [CHE.P7-6]

Inorganic Chemistry

Objectives:

- The students will be able to explain the fundamental concepts in coordination chemistry of transition metals.
- To have an deep insight of industrial materials used in industries
- To provide an insight into latest topics of newer materials

Skills to be developed:

- Proficiency in estimating the metal ions from its ores
- Different classes of titrations for the estimation of metal ions
- To analyse the different samples of water

Outcome:

- Students will be able to predict the geometry of transition metal complexes based on Werner's theory
- Students will acquaint the knowledge on manufacture of industrial materials like glass, ceramics, cement etc
- Acquire Basic knowledge of Nanochemistry to appreciate its applications in the field of Medicine, data storage devices and electronics.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**6**	**30**	**70**	**100**

UNIT-I

Coordination and Organometallic compounds -I 10 hours

Coordination compounds- difference between double salts and complex salts with examples. Ligands-definition and their classification (mono, bi, tri, tetra, penta,hexadentate ligands and ambidentate ligands), examples for each class. Coordination number- definition with examples. Nomenclature of coordination compounds in detail. Theories of structure and bonding: explanation for the formation of complexes by Werner's Theory in detail and its limitations.

EAN rule- statement with illustrations. Valence bond theory: postulates, low spin and high spin complexes with examples$[CoF6]^{3-}$, $[Co(NH3)6]^{3+}$, $Fe(CN)6]^{4-}$,$[Fe(CN)6]^{3-}$,$[Ti(H2O)6]^{3+}$, $[Co(H2O)6]^{3+}$, $[CoCl4]^{2-}$,
limitations of VBT.

Crystal field theory: (octahedral, tetrahedral and square planar complexes)$[CoF6]^{3-}$, $[Co(NH3)6]^{3+}$, $Fe(CN)6]^{4-}$,$[Fe(CN)6]^{3-}$,$[Ti(H2O)6]^{3+}$, $[Co(H2O)6]^{3+}$, $[CoCl4]^{2-}$.
Crystal field splitting and crystal field stabilization energies- definition and illustrations with examples. Limitations of CFT.

Magnetic properties of [CoF6]3−, [Co(NH3)6]3+, Fe(CN)6]4−,[Fe(CN)6]3−. Spectral properties of [Ti(H2O)6]3+, [Co(H2O)6]3+, [CoCl4]2−. Isomerism in complexes: Structural isomerism - ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism- geometrical and optical isomerism of coordination compounds with coordination number 4 and 6 with examples.

Organometallic compounds - ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta 2\text{-}C_2H_4)]$ and $[Fe(\eta 5 - C_5H_5)2$

UNIT-II

Coordination and Organometallic compounds – II 4 hours

Metal carbonyls: Structures of Cr(CO)6, Co2(CO)8, Mn2(CO)10; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy,

Na_2Ca EDTA in the treatment of heavy metal (Pb, Hg) poisoning ,Wilkinson's Catalyst in alkene hydrogenation, Monsanto acetic acid process.

Industrial Materials- I **6 hours**

Refractories: Definition**.** Properties of a good refractory, classification, determination of PCE values.

Abrasives: Definition and classification with examples, applications, hardness- definition and magnitude of hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials, manufacture of Portland cement (by wet process), setting of cement, grades, their significance.

UNIT-III

Industrial Materials – II **5 hours**

Paints and Varnishes: Constituents of oil and emulsion paints and their role. Constituents of varnishes.

Fuels: Characteristics, calorific value - definition and its determination using bomb calorimeter.

Coal – varieties. Liquid fuels- Petrol and diesel- antiknocking properties, octane number and cetane number- definition and significance. Gaseous fuels- advantages, constituents and their significance. Production of Coal gas, composition of LPG.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Analytical Chemistry-II **5 hours**

Solvent Extraction- definition, types and efficiency of extraction, sequence of extraction process, factors affecting extraction- pH, oxidation state, modifiers, synergistic masking and salting of agents, techniques- batch, continuous extraction and counter current extraction, applications.

Ultracentrifugation- Centrifugation, centrifugal force, sedimentation, centrifugal decantation, centrifuges, selection of centrifuge tubes, preparative, density gradient and isopycinic centrifugation. Analytical sedimentation, sedimentation co-efficient, sedimentation velocity- application of the technique in biological separation; membrane separation- principles and applications.

Ultrafilteration Zone refining techniques- Principles, instrumentation and applications.

UNIT-IV

Chemistry of Newer materials **10 hours**

Conducting polymers: Introduction, definition and examples- polyaniline, polyacetylene.Mechanism of conduction. Qualitative treatment of doping. Properties: elasticity with high electrical conductivities, Engineering and biological applications.

Superconductors: Introduction, definition, type-1, type-2 and atypical. Preparation of high temperature superconductor- Y1Ba2Cu3Ox±□. BCS theory (qualitative treatment only) and general applications of high temperature super conductors.

Nanomaterials: Introduction, definition and structure. Different methods of production: Sol gel synthesis, inert gas condensation, mechanical alloying (ball milling), plasma synthesis, electro deposition, and general applications.Nanofluids.

Fullerenes: Introduction, definition, preparation and isolation of C60. Structure and chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C60.Commercial uses of C60. Carbon nanotubes (CNT) -definition, classification and applications- space crafts and race cars.

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B.Sc., VI Semester (CBCS)

CHEMISTRY PRACTICALS P- VII

(INORGANIC CHEMISTRY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

List of experiments:

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of copper in brass.
4. Estimation of zinc using EDTA.
5. Estimation of Magnesium using EDTA.
6. Estimation of total hardness of water using EDTA.
7. Estimation of nickel using EDTA and standard zinc sulphate.
8. Gravimetric estimation of barium as barium sulphate.
9. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
10. Preparation of cuprammoniumsulphate and determination of λ max and hence CFSE.
11. Preparation of ferrous oxalate and its analysis.
12. Analysis of Lithopone Pigment.

Text Books

1. F A Cotton, G Wilkinson, C A Murillo and M. Bochmann-John., Concise Inorganic Chemistry, 5th Ed.
2. S P Banerjee Advanced Inorganic Chemistry Volume-2
3. S L Kakani and Amit Kakani., Material Science

References

1. Ditts R V, Analytical Chemistry- Methods of separation
2. Christian, Gary D; Analytical chemistry , 6th Ed. John Wiley & Sons, (2004)
3. W L Jolly and Mc Graw, Modern Inorganic Chemistry

B.Sc., VI Semester (CBCS)

CHEMISTRY PRACTICALS P- VII

(INORGANIC CHEMISTRY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

List of experiments:

13. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.
14. Estimation of calcium in lime stone.
15. Estimation of copper in brass.
16. Estimation of zinc using EDTA.
17. Estimation of Magnesium using EDTA.
18. Estimation of total hardness of water using EDTA.
19. Estimation of nickel using EDTA and standard zinc sulphate.
20. Gravimetric estimation of barium as barium sulphate.
21. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
22. Preparation of cuprammoniumsulphate and determination of λ max and hence CFSE.
23. Preparation of ferrous oxalate and its analysis.
24. Analysis of Lithopone Pigment.

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B.Sc VI SEMESTER

Chemistry Paper VIII [CHE.P8-6]

Biochemistry

Objectives:

- To provide students with a basic understanding of fundamental concepts in Biochemistry
- To introduce different techniques for separation and analysis of biomolecules.
- To study the biological role of carbohydrates, lipids, hormones etc

Skills to be developed:

- Use of apparatus such as colorimeter for estimation of biomolecules
- Preparation of buffers at a required pH, given a choice of solutions o acid/conjugate base pairs
- Implement protocols to analyse clinically significant metabolites such as glucose, creatinine, inorganic phosphate etc

Outcomes:

- Students will acquire knowledge and understanding of fundamental biochemical principles, such as the structure and function of biomolecules, metabolic pathways, and the regulation of biological and biochemical processes.
- Students will recognize the different biochemical techniques for separation of biomolecules.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**6**	**30**	**70**	**100**

UNIT – I

Introduction to Biochemistry **2 hours**

Contributions of Emil Fischer, Embden, Meyerhof, Parnas.Hans Kreb, Michaelis and Menton, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling,Hopkins and Miescher. Elemental and biochemical composition of living organisms.

Biophysics of water (mention the properties of water such as dielectric constant,surface tension, heat of vaporization, MP and BP & specific heat which makes water a solvent oflife), Role of water as a reactant in biological systems.

Carbohydrates **4 hours**

Structure and biological importance of derivatives of monosaccharaides.

Amino sugars- β-D-glucosamine, galactosamine and N-acetyl muramic acid (NAMA);N-acetyl neuraminic acid (NANA).

Sugar acids- Structure and biological importance of D-gluconic acid, D-glucuronic acidand D-glucaric acid.

Sugar phosphates – Structure and biological importance of Glucose-6-P, Fructose-6-P,β-D-ribose-5-P and deoxyribose-5-P.

Structure and biological importance of oligosaccharides- Isomaltose, cellobiose,trehalose.

Polysaccharides- source, comparative account of partial structure and biological function of starch,glycogen, cellulose.

Determination of calorific value of carbohydrates, fat and proteins using oxygen bomb calorimeter.Carbohydrates as informational molecul

Lipids **4 hours**

Introduction, Classification -simple, complex and derived with examples.

Fatty acids - Classification as saturated and unsaturated with examples and structure(lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonicacids). Essential fattyacids - definition with examples.

Triglycerides - Structure of simple and mixed glycerides, properties of triglycerides-acid and alkalihydrolysis, saponification number and its significance, iodine number and its significance, rancidity

(oxidative and hydrolytic), causes and prevention.

Biological importance of triglycerides.

Phosphoglycerides- General structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane),micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin,phosphatidylserine, phosphatidylinositol.
Lipoproteins- definition, types (HDL, LDLand VLDL).Sphingolipids - structure and biological significance ofceramide. Lipids as signals and pigments

UNIT-II

Proteins **5 hours**

α-amino acids: Introduction, structure (Glycine, Alanine, Valine, Cysteine, Aspartic acid, Lysine,Tyrosine and proline), classification on the basis of polarity of R-groups, essential and non-essentialamino acids with examples, ionic properties and reactions of amino acids with alcohol, nitrous acid andNinhydrin.
Levels of organizations of Protein: Primary structure, Secondary structure (α-helix, β-pleatedstructure& triple helix-Collagen), tertiary structure (forces stabilizing it) andquaternary structure.
Denaturation and renaturation- Thermal renaturation- Aufinsen's experiment with ribonuclease.
Classification of proteins based on structurecomposition and biological function (enzymes, hormones,transport agents, structural & antibodies with examples).

Biological oxidation **5 hours**

Bioenergetics- Introduction, stages of energy transformation. Exergonic and endergonic reactions.Energy coupling in biological reactions.Relationship between ΔG_0 and K_{eq}.
Structural features of ATP as a highenergy phosphate (electrostatic repulsion, opposing resonance, solvation of ATP).Examples of high energy phosphates other than ATP.
Biological oxidation- comparison of oxidation with combustion using glucose as an example. Redox potentials of some biologically important half reactions.Calculation of energy yield for the oxidation of NADH by oxygen, reduction of acetaldehyde by NADH. Mitochondrial electron transport chain, oxidative phosphorylation and substrate level phosphorylation.

UNIT-III

Chemistry of Nucleic acids and Molecular Biology **6 hours**

Types of nucleic acids, components of nucleic acids, bases, nucleosides and nucleotides with structures.Chargaff'srule of base equivalence. Polynucleotide-

partial structure, structure of DNA (Watson-Crick model)and RNA. Biological roles of DNA and RNA.Tm of DNA.Protein-nucleic acid interaction- chromatin .
Central dogma of molecular biology, semi conservative replication and mechanism of DNAreplication, Genetic code: general features. Definition of transcription and translation (mechanism oftranslation).
DNA finger printing- Definition and its applications.

Enzymes 4 hours

Introduction, holoenzyme (apo enzyme and co-enzyme).Active site, specificity (Group, absolute andstereo selectivity with examples).
Classification of enzymes(EC code number not required) with examples.
Enzyme substrate interaction- Fischer and Koshland models.
Enzyme kinetics - factors affecting rate of enzymatic reactions - enzyme concentration, pH and temperature substrate concentration,(mention M.M.equation).Allosteric enzymes - definition and example
Enzyme inhibitions- Competitive and noncompetitive with one example foreach.

UNIT-IV

Hormones 2 hours

Definition.Classification–(i) amino acid derivatives (epinephrine and thyroxine) (ii) peptide(oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon) (iii) Steroid hormones(progesterone, testosterone) with functions.Role of insulin and glucagon in glucose homeostasis.Mediators of hormone action- Ca^{2+} and cyclic AMP.

Metabolism 6 hours

Catabolism and anabolism: explanation with an example. Carbohydrate metabolism-Glycolysis, fate of pyruvate (Pyruvate to lactate, acetyl CoA, OAA and ethanol).TCA cycle, energetics. Gluconeogenesis: definition, synthesis of glucose from lactate.
Fatty acid metabolism: activation of fatty acids, role of carnitine, β-oxidation pathway (C16-Palmiticacid), energetics. Formation of ketone bodies Starve-Feed cycle
Protein metabolism: General aspects of amino acid degradation - transamination, deamination anddecarboxylation. Urea cycle.Integration of carbohydrates, lipids and protein metabolic pathways.

Biochemical techniques **2hours**

Principle and applications of Paper chromatography and TLC, Adsorption Chromatography. Electrophoresis– SDS-PAGE, UV-visible spectrophotometry, and Reverse osmosis.

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Text Books:

1. A Text book of Comprehensive Chemistry: Vinod Kumar B and M. Ashwatha Narayanappa,, United Publishers, Mangalore, (2007)
2. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., (1983).

Reference Books:

1. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and sons, (1999).
3. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
4. Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
5. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).

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B.Sc., VI Semester (CBCS)

CHEMISTRY PRACTICALS P- VIII

(BIOCHEMISTRY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

List of experiments:

1. Preparation of buffers and determination of their pH values using pH meter.
2. Estimation of creatinine by Jaffe's method.
3. Estimation of inorganic phosphate by Fiske-Subbarow method.
4. Estimation of Reducing sugars by DNS (dinitrosalicylic acid) method.
7. Isolation and estimation of casein from milk.
8. Separation of amino acids by TLC and paper chromatography.
9. Estimation of Haemoglobin by Wong method..
10. Estimation of cholesterol by Zak method.
11. In house projects/ Power point presentations.

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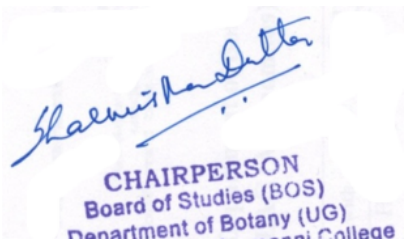
Botany

BOS Members:

2016

S. No	Name and Address	Panel of Experts
1.	Prof. Sujatha N.S. (Dept. of Botany) mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Chairperson (Department Name)
2.	Dr. V. Sivaram Bangalore University, Jnana Bharathi Campus, Bengaluru	University Nominee
3.	Dr. Sundaresan V. Central Institute for Medicinal and Aromatic Plants, Yelahanka, Bengaluru	Industry Expert
4.	Dr. Mallikarjuna P.B. Government First Grade College for Women, Kolar	Subject Expert (Govt. Aided)
5.	Dr. Lalitha Rani Suresh Mount Carmel College Autonomous, Bengaluru	Subject Expert (Autonomous)
6.	Dr. Vaishnavi M. St. Joseph College, Bengaluru	Alumni Representatives
7.	Prof. Sharmistha Dutta mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member
8.	Dr. S. SriLakshmi mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member
9.	Dr. M. Reema Kumari mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member
10.	Ms. Kavya B. mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member



2017

S. No	Name and Address	Panel of Experts
1.	Prof. Sharmistha Dutta (Dept. of Botany) mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Chairperson (Department Name)
2.	Dr. V. Sivaram Bangalore University, Jnana Bharathi Campus, Bengaluru	University Nominee
3.	Dr. Sundaresan V. Central Institute for Medicinal and Aromatic Plants, Yelahanka, Bengaluru	Industry Expert
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8.	Dr. S. SriLakshmi mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member
9.	Dr. M. Reema Kumari mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member
10.	Ms. Kavya B. mLAC Autonomous, Malleswaram 18th Cross, Bengaluru	Member

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Department of Botany (UG)

Program outcome of B.Sc.

The student centric program imparts knowledge, self-confidence, analytical ability and be a responsible citizen.

- Inculcate compassionate, commitment and concern for others, importance of nature, conservation of nature, and biodiversity.
- Understands the needs of the society and cater to the benefits of it.

Course outcome – After the completion of the course, a student is able

- Entrepreneurship skill development in Edible Mushroom cultivation, Biofertilizer production, Greenhouse maintenance, Vegetative propagation, Hydroponics and developing Plant hybrids through classical methods.
- Facilitate students to take-up successful career in field of Botany.
- Students become focused towards Research and Teaching opportunities.
- Students acquire digital skills and integrate the fundamental concepts with modern tools.
- Expertise students to prepare and clear competitive exams.

Program specific outcome –

- Knowledge and understanding about plant diversity.
- Practical skills and hands on experience.
- Presentation skills (oral & writing) in Plant sciences.
- Scientific knowledge in Plant science and Plant functions.
- Knowledge about biodiversity, biodiversity loss, and conservation strategies.
- Entrepreneurship skill development.
- Help to prepare for competitive exams like JAM, TFIR etc.
- Applications of Biotechnology in Plant and Human welfare.
- Career opportunities.
- Scope for Higher studies.

I SEMESTER B.Sc.

BOT.T1-1: Diversity of Non-Vascular Plants Part –I

INTRODUCTION TO MICROBIOLOGY, VIRUSES, BACTERIA, CYANOBACTERIA AND PHYCOLOGY

Objective:

- To Know the scope and importance of the Non-Vascular plants.
- To provide insighton various primitive plant groups in Botany.
- To provide thorough knowledge on a few selected forms of Viruses, Bacteria, Cyanobacteria and Phycology.
- To study the applied aspects of microbiology and phycology, and their importance in various industries.
- To explore Phytoplankton and flora in nearby waterbody as a part of best practise.

Skills to be developed:

- Handling Microscope.
- Aseptic conditions in laboratory.
- Identification of Bacteria, Cyanobacteria and Algae.
- Bacterial,Cyanobacteria and Algae staining technique.
- Working of Instruments.

Outcome:

- Understand the concept and principle of Aseptic techniques.
- Understand the morphology, reproduction and importance of Viruses, Bacteria, Cyanobacteria and Algae.
- Principle, working and applications of instruments viz, Autoclave, Incubator, Inoculation loop, LAF and Hot air oven.
- Understand the useful and harmful activities of Algae.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	02	04	30	70	100

Unit I

Introduction to Microbiology **07hrs**

Introduction, aim, objectives, scope, significance and contributions of various scientists to the field of Microbiology (Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, Iwanowsky).

Aseptic techniques and instruments – Autoclave, Incubator, Inoculation loop, LAF and Hot air oven. Brief account of culture media (NA, NB, MRBA), brief account of serial dilution, pour plate method.

Unit II: Study of Viruses and Bacteria **12hrs**

Viruses – General characters, brief account of TMV and Bacteriophage, Prions, Viroids and Interferons. Plant-virus interactions.

Common plant viral diseases – Yellow mosaic of beans, Papaya leaf curl.

Bacteria – Introduction, Classification based on nutrition, Gram's staining and serological techniques and ultra structure of cell. Plasmids structure, function and application. Common plant bacterial diseases – Citrus canker, Bacterial Leaf Blight. General account of Mycoplasma- Sandal spike disease.

Unit III: Study of Cyanobacteria **05hrs**

Introduction, general characteristics, ultra structure of cell, type study – *Gloeocapsa, Anabaena, Scytonema.*

Unit IV: Phycology **20hrs**

Introduction - a detailed account of Fritsch's classification with general characteristics of each class (Pertaining to type forms). Type study – occurrence, structure, reproduction and life cycle of *Chlamydomonas, Oedogonium,* Diatoms, *Sargassum* and *Polysiphonia.* Contribution of M.O.P. Iyengar.

Unit V: Applied Microbiology and Phycology **08hrs**

Role of bacteria in agriculture, medicines and industry. *Bacillus thuringiensis, Agrobacterium tumefaciens*– role in Biotechnology.

Role of algae in agriculture, industry, medicine. Toxic algae – Algal blooms.

Brief account on Biofertilizers, Biogas production, Biofuel (*Chlorella*) Bioremediation, single cell protein.

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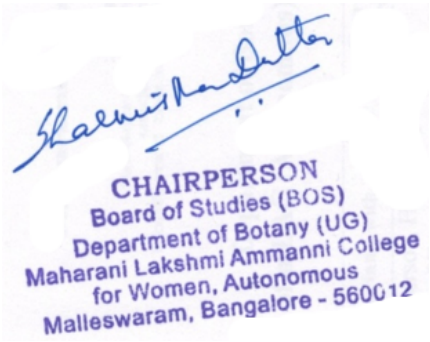

TEXT BOOKS

1. Aneja, K.R. **Experiments in Microbiology, Pathology and Tissue Culture**. Vishwa Prakashan, New Delhi. 1993.
2. Annie Ragland. **Algae and Bryophytes**. Saras Publication, Kanya Kumari, India. 2012.
3. Basu, A.N. **Essentials of Plant Viruses, Vectors and Plant diseases**. New Age International, New Delhi.1913.
4. Chopra, G.L. **A text book of Algae**. Rastogi publications, Meerut.1984.
5. David Seig. Algae for Entrepreneurs. www.making-biodiesel-books.com. 2011.
6. Desikachari, T.V. **Cyanophyta**. ICAR, New Delhi.1959.
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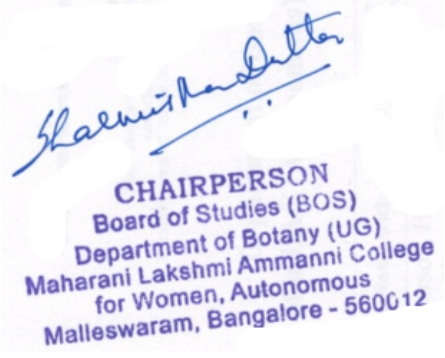

BOT.P1-1: Diversity of Non-Vascular Plants Part –I

INTRODUCTION TO MICROBIOLOGY, VIRUSES, BACTERIA, CYANOBACTERIA AND PHYCOLOGY

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total Units-13

1. Study of instruments – Autoclave, Incubator, Inoculation loop, Laminar Airflow Chamber, Hot air oven
   Sterilization of glassware, media preparation (NA, MRBA)
   Isolation of bacteria from soil by pour plate method. 02 Units
2. Plant diseases: Viral – Yellow mosaic of beans, Papaya leaf curl
   Bacterial – Citrus canker, Bacterial Leaf Blight
   Mycoplasma – Sandal spike disease 01 Unit
3. Gram Staining – a) Lactobacillus from curd sample
   b) Rhizobium from root nodules
   01Units
4. Measurement of cell concentration – Yeast cells using Haemocytometer.
   01 Unit
5. Type study of Cyanobacteria – *Anabaena, Gloeocapsa, Scytonema*. 01 Unit
6. Type study of Algae – *Chlamydomonas, Oedogonium,* Diatoms, *Sargassum, Polysiphonia*. 05 Units
7. Report on field visit: With relevance to applied Microbiology / Phycology.
   01 Unit
8. Record, any two algal submission and Field Report for Submission.

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II SEMESTER B.Sc.

BOT.T2-2: Diversity of Non-Vascular Plants Part –II

MYCOLOGY, PLANT PATHOLOGY, BRYOPHYTES AND PLANT ANATOMY

Objective:

- To know the scope and importance of the Non-Vascular plants.
- To provide thorough knowledge on selected forms of Mycology, Plant Pathology, Bryophytes and Plant Anatomy
- To study the applied aspects of Mycology, Bryophytes and Plant Anatomy and their importance in various industries.
- To study Mushroom cultivation.

Skills to be developed:

- Free hand Sectioning.
- Hands on learning of the internal anatomy of plant parts.
- Identification of Mycology, Plant Pathology, Bryophytes and Plant Anatomy
- Preparing herbaria for plant pathology specimens.

Outcome:

- Understand the morphology, reproduction, life cycle and importance Mycology, Plant Pathology, Bryophytes.
- Know the prevention and control measures of plant diseases and its effect on economy of crops.
- Learn about applications and uses of Mycology, Plant Pathology, Bryophytes and wood anatomy in various industries.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	02	04	30	70	100

Unit I

MYCOLOGY **13hrs**

Introduction - general characteristics, occurrence, thallus organization, reproduction and Alexopolus classification. Structure, reproduction and life history of *Albugo*, *Penicillium*, *Puccinia* and *Cercospora*.

Economic importance – role of fungi in medicine, agriculture and industries.

Study of Lichens and *Mycorrhiza*.*Saccharomyces* a model genetic organism.

Unit II

PLANT PATHOLOGY **10 hrs**

General account of symptoms, pathogen, etiology, mode of infection of fungal diseases; Koleroga, Coffee rust, Red rot of sugarcane, Sooty mold of Jack fruit, Powdery mildew of grapes. A brief account of Biopesticides with reference to *Trichoderma*.

Contribution of Father of Indian Mycology and Plant Pathology-Edwin John Butler.

Unit III

BRYOPHYTA **13 hrs**

General characteristics, classification, distribution, structure, reproduction and alternation of generation in *Marchantia, Anthoceros* and *Funaria*.

Contribution of Indian Bryologist S.R. Kashyap.

Economic importance of Bryophytes.

Unit IV

PLANT ANATOMY **16 hrs**

Meristematic Tissues: Structure, function, classification of meristems, organization of Apical meristems: Tunica-carpus theory and Histogen theory. A brief account of simple and permanent tissues, Vascular tissues and Secretory cells and tissues.

Anatomy of Dicot and monocot roots and stems.

Secondary growthinDicot stem and root.

Anamolous secondary growth of dicot root (*Beta vulgaris*), dicot stem (*Boerhaavia*) and monocot stem (*Dracaena*).

Wood anatomy: Definition, types of wood, properties of wood, wood seasoning, commercial uses and timber identification, Dendrochronology. A brief account on some of the important Indian woods and Plywoods.

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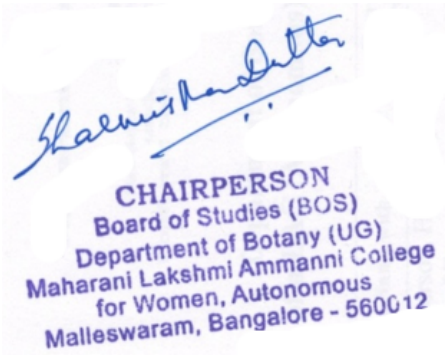

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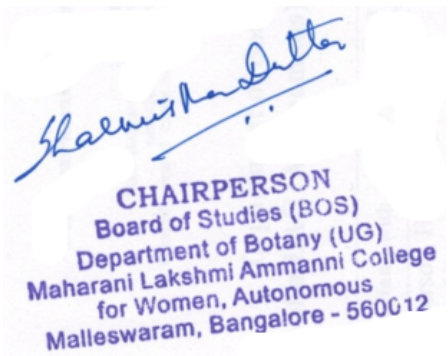

BOT.P2-2: Diversity of Non-Vascular Plants Part –II

MYCOLOGY, PLANT PATHOLOGY, BRYOPHYTES AND PLANT ANATOMY

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total Units-13

1. Identification and classification of fungi members included in the theory. 3 Units
2. Demonstration of mushroom cultivation, study of lichens and study of Mycorrhiza. 2 Units
3. Study of plant diseases included in the theory 2 Units
4. Study of Bryophyte forms included in the theory 3 Units
5. Normal and Anomalous secondary growth in stem and root ex. *Tridax*, *DracaenaBoerhaavia* and *Beta vulgaris* 2 Units
6. Field visit to study pathogen and host interaction/ mushroom cultivation/ApplicationofBiopesticides 1 Unit
7. Report of field visit: Project report of mushroom cultivation/Application of Biopesticides/ study of pathogen and host interaction

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III SEMESTER B.Sc.

BOT.T3-3:TRACHEOPHYTES, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY AND CONSERVATION

Objective:

- To provide insight into morphology, anatomy and reproduction in representative members of phylogenetically important group – Tracheophyta.
- To provide basic knowledge about importance of seedless plants in the process of evolution.
- To acquaint the students with Ecological factors and complex interrelationship between organisms and environment.
- To learn methods of studying vegetation, community patterns, processes and ecosystem functions.
- To study biodiversity and its importance, biodiversity loss and its management and principles of phytogeography.

Skills to be developed:

- Identification of Tracheophytes.
- Chloride and Oxygen content in water.
- To enumerate various parameters of Edaphic Factor.
- Identifying plants with ecological adaptations.
- Awareness on the ecology sensitization of young minds towards the Biodiversity Conservation for sustainable development.

Outcome:

- The students will be aware of the group of plants that have given rise to land habit and the flowering plants.
- Learners will be able to identify new traits that first appear in seedless tracheophytes and how each trait is important for adaptation to life on land.

- Phytogeography provides familiarity of plant life forms in Karnataka as well as India.
- Knowledge of ecological, edaphic and biotic factors regulating different ecosystems and their components.
- The students would be able to value the importance of biodiversity and its role in stabilizing the climate and economy.
- They would know the causes and consequences of loss of biodiversity and planning of conservation strategiesof nature and natural resources.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	02	04	30	70	100

Unit I

Tracheophytes - I **11 hrs**

PTERIDOPHYTES: General characteristics with classification (as per Sporne). Study of diversity in morphology, anatomy and reproduction of the following groups in respective forms: *Psilotum*, *Selaginella, Pteris.*

Brief account of Stelar evolution in Pteridophytes and Heterospory and seed habit (*Selaginella*).

Unit II

Tracheophytes – II **10 hrs**

GYMNOSPERMS: General characteristics and classification. Economic importance of Gymnosperms. Morphology and Anatomy of vegetative structures- root stem and leaf, reproductive structures and life cycle of *Pinus* and *Gnetum.*

Paleobotany: Introduction and applications. Outline of geological time scale. Types of fossilization with examples. Contribution of Indian Paleobotanist – Birbal Sahni.

Unit III

Environmental Biology **16 hrs**

Ecological factors: Climatic – Light, Temperature, Rainfall, Wind and Atmospheric humidity.

Edaphic factors: Soil formation, soil profile, soil air, soil microorganisms, Soil erosion.

Biotic factors – Positive and negative interactions.

Ecosystem – Components of ecosystem, trophic level, food chain, food web, ecological pyramids, Types of ecosystem - Marineand Grassland.

Ecological Succession - Hydrosere and Xerosere.

Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

Unit IV

Phytogeography and Conservation **15 hrs**

Phytogeographical regions of India, Vegetation types of Karnataka and vegetational analysis by quadrat method, remote sensing and GIS.

Conservation of Natural resources (Soil, Forest and Lake), Soil reclamation. Afforestation, Social forestry and Agroforestry,Watershed management.

Conservation of plant diversity: *In-situ* and *Ex-situ* conservation – National park, Sancturies and Bioreserves. Role of Seed bank and Gene bank.Soil conservation.

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8. EamesA.J.**Morphology of vascular plants (lower groups)**.McGraw Hill, New York.1936.
9. Andrews H.N. **Studies in Paleobotany**. John Wiley & Sons NewYork.1961.
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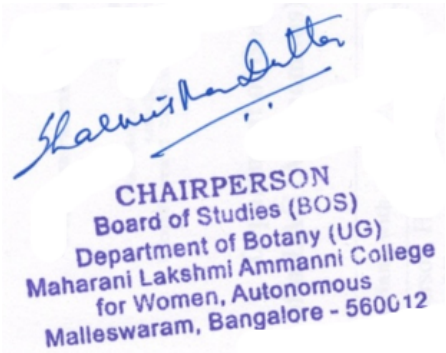
BOT.P3-3: TRACHEOPHYTES, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY AND CONSERVATION

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total Units - 13

1. Identification and Classification of Pteridophyte and Gymnospermsforms included in theory. 5 units
2. Ecological adaptations – study of one example for each adaptation 2 units
3. Estimation of chloride and dissolved oxygen content in the given sample 2 units
4. Quadrat method of studying vegetation. 1unit
5. Soil texture and soil pH 1unit
6. Marking of vegetation types of Karnataka on Karnataka map and Phytogeo graphicalareasofIndia. 2 units
7. Record & Submissions: Submission of report (a case study) on the following:
   - Rain water harvesting
   - Weed management
   - Conservation of Lakes
   - Waste water treatment
   - Terrace gardening
   - Vertical gardening
   - Solid waste management
   - Medicinal plant conservation



IV SEMESTER B.Sc.

BOT.T4-4: EMBRYOLOGY OF ANGIOSPERMS AND PLANT PHYSIOLOGY - I

Objective:

- To study the structure and development of anther, Microsporogenesis, Micro gametogenesis and Palynology.
- To correlate structure and development of Mega sporogenesis, Mega gametogenesis with their significant role in fertilization, fruiting, seed and embryo development.
- To introduce students with concepts, principlesand importance of water and its uptake in plant growth and development.
- To understand food transport and translocation mechanisms in the phloem.
- To enlighten the importance of altered metabolism in plants under stress.

Skills to be developed:

- Identification of various stages of development in anther and ovule.
- Identification of types of Pollen grain based on NPC system of classification.
- Preparing permanent slides of whole mount of pollen grains and section of ovules.
- Understanding of interplay between plant vascular tissues for commercial applications of plant physiology.
- Learn the importance of mineral nutrients in the growth and the impact of changing environmental factors on plant metabolism.

Outcome:

- Knowledge of various aspects of growth, development and organization of reproductive organs in angiosperms.
- Student would have an understanding of inter-relationship of anther and ovule development with fertilization and endosperm development.
- Acquaint with physiological networking of water and nutrient transport.

- Understanding of stress physiology in plants would help to understand the importance to holistic fitness of environment.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	02	04	30	70	100

Unit I

Embryology of Angiosperms – I **13 hrs**

Microsporogenesis - Development and structure of young and mature anther, anther wall layers, Tapetum – types and functions. Sporogenous tissue - microspore mother cells (mmc), cytokinesis, microspore tetrads. Rare features - Pollinia, compound pollengrains. Microgametogenesis – formation of vegetative and generative cells, male germ unit,structure of male gametophyte, Nemec phenomenon.

PALYNOLOGY – pollen morphology – pollen wall, aperture, shape, size and architecture, NPC system, pollen wall stratification. Applied palynology – aeropalynology and melissopalynology.

Contribution of Indian botanists in the field of Embryology- P. Maheshwari, B.G.L. Swamy and contemporary palynologist Shivanna.

Unit II

Embryology of Angiosperms –II **13 hrs**

Structure of ovule and types of ovule.

Megasporogenesis in crassinucellate type of ovule.

Megagametogenesis – types of embryosac development monosporic – *Polygonum* type, bisporic – *Allium* type, tetrasporic – *Fritillaria* type. Structure of mature embryosac (*Polygonum* type). General account on fertilization - pollen germination, growth of pollen tube through style (types of styles), entry of pollen tube into ovule (porogamy, mesogamy, chalazogamy), entry of pollen tube into embryo sac, syngamy, triple fusion. Significance of double fertilization, post fertilization changes.

Endosperm – types and its biological importance, free nuclear (*Cocos nucifera*), cellular (*Cucumis*), helobial types.

Embryogenesis – Dicot (*Capsella bursa-pastoris*) and Monocot (*Poa*). Polyembryony – definition typesand significance.

Unit III

Plant Physiology – I A **13 hrs**

Water relations: importance of water, diffusion, osmosis, water potential, osmotic potential, membrane and their permeability, SPAC concept. Absorption of water: mechanisms of water absorption, factors affecting rate of water absorption. Stress physiology: water stress, heat stress, salt stress.

Unit IV

Plant Physiology – I B **13 hrs**

Mechanism of Ascent of sap: vital and physical force theories.

Transpiration: loss of water, types, stomatal dynamics, stomatal mechanisms, significance, factors affecting transpiration, antitranspirants and guttation.

Mineral nutrition in plants: Macronutrients (N, P, K, Mg) and micronutrients (Ca, Zn, Co and Mn), their deficiency symptoms in plants. A brief account on Aquaponics/hydrophonics.

Phloem transport – transport of organic solutes, path of transport, vein loading and unloading, transcellular streaming hypothesis, contractile protein hypothesis, mass flow hypothesis, and source – sink concept.

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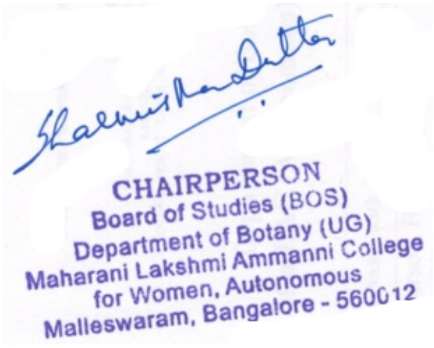

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BOT.P4-4: EMBRYOLOGY OF ANGIOSPERMS AND PLANT PHYSIOLOGY - I

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Total Units - 13

1. Permanent slides of young and mature anther. 1 unit
2. Types of pollen grains eg.*Acacia*, *Calotropis*, *Hibiscus* and grass (PS) 1 unit
3. Permanent slides of Embryo sac development 2n , 4n and organized embryo sac 1unit
4. Types of Ovules. 1 unit
5. Mounting of *Tridax* embryo 1 unit
6. Determination of osmotic potential of cell sap by plasmolytic method. 1 unit
7. Determination of stomatal index. 1 unit
8. Determination of pH of plant samples. 1 unit
9. Setup experiments 2 units
    - Membrane permeability at different temperature
    - Thistle funnel experiments
    - Farmer's potometer
    - Ganong's potometer
10. Experiments to comment on 1 unit
    - Hydroponics
    - Transpiration pull
    - Mass flow hypothesis
    - Ringing experiment
11. Submission (3 embryology slides – WM of Pollinia, Types of pollen grains and T.S. of ovary for placentation 2 unit
12. Record

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V SEMESTER B.Sc.

BOT.T5-5: TAXONOMY AND ECONOMIC BOTANY

Objective:

- To study different types of classification to understand the evolution.
- To understand the functionality of various Herbaria and Botanical gardens.
- To learn to identify the selected families of angiosperms by Bentham and Hookers system of classification.
- Learn the taxonomic evidences from molecular, numerical and chemicals.
- Learn the economic value of angiosperms

Skills to be developed:

- Herbarium techniques.
- Assign flowering plants to family level
- Economic value of plants and various parts modified as food storage organs in plants.

Outcome:

- Know the importance and scope of the paper
- Discover diversity and richness of the country
- Understand the value of the Plant resources

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	02	03	30	70	100

Unit I

INTRODUCTION TO PLANT SYSTEMATICS **10 hrs**

Introduction; Systems of classification, Broad outline of classification proposed by Bentham & Hooker and Hutchinson, Brief account of APG system. Plant identification and Taxonomic keys; Taxonomical literature, Botanical gardens (one state, one national & one international), Herbarium techniques.

Plant systematics: Binomial nomenclature, ICN aims and principles of nomenclature. Modern trends in taxonomy – Chemotaxonomy, Numerical taxonomy and Molecular systematics.

Unit II

ANGIOAPERMIC FAMILIES **22 hrs**

Taxonomic studies of the families based on Bentham and Hooker system of classification and their economic importance.

Dicotyledonae – Polypetalae: Annonaceae, Brassicaceae, Apiaceae, Fabaceae, Caesalpiniaceae, Mimosaceae, Meliaceae, Rutaceae and Cucurbitaceae.

Gamopetalae: Rubiaceae, Asteraceae, Asclepiadaceae, Apocynaceae, Verbenaceae, Lamiaceae and Bignoniaceae.

Monochlamydeae: Euphorbiaceae and Amaranthaceae.

Monocotyledonae: Orchidaceae, Musaceae, Cannaceae and Poaceae.

Unit III

ECONOMIC BOTANY **08 hrs**

Study of the following plants with Botanical names, family, origin, parts used and economic importance (Two uses).

Cereals, Millets, Pulses, Fruits and Vegetables of the families studied.

Edible oils – Groundnut and Sesame

Sugar & Starch – Sugarcane, Beetroot, Potato and Tapioca

Fibers – Cotton and Jute

Paper pulp – Bamboo and Eucalyptus

Beverages – Coffee, Tea and Cocoa

Spices – Ginger, Cardamom, Clove, Cinnamon, Asafoetida and Turmeric

Medicinal and Aromatic plants – Aloevera, Sarpagandha, Patchouli and Lemon grass

NWFP – Honey, Resin.

TEXT BOOKS

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5. Sambamurthy A.V.S.S. **Taxonomy of Angiosperms.** IK International publishers, New Delhi.2005.
6. Singh V. & D.K. Jain. **Taxonomy of Angiosperms**. Rastogi publications, Meerut.2006.
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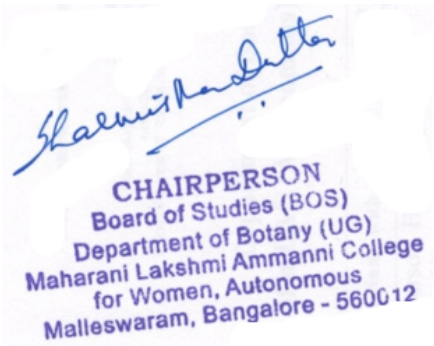

BOT.P5-5: TAXONOMY AND ECONOMIC BOTANY

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Total Units: 13

1. Methods of identification of plants with technical terms - Vegetative, Inflorescence, flower and Fruits

   1 Unit

2. Morphology of Angiosperms–

   Modifications

   Tap root- Conical, Fusiform, Napiform,
   Adventitious root- Tuberous, Fasciculated, Climbing
   Stem- Underground, Sub-aerial, Aerial (any two for each)
   Leaf- any two types

   Types of Inflorescence and Fruits

   Inflorescence related to families of syllabus, Fruits: Simple- Fleshy, legume, follicle, Schizocarpic, aggregate- Etario of follicles & multiple- Sorosis and Syconus

   1 Unit

3. Study of taxonomic characters of families included in theory

   9 Units

4. Economic Botany: Common names, Botanical names, families, part used and economic importance

   1 Unit

5. Herbarium techniques(Hand lens, pocket lens, herbarium sheet, plant press, Herbarium Cabinet,Sicature) 1 Unit

6. Study of local flora by arranging local collection trips
7. Record & Submission of 3 herbarium sheets and Economic Botany.

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BOT.T6-6: PLANT PHYSIOLOGY- II

Objective:

- To learn the process of Photosynthesis, Respiration and Nitrogen metabolism in plants.
- To understand the assimilation of different biochemicals.
- To get detail knowledge and applications of Phytohormones.
- To explore Sensory photobiology and Movements exhibited by plants.

Skills to be developed:

- Identification and estimation of different phytochemicals from plant sources.
- Determination of various by-products evolved during different metabolic activities of plants.
- Application of phytohormones.

Outcome:

- Understand the process of Photosynthesis, Respiration and Nitrogen metabolism in plants.
- Role of environmental factors in determining plant growth and development.
- Understand the biosynthesis and defence mechanism exhibited Plants.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	02	03	30	70	100

Unit – I **13 hrs**

Enzymes–Nomenclature, classification, chemical composition, prosthetic groups coenzymes, cofactors, vitamins, properties of enzymes, mechanism of enzymes action, enzyme kinetics, factors affecting enzyme activity, Inhibition of enzyme action (Competitive, Non Competitive, feedback), Allosteric enzyme.

Nitrogen Metabolism– Sources of nitrogen, Nitrogen fixation, nif genes in relation to symbiotic fixation in Rhizobium. Synthesis of amino acids and Nitrogen cycle. Nitrate metabolism, Assimilation of Ammonia

Unit –II

BIOENERGETICS **14hrs**

Photosynthesis– Introduction, ultra structure of the chloroplast, photosynthetic apparatus, principle of light absorption, Emerson's enhancement effect, photosystems I & II, Light reaction – Hill reaction, photophosphorylation (cyclic, non-cyclic), carbon reactions (Calvin Cycle, C4 – Pathway, CAM), Factors affecting the process. Photorespiration – Organelles involvedmechanism and significance.

Respiration– Introduction, ultra structure of mitochondria, mechanism of aerobic respiration – glycolysis,TCA cycle, ETS, ATP synthase and oxidative phosphorylation, mechanism of anaerobic respiration(alcoholic fermentation and lactic acid fermentation), Respiratory Quotient and its significance, factors affecting respiration.

Unit –III **13 hrs**

Plant growth and growth regulators–Definition of Growth, Kinetics, Factors affecting growth, Phytohormones, Metabolism, Physiological effects, Mode of action of Auxins, Gibberellins, Cytokinins, Ethylene and ABA. Applications of these hormones in agriculture and horticulture.

Photobiology– A brief account of dormancy, Photoperiodism, Phytochrome and its role, Florigen concept, Vernalization, Biological clock and circadian rhythms.

Plant movements– A brief account on the classification and types of movements.

Defence Mechanism- A brief account of Secondary metabolites (Phenolics, Flavonoids and Alkaloids) and their role in plant defence.

TEXT BOOKS

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20. Wilkins, M.B. (eds). **Advanced plant physiology**. Pitman Publishing Ltd., London.1989.
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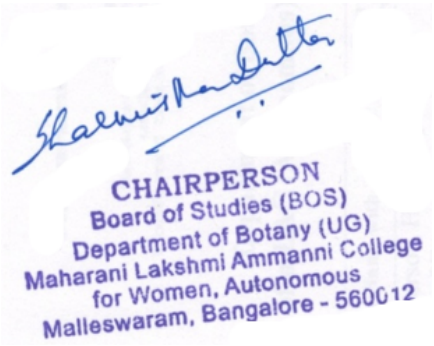
22. Wilson, K and Goulding, K.H. (eds.) **A Biologist Guide to Principles and Techniques of Practical Biochemistry**. Edward Arnold, London, UK. 1986.



BOT.P6-6: PLANT PHYSIOLOGY- II

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Total Units: 13

1. Separation of Photosynthetic pigments by paper chromatography and measurement of Rf Values. 2 units
2. Estimation of Ascorbic acid content in a plant sample.
   1 units
3. Experiments
   3 units
   - i. Determination of rate of photosynthesis at different concentrations of CO_2
   - ii. Determination of rate of photosynthesis at different wavelengths of light.
   - iii. Determination of RQ of carbohydrates, fats and proteins.
   - iv. Evolution of O_2 during photosynthesis.
   - v. Evolution of CO_2 during respiration.
   - vi. Kuhne's fermentation vessel.
   - vii. Mohl's half leaf Experiment.
   - viii. Evolution of heat during respiration
4. Estimation of Chlorophyll by Colorimeter analysis.
   1 unit
5. Plant Movements – Geotropism, Hydrotropism, Phototropism.
   2 units
6. Effect of Phytohormones on plant growth.
   1 unit
7. Estimation of IAA
   1 unit
8. Seed viability test
   1 unit
9. Project 1 unit
10. Record and Submission.

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VI SEMESTER B.Sc.

BOT.T7-7: CYTOLOGY, GENETICS, PLANT BREEDING AND EVOLUTION

Objective:

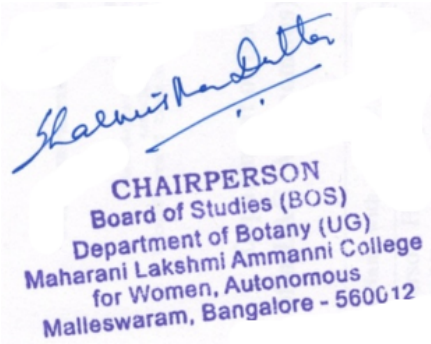
- To study the Structure, types, classification and ploidy of Chromosomes.
- To understand types of cell division and various stages of cell divisions.
- To know the different types of chromosomal aberrations.
- To learn Mendelian genetics,Sex determination and Extra chromosomal inheritance.
- To familiarize about Evolution and its significance.
- To gain knowledge on plant breeding and its importance in Polyploidy.

Skills to be developed:

- Identification of different stages of cell divisions.
- Stain preparation and staining techniques.
- Preparation of permanent slides of cell division.
- Various vegetative plant propagation techniques to achieve plant hybrids.

Outcome:

- Chromosomal Biology
- Familiarization of Plant Genetics.
- Conventional methods of achieving plant hybrids.
- Evolutionary concepts and its significance.



Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	02	03	30	70	100

Unit - I

CYTOLOGY **17 hrs**

Chromosome biology –Chromosome staining and Chromosome painting (FISH), Structure of eukaryotic chromosome;centromere,kinetochore and telomere. Nucleosome and its importance in the organisation of eukaryotic chromosome, Types of Chromosomes, special types (B–chromosome). Karyotype and Idiogram, c-value and genome size, Euchromatin and Heterochromatin.

Cell Division–Cell cycle and its regulation with reference to cell division, Mitosis: Phases, mitotic apparatus, Cytokinesis, mitotic inhibitors, significance of mitosis; Meiosis- phases of meiotic cycle, Significance of meiosis, cytological proof of crossing over, synaptonemal complex. Brief study on Apoptosis (PCD). **Aberrations:Numericalaberrations**, changes in Chromosome number, polyploidy and aneuploidy - Trisomics and monosomics. **Structural aberrations** manifested during meiosis: Deficiency, Duplication, Inversion and Translocation.

Unit - II

GENETICS AND PLANT BREEDING **17Hrs**

Biography of Mendel (in brief), Mendel's experiments:Monohybrid cross – law of dominance, law of segregation, purity of gametes. Homozygous, heterozygous, phenotype, genotype, monohybrid test cross, Dihybridcross-law of independent assortment, dihybrid test cross, incomplete dominance(*Mirabilis jalapa*, Snapdragon). Modification of Mendelian ratios (With reference to plant examples). Interaction of genes epistasis (dominant & recessive); supplementary factors, complementary factors: Polygenic inheritance in Maize, Self Sterility in*Nicotiana*, Linkage & Crossing over in Maize.

Sex Determination: Chromosomal mechanism of sex determination methods, XX –XY, ZZ – ZW & XX – XO (Sex determination in *Melandrium*) and genetic problems related to topics.

Plant breeding: Aims and objectives of plant breeding- a historical account, plant introduction and quarantine methods. Vegetative propagation methods - Cutting, grafting, layering, gootee, cloning Intergeneric and interspecific hybridization. A brief account of shade net, polyhouse and green house.

Unit - III

EVOLUTION **6hrs**

Theories of evolution (Darwinism, Neo-Darwinism), modern concepts of evolution. Evolution of wheat and cotton.

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TEXT BOOKS

6. Sinnott, E.W., Dunn. L.C. and Dobzhansky, T. **Principles of Genetics**. McGraw Hill Book Company. New York.1958.
7. Gupta.P.K., **Genetics**, Rastogi publications,New Delhi. 1994.
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BOT.P7-7: CYTOLOGY, GENETICS, PLANT BREEDING AND EVOLUTION

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Total Units 13

1. Preparation of cytological stains- Aceto carmine, Aceto orcein
2. Mitosis from *Allium* root tips- Aceto orcein 3 Units
3. Meiosis from *Allium* flower buds- Aceto carmine. 3 Units
4. Karyotype Idiogram: Camera Lucida drawing. 1 Unit
5. Permanent Slides of Mitosis. 1 Unit
6. Permanent Slides of Meiosis. 1 Unit
   a) Genetic Problems- 2 Unit
      Dihybrid Cross and Test cross
   b) Incomplete dominance
   c) Complementary factors
   d) Supplementary factors
   e) Epistasis
7. Cutting,Grafting, Layering and Gootee 1 Unit
8. Emasculation and Bagging of the flower buds of available *sps*. 1 Unit
9. Submission: Record and 6 Slides (Both mitosis and meiosis)

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VI SEMESTER B.Sc.

BOT.T8-8: MOLECULAR BIOLOGY, GENETIC ENGINEERING AND PLANT BIOTECHNOLOGY

Objective:

- To know about the genomic organization of living organisms
- To understand the mechanism and essential component required for DNA replication.
- To learn the steps involved in Biosynthesis of proteins and their regulation in Prokaryotic and Eukaryotic cells.
- Tounderstand the fundamentals of Recombinant DNA Technology.
- Toknow about the Genetic Engineering and its significance.
- Tounderstand the principle and basic protocols for Plant Tissue Culture.

Skills to be developed:

- RNA estimation.
- DNA extraction from plant sample.
- PCR technique
- Tissue culture techniques.
- Production of wine and alcohol

Outcome:

- Functionality of Nucleic Acids.
- Recombinant DNA technology
- Applications of Biotechnology in Plant and Human welfare

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	02	03	30	70	100

Unit I

MOLECULAR BIOLOGY **10hrs**

Introduction, discovery,chemical nature& replication of genetic material, non genetic RNA, concepts of ribozymesgenetic code. Biosynthesis of proteins, Regulation of gene action in prokaryotes (Lac operon concept only). Regulation of gene action in Eukaryotes (Britten and Davidson Model).

Unit II

GENETIC ENGINEERING **13 hrs**

Steps in Recombinant DNA technology, Restriction enzymes, Cloning Vectors,gene library, cDNA library, molecular probes. Molecular techniques: Electrophoresis and Polymerase Chain Reaction. Gene delivery system. DNA sequencing.Molecular markers (RFLP and RAPD) in crop improvement program. Genetic model organism *Arabidopsis thaliana*. GM crops - Bt cotton, Bt brinjal and *Petunia*. Brief account of crisper cas.

Unit III

PLANT BIOTECHNOLOGY: **14 hrs**

Plant Tissue Culture Definitions & scope.*In vitro* culture techniques: Sterilization methods, Culture media –composition and types of media (MS, Whites), Inoculation, Incubation and Acclimatization.Callus, single cell and suspension culture and its significance. Organ culture: Anther & Meristem culture. Organogenesis, somatic embryogenesis and artificial seeds. Somatic Hybridization: Isolation, fusion and protoplast culture. Somoclonal variation &hairy root culture.

Microbial biotechnology: Uses of microbes in industries and agriculture.Fermentation:Types, bioreactor and Media Fermentor. Production and application of α-amylase, ethanol, and Penicillin. Bioplastics and biofuels. A brief account on Metagenomics.

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TEXT BOOKS:

1. Gupta, P. K. **Elements of Biotechnology**. Rastogi Publications. Meerut. 1994.
2. Ignacimuthu,S.,**Plant Biotechnology.** Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. 2003.
3. Kalyan Kumar De. **Plant Tissue Culture**. New Central Book Agency (P) Ltd., Calcutta. 1997.
4. Mascarenhas A.F.,**Hand book of Plant Tissue Culture**. Indian Council of Agricultural Research. New Delhi.1991.
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10. Crueger F and Anneliese Crueger, **Biotechnology: Industrial Microbiology**Panima publishing Corporation, New Delhi. 2000.
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13. Casida, L. E. Jr. **Industrial Microbiology**.New Age International Publishers, New Delhi. 1996.
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15. Alexander N. Glazer and Hiroshi Nikaido, **Microbial Biotechnology: Fundamentals of Applied microbiology.** W.H. Freeman and Co., New York. 1994.
16. Satyanarayana U. **Biotechnology**, Books and Allied (P) Ltd. Kolkata.2010.

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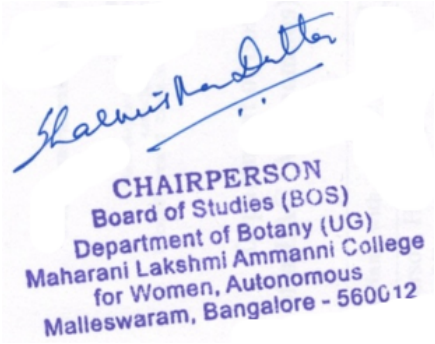
BOT.P8-8: MOLECULAR BIOLOGY, GENETIC ENGINEERING AND PLANT BIOTECHNOLOGY

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
39	01	03	15	35	50

Total Units – 13

1. Instrumentation: water bath, cooler centrifuge, PCR and electrophoresis 2 Units
2. Estimation of RNA 1Unit
3. Extraction and separation of plant DNA by agarose gel electrophoresis 2 Units
4. Preparation of MS and White's media. 2 Units
5. Meristem / Anther Culture. 2Units

6. Isolation of Protoplast from leaves (mechanical method) 1 Unit
7. Preparation of Synthetic seeds 1 Unit
8. Wine fermentation 2 Units
9. Visit to Biotech Industries/Institute.
10. Record and Submission of Tour Report



BIO-TECHNOLOGY

BOARD OF STUDIES 2016-2017

Sl. No.	NAME	DESIGNATION	ORGANIZATION
1.	Prof. M.B. Nagaveni	Chairperson	Head of the Department
2.	Prof.K.J.Thara Saraswathi	Professor	**University Expert** Department of Microbiology and Biotechnology Bangalore University, Jnanabharathi Campus, Bangalore
2	Prof. Paturu Kondaiah	Professor	**Subject Expert** Department of Molecular Reproduction, Development and Genetics, IISc, Bengaluru- 12
3.	Dr. Meghana	Member	**Alumnus** BS Program Faculty, IISc, Bangalore
4.	Dr. Madhumathi.M	Member	**Industry expert** Anthem Biosciences Electronic city, Hosur Road, Bangalore
5.	Dr. Babitha.B	Member	Assistant Professor mLAC
6.	Dr. Gowri Neelima.M	Member	Assistant Professor mLAC
7.	Dr. Medhini N	Member	Assistant Professor mLAC
8.	Ms. Hemavathy.E	Member	Assistant Professor mLAC

DEPARTMENT OF BIOTECHNOLOGY

Program Outcome:

Biotechnology, a fascinating science of inventions and innovations play a major part in driving India towards global economy leadership. Biotechnology success depends upon harnessing intellectual capabilities of students to create interest towards research.

The endeavours of the Biotechnology department, mLAC promises to sustain and enhance its quality in teaching learning strategies, motivating students towards quality research and making them professionally competent.

In this context the program aim to:

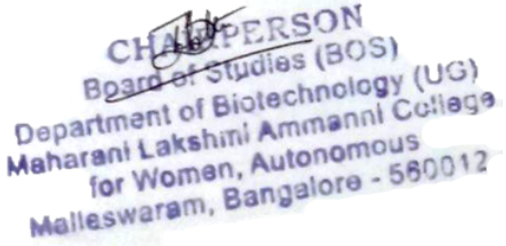
- Equip students with creativity, innovation and entrepreneurship skills to face the competitive world.
- Inculcate critical and analytical thinking on the existing knowledge of theory and practical learning to its applied aspects.
- Generate an in-depth understanding on classical and modern issues in thrust areas of Biotechnology: Cell biology, Genetics, Microbiology, Biophysics, Biochemistry, Molecular Biology, Genetic engineering, Environmental Biotechnology, Immunology, Animal Biotechnology, Plant Biotechnology and Industrial Biotechnology.
- Meet challenges of ever-growing Biotechnology industry through extensive training in practical's and conducting hands on workshops.
- Offer an excellent ingress in research through projects introduced in curriculum, helping them to experience excitements in applied sciences.

- Initiate in promoting research culture, overall grooming and personality development of students through seminar presentations, model-making and lecture competitions.
- Self-study topics adopted in the curriculum inspire students related to cutting edge developments in the subject

Program Specific Outcome:

After the completion of the course, a student is able to:

- Engage in higher studies, research and development or work in different biotechnological industries.
- Help students to take up various competitive exams as well as motivating them to study further advanced level of studies in Biotechnology.
- Promote entrepreneurship skills amongst students to setup as incubator center or start-ups.



B.Sc I SEMESTER

BIT.T1-1: BIOTECHNOLOGY- I

(CELL BIOLOGY AND GENETICS)

Objectives:

- The paper intends to give a detailed knowledge on basic and applied component in Cell Biology and Genetics
- Familiarize with basic concepts and techniques related to Cell Biology such as to understand the structure and functions of cell organelles, role of cell division and cell death and basics of cancer biology.
- To learn the basic concepts in Genetics with focus on deeper understanding on classical and modern genetics, inheritance pattern and various genetic disorders,.

Skills to be developed:

- Practical knowledge will strengthen student's knowledge and confidence on basic and advanced research in Cell Biology and Genetics.
- Practical skills include measurement of cell size, isolation of organelles, Karyotype analysis, squash preparation for cell division, construction of pedigree analysis.
- These topics help students to pursue research in basic science and create a positive attitude towards science learning.

Outcome:

- Knowledge of the various cell organelles
- Understand the mechanism of cell division and cell death.
- Deeper insight on classical and modern genetics with illustrations
- Application of genetics to solve real-life problems associated with genetic disorders
- Understand various inheritance pattern and relate to natural examples.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
52	**2**	**4**	**30**	**70**	**100**

PART A: CELL BIOLOGY

Total hours:28

Unit 1. Cell as a Basic unit of Living Systems

Cell as a unit of life, The Cell Theory.
Ultra structure of Plant and Animal cell

1 Hour

Unit 2.Plasma membrane and its functions

Structure of Plasma membrane – Fluid Mosaic model, functions, Transport mechanisms- Passive transport (Osmosis and Diffusion- simple and facilitated) & Active transport (Permeases, Sodium Potassium pump, Calcium ATPase pumps), exocytosis and endocytosis- mechanism, Modifications of plasma membrane (Microvilli, Gap junction, Tight junctions, Desmosomes).

5 Hours

Unit 3. Cellular Organelles

Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, ER-golgi modifications, Mitochondria and cellular respiration (Glycolysis and Krebs cycle),Chloroplast and photosynthesis, Ribosomes, Lysosomes, Peroxysomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin), Vacuole , Cytosol-properties, significance of water in cells. Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments). Plant cell wall- structure, composition and functions.

6 Hours

Unit 4. Chromosomes

Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition

Karyotype and chromosome banding techniques.

Ultrastructure: Folded- fibre and nucleosome models.

Special type of chromosomes: Salivary gland and Lampbrush chromosomes.

5 Hours

Unit 5. Cell Division

Cell Cycle and regulation, mitosis and meiosis.

5 Hours

Unit 6. Cell Senescence and cell death

Cell Senescence- definition, ageing, theories of ageing- molecular and cellular

Cell death- necrosis and apoptosis

2 Hours

Unit 7: Cancer biology

Cellular changes in benign and malignant tumor, oncogenes and tumor suppressor genes.

2 Hours

Unit 8: Stem Cell Biology

Concept of stem cell and its applications.

2 Hours

PART B: GENETICS

Total Hours: 24

Unit 1: Introduction to Genetics:

Definition of genetics terms : Gene, Genotype, Phenotype, Allele, Gene loci, Heterologous, Homologous, Crossing over, Genetic cross- Test cross, Back cross, Reciprocal cross, Pedigree, Inheritance, Wild type, Mutant – dominant and recessive.

1 Hour

Unit 2: Types of inheritance

Mendelian Inheritance-Mendel and his experiments, Laws of heredity, Test cross and simple problems.

Non-Mendelian inheritance-
Cytoplasmic Inheritance - Plastid inheritance in Mirabilis, Petite characters in Yeast and Kappa particles in Paramecium.
Maternal inheritance in Lymnaea.

4 Hours

Unit 3: Interaction of Genes
Supplementary factors: comb pattern in fowls
Complementary genes- Flower colour in sweet peas
Multiple factors – Skin colour in human beings
Epistasis – Plumage colour in poultry
Multiple allelism: Blood groups in Human beings.

4 Hours

Unit 4: Sex Determination in Plants and animals
Sex Determination, genic balance theory, chromosome theory of Sex Determination. Concept of allosomes and autosomes, Mechanism of Sex Determination **(** XX- XY, XX-XO, ZW-ZZ, ZO-ZZ types), Sex Determination in man, role of Y- chromosome, Barr bodies, Dosage compensation and Lyon hypothesis.
Chromosome mosaicism- intersex, gynandromorphy and hermaphrodite.

4 Hours

Unit 5: Linkage and Crossing Over
Coupling and repulsion hypothesis, Mechanism of crossing over and its importance, Chromosome mapping-linkage map in maize, Linkage in maize and Drosophila

3 Hours

Unit 6: Chromosomal variations
A general account of structural and numerical aberrations, chromosomal evolution of wheat and cotton.

2 **Hours**

Unit 7: Mutations
Types- spontaneous and induced, mutagens- physical and chemical, mutation at the molecular level. Induced mutations in plants, animals and microbes for economic benefit of man. Mutation breeding.

3 Hours

Unit 8: Human genetics

Dominant and recessive inheritance patterns with examples, X- linked inheritance (dominant and recessive) with examples, Pedigree chart, chromosomal anomalies in man, autosomal (Down's syndrome, Edwards's syndrome), allosomal (Klinefelter's syndrome, Turner's syndrome)

3 Hours

REFERENCES:

CELL BIOLOGY

1. Bruce Alberts *et al*, (1983) Molecular Biology of Cell, Garland Publications
2. MJD (1977) Animal Cytology and Evolution, White Cambidge University Publications
3. Harvey Lodish *et al* (2007) Molecular Cell Biology, Scientific American Books
4. Jack D Bruke (2002) Cell Biology, William Twilkins Company
5. Ambrose & Dorothy M Easty (1982), Cell Biology, ELBS Publications
6. Sharp (2008) Fundamentals of Cytology, McGraw Hill Company
7. G. Karp *(2009) Cell and Molecular Biology: Concepts and Experiments*, 6th ed. USA: Wiley and Sons

GENETICS

1. Daniel L. Hartl (1996) Basic Genetics, Jones & Barlett Publishers, USA
2. Monroe W Strickberger (1985) Genetics, Macmillan Publishers, New York
3. Edmund W Sinnott (2006) Principles of Genetics, Tata Mcgraw Hill Publishing Co Ltd
4. Genetics- A Blue print of Life (1996) Sandhya Mitra, Tata McGraw Hill Publication
5. E.J. Gardener *et al* (1991) Principles of Genetics, John Wiley & Sons Publications.
6. P.S.Verma & V.K.Agarwal (1974) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S.Chand Publishers.

B.Sc ISEMESTER
BIT.P1-1: BIOTECHNOLOGY- I
(CELL BIOLOGY AND GENETICS)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total units: 15

1. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast 2 units
2. Cell division: Mitotic and meiotic studies in grasshopper testes, onion root tips and flower buds and preparation of permanent slides. 4 units
3. Chromosomes: Mounting of polytene chromosomes 1 unit
4. Buccal smear - Barr bodies 1 unit
5. Karyotype analysis - Human and Onion 2 units
   Human – Normal and abnormal- Down's and Turner's syndrome
6. Construction of pedigree chart 1 unit
7. Isolation of mitochondria and determination of mitochondrial activity. 1 unit
8. Vital staining of mitochondria 1 unit
9. RBC and WBC cell count by haemocytometer 1 unit
10. Study of monohybrid and dihybrid cross using colour beads 1 unit

Each student is required to submit five permanent slides (mitosis and meiosis- atleast 2 from each).

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B.Sc SEMESTER- II

BIT.T2-2: BIOTECHNOLOGY- II
(GENERAL MICROBIOLOGY AND BIOSTATISTICS)

Objectives:

- Better understanding of the different microbial forms and various bacterial, viral and fungal diseases affecting humans
- Knowledge on *in vitro* methods to isolate, grow and maintain microbial cultures in the laboratory
- Understand the working principle and applications of different types of microscopes.
- Familiarize the applications of biostatistics in academia and in research

Skills to be developed:

- Isolation techniques and culture maintenance in the laboratory.
- Handling of Microbiological laboratory equipments.
- Maintenance of aseptic conditions
- Preventive measures to be practiced to safeguard health and resources
- Problem- solving with reference to real-life data

Outcome:

- Differentiate the different microbial forms and understand their importance on health and environment
- Better understanding of microbial diseases of health concern.
- Students will be able to assess data sources and data quality for the purpose of selecting appropriate data for specific research questions.
- Identify appropriate statistical methods to be applied in a given research setting, or apply specific methods and acknowledge the limitations of these methods.

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
52	**2**	**4**	**30**	**70**	**100**

PART A: GENERAL MICROBIOLOGY

Total Hours: 37

Unit 1: Overview of history of Microbiology

History of Microbiology, Contributions of Anton van Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming, Scope of Microbiology.

3 Hours

Unit 2: Microscopy

Principles of Microscopy - resolving power, numerical aperture, working distance and magnification

Working principles and applications of different types of microscope– Bright field, Dark field, phase contrast, fluorescence and electron microscope (SEM and TEM)

4 Hours

Unit 3: Microbial Taxonomy

Definition, concept of species and strains, nomenclature, kingdom and domain system of classification

2 Hours

Unit 4: Diversity of Microorganisms

General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, structure, mode of reproduction and economic importance.

9 Hours

Unit 5: Microbial Techniques

A). STERILIZATION: Principles and applications of

a. Physical Methods: Autoclave, Hot air oven, laminar airflow, Seitz filter, sintered glass Filter and membrane filter.

b. Chemical Methods: Alcohol, Aldehydes, Phenols, Halogens and Gaseous agents.

c. Radiation Methods: UV rays and Gamma rays.

5 Hours

B).**Culture Techniques:**
Culture media: nutritional requirements, nutritional types of micro organisms, components of media, types of media- solid, liquid, semi solid; simple, complex, selective , differential and enriched media
Pure culture: Pure culture techniques- serial dilution, pour plate, streak plate and spread plate method, Candle jar method, micromanipulator technique.

5 Hours

C). **Stains and Staining Techniques**: Principles of staining, Types of stains: Simple Stains, Structural stains and Differential stains **3 Hours**

Unit 6: Pathogenic Microorganisms
A. Bacterial diseases of man – Tuberculosis and Cholera
B. Viral diseases: AIDS (HIV), CaMV, Bacteriophage- Lambda phage
C. Fungal diseases: Candidiasis
D. Protozoan parasite: Malaria **6 Hours**

PART B-BIOSTATISTICS

Total hours: 15

Unit 1: Importance and application
Tabulation and classification of data, Frequency distribution and Graphical distribution of data.

2 Hours

Unit 2: Measures of Central Tendencies
Mean, Median, Mode and their properties **3Hours**

Unit 3: Measures of Dispersion
Mean deviation, Variance, Standard deviation and Coefficient of Variation

3 Hours

Unit 4: Hypothesis Testing
Student *t* and Chi-square test **2 Hours**

Unit 5: Probability and Distribution
Concepts and problems on probability, Binomial, Poisson, Normal Distribution and their applications

5 Hour

REFERENCES:

MICROBIOLOGY

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
3. Pelczar MJ, Chan ECS and Krieg NR. (1998). Microbiology. 5th edition. McGraw Hill Book Company.
4. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
5. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology.7th edition. McGraw Hill Higher Education.
7. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
8. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
9. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ).University Press Publication.

BIOSTATISTICS

1. Bliss, C.J.K. (1967) Statistics in Biology, Vol. I McGraw hill. New York.
2. Campbell R.C. (1974) Statistics for Biologists, Cambridge Univ, Press, Cambridge
3. Daniel (1999) Biostatistics (3rd edition) Panima Publishing, Corporation
4. Sward law, A. C. (1985) Practical Statistics for Exponents Biologists, John Wiley and Sons, Inc., NY
5. Khan (1999) Fundamentals of Biostatistics Publishing Corporation.

B.Sc SEMESTER – II
BIT.P2-2: BIOTECHNOLOGY- II
(GENERAL MICROBIOLOGY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total Units: 15

1. Safety measures in microbiology laboratory 1 Unit
2. Cleaning and sterilization of glasswares 1 Unit
3. Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar air flow and centrifuge. 2 Units
4. Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining, fungal staining, Bacterial mobility by hanging drop method. 3 Unit
5. Media preparation: Nutrient agar, blood agar, EMB, MRBA and Nutrient broth. 2 Units
6. Isolation of bacteria and fungi from soil, air, and water- dilution and pour plate methods 2 Units
7. Antibiotic sensitivity test – paper disc method 1 Unit
8. Biochemical tests – Starch hydrolysis, Catalase, Oxidase, Lipid hydrolysis & Gelatin liquefaction. 3 Units

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B.Sc SEMESTER-III

BIT.T3-3: BIOTECHNOLOGY- III
(BIOCHEMISTRY AND BIOPHYSICS)

Objectives:

- Better understanding and insight into the structure and biological functions of the various biomolecules
- Understand the importance of vitamins and hormones for a healthy body system
- Familiarize with metabolism concept with focus on carbohydrate metabolism.
- Understand the importance and scope of Biophysics with emphasis on principle and applications of various analytical and spectroscopic techniques
- Learn types of isotopes and their biological activity

Skills to be developed:

- Concept of Stoichiometry with reference to normality, molarity, molality, percent solutions
- Qualitative and quantitative methods to determine various biomolecules
- Preparation of various buffers.
- Extraction and purification methods for proteins and its quantification
- Determination of enzyme concentration and specific activity.
- Handling of analytical instruments.

Outcome:

- Gain basic knowledge about various biomolecules
- Understand carbohydrate metabolic pathway and significance.
- Knowledge on types as well as deficiency symptoms of vitamins and hormones
- Insight on structure and function of enzymes with focus on enzyme kinetics
- Knowledge on various high-end analytical and spectroscopic equipments and their applications in research.

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
52	2	4	30	70	100

Unit 1: Amino acids and Proteins

Amino acids- Classification on the basis of polarity of R- groups. Ionic & acid base properties and reactions of amino acids. Peptides- Peptide bond, biologically important peptides- oxytocin, vasopressin.

Proteins- Classification based on structure, function & composition. Structural organization of proteins (Primary, secondary, tertiary and quaternary structure), Denaturation of proteins.

7 Hours

Unit 2: Enzymes

Introduction, classification, enzyme kinetics- factors influencing enzyme activity, co-enzymes and co-factors.

6 Hours

Unit 3: Carbohydrates

Structure of monosaccharides, classification with examples, optical properties, anomers and epimers definition with examples. Derived monosaccharides- Amino sugars, Sugar acids, Sugars phosphates & deoxy sugars – biological importance with examples. Oligosaccharides- structure and biological importance of maltose, sucrose, lactose, cellobiose and isomaltose. Polysaccharides- Classification based on function and composition.Partial structure and biological importance of starch, glycogen and cellulose.

6 Hours

Unit 4: Lipids

Classification of lipids. Fatty acids- definition, saturated and unsaturated fatty acids with examples and structure, Essential fatty acids. Triglycerides- simple and mixed triglycerides, properties-hydrolysis- acid, alkali and enzyme, rancidity (oxidative and hydrolytic). Definition and significance of saponification number, iodine number and acid number. Phosphoglycerides- Structure and biological importance of lecithin, cephalin and plasmalogens. Sphingolipids- classification and biological importance. Lipoproteins- Types and functions.

6 Hours

Unit 5: Metabolism

Anabolism and Catabolism - Definition with example.Carbohydrate metabolism- Glycolysis, fate of pyruvate,TCA cycle and energetics. **3 Hours**

Unit 6: Vitamins

Definition, classification- water soluble and fat soluble vitamins, and their biological functions, Dietary source.

3 Hours

Unit 7: Hormones

Definition, classification with examples and functions.

3 Hours

Unit 8: Biophysics

Introduction and scope of Biophysics.

1 Hour

Unit 9: pH and Buffers

pH- definition and its biological importance. Buffers- Types, buffer action. pH of buffers- Henderson Hasselbalch equation (derivation), preparation of buffers.

4 Hours

Unit 10: Analytical techniques

a) Principles and applications of Chromatography (Paper, thin- layer, Column – Affinity, Gel filtration, Ion Exchange, Gas Liquid and HPLC)
b) Centrifugation – Principle, types- preparative and differential and their application.

7 Hours

Unit 11: Spectroscopic techniques

Principles and applications of UV-Visible spectroscopy, X-ray crystallography, NMR, IR, fluorescence & atomic absorption.

4 Hours

Unit 12: **Isotopes**

Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

2 Hours

REFERENCES:

1. Nelson, D.L., Cox, M.M. Lehninger (2004) Principles of Biochemistry. CBS Publishers & Distributors.
2. Ubret Stryer Biochemistry, Freeman International Edition.
3. Keshav Trehan Biochemistry, Wiley Eastern Publications
4. J.L. Jain Fundamentals of Biochemistry S. Chand and company
5. Biochemistry, Prasaranga, Bangalore University
6. Dr. A.C. Deb Fundamental of Biochemistry-
7. P.L. Soni Textbook of Organic Chemistry (A Modern approach), Sultan Chand and Sons, Publishers.
8. Roger L.P. Adams, John T. Knower and David P. Leader The Biochemistry of Nucleic acid-tenth Edition-, Chapman and Hall Publications.
9. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
10. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency

B.Sc SEMESTER - III
BIT.P3-3: BIOTECHNOLOGY- III
(BIOCHEMISTRY AND BIOPHYSICS)

Total units: 15

1. Stoichiometry – normality, molarity, molality, percent solutions 1 unit
2. Preparation of buffers – citrate and phosphate. 2 units
3. Estimation of reducing sugar (glucose/ maltose/lactose) by DNS and Somogy's method 2 units
4. Estimation of protein by Lowry's method 1 unit
5. Extraction, partial purification of protein from plant source by ammonium sulphate precipitation and estimation by Biuret method. 4 unit
6. Assay of enzyme activity- Amylase 2 units
7. Separation of sugars by TLC 1 unit
8. Estimation of aminoacids by Ninhydrin method 1 unit
9. Estimation of inorganic phosphate by Subbarao method. 1unit

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B.Sc SEMESTER-IV
BIT.T4-4: BIOTECHNOLOGY- IV
(MOLECULAR BIOLOGY)

Objectives:

- Focus on both the fundamental and applied aspects of Molecular biology.
- Understand the basic concept involved in DNA replication, recombination, transcription, translation, gene regulation in both prokaryotes and eukaryotes
- Familiarize with the different types of Mutations and their consequences in gene expression
- Know about gene organization in mitochondria and chloroplast and their importance
- Understand the importance of transposable elements in expression of traits and iin evolution of an organism

Skill to be developed:

- Quantification of nucleic acids.
- Students will gain an in-depth knowledge on isolation and purity determination of nucleic acids
- Problem solving on DNA topology and calculation of molecular weight of nucleic acid
- Technique of transformation and calculation of transformation efficiency

Outcome:

- Knowledge on Molecular biology concepts will equip students towards advanced science concepts.
- In depth knowledge on the molecular mechanisms involved in replication, gene expression and gene regulation.
- Compare and contrast the above mechanism in prokaryotic and eukaryotic systems.
- Understand the Influence of mutations, extra chromosomal and transposable elements on the phenotypic traits of an organism

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
52	**2**	**4**	**30**	**70**	**100**

Unit 1: Molecular basis of life

An introduction to RNA and DNA as genetic material, experimental proof of DNA as genetic material.

2 Hours

Unit 2: Nucleic Acids

Structure and functions of DNA and RNA. Watson and Crick model of DNA and other forms of DNA (A and Z DNA). DNA topology- Linking number.

5 Hours

Unit 3: DNA Replication and DNA Repair

Mechanism of DNA replication – Enzymes involved in replication in prokaryotes and eukaryotes. Distinguishing features between Prokaryotic and Eukaryotic replication, Theta model and Rolling circle model.

Causes and mechanism of DNA Repair- photoreactivation, excision repair, mismatch repair, recombination repair and SOS **8 Hours**

Unit 4: Recombination in prokaryotes

A brief introduction about plasmids, preparation of competent cells, Transformation.Conjugation and Transduction- Mechanism and applications.

4 Hours

Unit 5: Structure of prokaryotic gene and eukaryotic gene

Bacterial chromosome and plasmid.Chromatin, Role of Histone modifications in gene activation and gene expression.

3 Hours

Unit 6: Transcription in Prokaryotes and Eukaryotes

Mechanisms, Promoters and RNA polymerase, transcriptional factors, Post transcriptional modification of eukaryotic mRNA.

7 Hours

Unit 7: Translation

Mechanism of translation in Prokaryotes and Eukaryotes, Post translational modification of proteins. Genetic code- Properties and wobble hypothesis

9 Hours

Unit 8: Regulation of gene expression

Regulation of gene expression in prokaryotes- operon concept (Lac and Trp).Regulation of gene expression in eukaryotes- transcriptional activation, galactose metabolism in yeast.

8 Hours

Unit 9: Gene organization in mitochondria and chloroplast

Gene organization in mitochondria and chloroplast, functions of mitochondrial DNA, Disorders due to defects in mitochondrial DNA

2 Hours

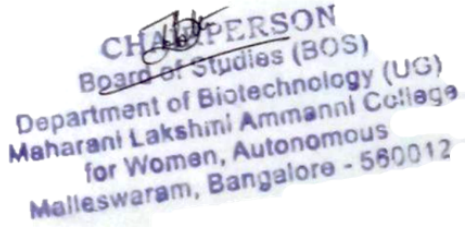
Unit 10. Insertional elements and Transposons

Transposable elements in Maize and Drosophila

REFERENCES:

1. Glick, B.R and Pasternak J.J (1998) Molecular biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.

2. Howe. C. (1995) Gene cloning and manipulation, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering Academic Press Inc. Florida, USA.
5. Sambrook *et al* (2000) Molecular cloning Volumes I, II & III, Cold spring Harbor Laboratory Press New York, USA
6. Walker J. M. and Ging Old, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K.
7. Karp.G (2002) Cell & Molecular Biology, 3rd Edition, John Wiley & Sons.



B.Sc SEMESTER - IV
BIT.P4-4: BIOTECHNOLOGY- IV
(MOLECULAR BIOLOGY)

Total units: 15

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

1. Preparation of DNA model (A, B and Z) 1 unit
2. Estimation of DNA by DPA method 1 unit
3. Estimation of RNA by Orcinol method 1 unit
4. Isolation and purity determination of DNA from animal source 2 units
5. Isolation and purity determination of DNA from plant source by CTAB method 2 units
6. Isolation and purity determination of RNA from microbes by hot phenol method 2 units
7. Agarose gel electrophoresis and molecular weight determination 2 units
8. Topological problems- simple problems based on linking number. 1 unit
9. Preparation of competent cells, Transformation and calculation of transformation efficiency 3 units

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B.Sc SEMESTER - V

BIT.T5-5: BIOTECHNOLOGY- V
(GENETIC ENGINEERING AND ENVIRONMENTAL BIOTECHNOLOGY)

Objectives:

- Intended to learn about tools used in genetic engineering with focus on different vectors, enzymes and construction of recombinant DNA molecule.
- To study about various genetic engineering techniques and applications in human health.
- An Insight about conventional and modern fuels and their global environmental impact.
- An insight into importance of Biotechnology in the areas of agriculture(Biofertilizers and Biopesticides) and environment (Bioremediation, composting, vermicomposting, waste water treatment and biofuels)

Skills to be developed:

- Hands on experience on molecular techniques such as PCR, Agarose gel and SDS-PAGE electropheresis.
- Carry out genetic engineering methods like restriction digestion and ligation
- Quality analysis of water- MPN, Total hardness and BOD determination
- Isolation of beneficial microorganisms (Rhizobium and VAM) in soil which have huge impact on agriculture

Outcome:

- Better understanding of high-end equipments and practical expertise in Genetic engineering obtained which can change into research project in following semester.
- Understanding core experiments under Genetic engineering which has tremendous application in R & D lab and Biotechnology industry.
- Environmental awareness of emerging concern such as waste management can be addressed

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
40	2	3	30	70	100

PART- A: GENETIC ENGINEERING

Total hours: 22

Unit 1: Introduction and Tools of Genetic Engineering

History - discovery of restriction enzymes, development of plasmid vectors, work of Stanley and Cohen; scope of genetic engineering; Enzymes - restriction enzymes(nomenclature, types, properties and mechanism of action), ligases (T4 and *E.coli* DNA ligases- properties and mechanism of action).

Vectors - Plasmid (pBR322, pUC) and bacteriophage vectors (λ phage, M13); expression vectors -regulatable promoters (IPTG-inducible T7 promoter)

6 Hours

Unit 2: Construction of recombinant DNA molecules

Isolation of vector and foreign DNA, construction of rDNA – directional cloning, cloning blunt-ended DNA, overview and applications of genomic and cDNA libraries.

3 Hours

Unit 3: Transformation and screening techniques

Calcium chloride method, electroporation, transformation efficiency and frequency.

Screening of clones – insertional inactivation, restriction digestion, blue-white screening, colony hybridization.

3 Hours

Unit 4: Genetic Engineering Techniques

Electrophoretic techniques – DNA, RNA, protein; Blotting techniques – Southern, Northern, Western Blot; Autoradiography, detection with non-radioactive probes; Polymerase Chain Reaction; DNA sequencing – Sanger's method; NextGen Sequencing **7 Hours**

Unit 5: Applications of genetic engineering in human health

Production of insulin, human growth hormone; Vaccines – Hepatitis B vaccine, Influenza vaccine; PCR and NGS for disease diagnosis. **3 Hours**

REFERENCES:

1. Glick, B.R and Pasternak J.J, Patten CL (2010) Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C.
2. Christopher H. (1995) Gene cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (2008) An Introduction of Genetic Engineering (3rd edition) Cambridge University Press.
4. Primrose, S.B., Twyman, R.M and Old. R.W. (2001) Principles of Gene manipulation (6th Edition) Blackwell Science.
5. Watson J.D. (2007) Recombinant DNA: genes and genomes: a short course. W.H. Freeman: Cold Spring Harbor Laboratory Press.
6. Ernst.LWinnacker (1987)From Genes to Clones: Introduction to Gene Technology, WILEY-VCH Verlag.

PART - B: ENVIRONMENTAL BIOTECHNOLOGY

Total hours: 18

Unit 1:

Renewable and Non-Renewable resources of energy **1 Hour**

Unit 2: Modern fuels

Biogas, Microbial Hydrogen production, conversion of sugar to alcohol and Gasohol. Biodiesel production from *Jatropha*. **2 Hours**

Unit 3: Biofertilizers

Production and applications of Bacteria- *Rhizobium, Azotobacter, Azospirillum*; Algae; *Azolla*, Fungi (VAM and *Trichoderma*) **2 Hours**

Unit 4: Bioleaching

Enrichment of ores by microorganisms (Gold, Copper and Uranium) **2 Hours**

Unit 5: Biopesticides

Overview of Bacterial (*Bacillus thuringiensis*), Viral (baculovirus) and Fungal (*Beauveria bassiana*) biopesticides. **1 Hour**

Unit 6: Bioremediation

Definition, bioremediation technologies- *in-situ* and *ex-situ* techniques; Bioremediation of Heavy metals, Degradation of petroleum products (n-alkanes and aromatic hydrocarbons); halogenated aromatic compounds; lignocellulosic compounds.Phytoremediation-Types (Phytoextraction, Phytostabilisation, Phytostimulation, Phytotransformation andRhizofiltration). **5 Hours**

Unit 7: Waste management

Treatment of Municipal sewage waste water (primary, secondary and tertiary treatment process). Solid waste management- waste category, Composting- Types (heap, pit, windrow and Bin methods) and vermicomposting. **5 Hours**

REFERENCES:

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic Concepts and Applications, 2nd Edition, I.K. International Publishing House Pvt Ltd.
2. P. K. Mohapatra (2006) Textbook of Environmental Biotechnology, I.K. International Publishing House Pvt Ltd.
3. Jogdand S N (2010) Environmental Biotechnology, Himalaya Publishing House
4. S. K. Agarwal (2005) Advanced Environmental Biotechnology, APH Publishing Corporation.
5. A.K. Chatterji (2011) Introduction to Environmental Biotechnology, PHI Learning Pvt. Ltd.
6. Alan Scragg (2005) Environmental Biotechnology, OUP.
7. U Satyanarayana (2013) Biotechnology, Books and Allied (P) Limited.

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SEMESTER - V

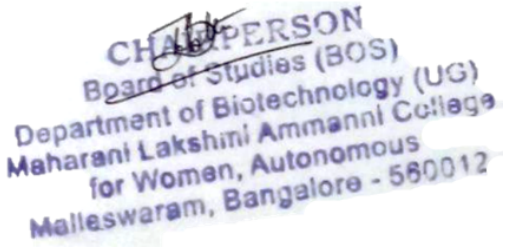
BIT.P5-5: BIOTECHNOLOGY- V

(GENETIC ENGINEERING AND ENVIRONMENTAL BIOTECHNOLOGY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total units : 15

1. Isolation of plasmid DNA (*E. coli*) 2 unit
2. Restriction digestion of DNA and agarose gel electrophoresis 1 unit
3. Ligation of DNA 1 unit
4. Amplification of DNA by PCR 2 units
5. SDS-PAGE 2 units
6. Bacterial examination of water by MPN method 2 units
7. Estimation of BOD and Total hardness of water 2unit
8. VAM staining 1 unit
9. Staining of *Rhizobium* and *Trichoderma* 2units



B.Sc SEMESTER - V

BIT.T6-5: BIOTECHNOLOGY- VI
(IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY)

Objectives:

- To learn the importance and applications of Immunology and Animal Biotechnology
- To understand the different aspects of immunity- innate and adaptive
- To obtain a deeper understanding on basic concepts and techniques related to Immunology such as the structure and significance of antigen, antibody and complement system, immunological techniques and immunization.
- To learn the basic concepts in Animal Biotechnology with focus on technique and applications of animal cell culture and transgenic animals

Skills to be developed:

- Hands on experience on laboratory procedure used in diagnostic labs for detection of immunological disorders and disease identification
- Isolation and culturing method in animal cell culture laboratory.
- Handling of laboratory equipments and maintenance of aseptic conditions within animal cell culture lab.

Outcome:

- On a broader sense, students will be able to understand the techniques in Immunology and Animal Biotechnology which will be manifested as projects.
- These techniques equip them to find job in R & D lab/diagnostic laboratories/ Biotechnology industry.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**3**	**30**	**70**	**100**

PART - A: IMMUNOLOGY

Total Hours: 22

Unit 1: Introduction to Immunology

History and Scope of Immunology. Immunity- Innate immunity- Anatomical and Chemical barriers. Adaptive immunity- Cell mediated and Humoral immunity. Active and passive immunity.

3 Hours

Unit 2: Cells and organs of immune system

Organs- Primary and Secondary lymphoid organs and their functions. Cells- APCs, NK cells, Granulocytes, Mast cells, T cells, B cells-Structure and functions; Hematopoiesis.

3 Hours

Unit 3: Antigens and Antibodies

Antigens – General characteristics of antigens, types, Epitopes, Haptens.

Antibodies- Structure, types, properties and functions of immunoglobulins, production of antibodies- B cell stimulation, Monoclonal antibody.

5 Hours

Unit 4: Complement system

Structure, Components, Properties and Functions.

2 Hours

Unit 5: Diseases associated with the immune system

Hypersensitivity- Definition, Types with an example, Tissue rejection, Autoimmune disorders.

3 Hours

Unit 6: Immunological Techniques

Antigen-Antibody reaction: Precipitation, Immunodiffusion (RID, ODD) Immunoelectrophoresis (Rocket immunoelectrophoresis), Immunoagglutination (Haemagglutination, ABO blood grouping, Rh typing), Labeled antibody assays (RIA, ELISA and Immunofluorescent techniques)

4 Hours

Unit 7: Vaccines and Immunization

Types of vaccines-Inactivated, Attenuated, Recombinant Vaccines (Peptide and DNA Vaccines)

2 Hours

REFERENCES:

1. William E. Paul (1989) Fundamental immunology, 2nd Edition Raven Press, New York.
2. William R. Clark (1991) The Experimental Foundations of Modern Immunology (4th Edition) John Wiley, and Sons, New York.
3. Ivan, M Rohitt and Peter J Delves (2001) Roitt's Essential Immunology; Blackwell Science.
4. W H Freeman (2013) Immunology, Oven and Punt, Stanford Publications, 7thedn.
5. J H L Playfare (1987) Immunology at Glance, Blackwell Science.

PART - B: ANIMAL BIOTECHNOLOGY

Total hours: 18

Unit 1: Introduction to Cell culture and growth medium

History and scope of animal cell and tissue culture, advantages and disadvantages of tissue culture, requirement of animal cell culture lab, sterilization techniques, types of medium (Defined and undefined), significance of serum, Growth factors promoting proliferation of animal cell culture- EGF, FGF, PDGF, TGF, IL I, IL II, IGF, NGF, Erythropoietin.

4 Hours

Unit 2: Basics of Cell culture techniques

Primary and secondary cell cultures, Disaggregation of tissue (physical, chemical methods- trypsin, collagenase), continuous cell lines, characteristics of cell lines, maintenance of cell lines, suspension cell cultures and adherent cell cultures.Measurement of cell viability - Evan's blue method, Trypan blue method, cell toxicity assay- MTT assay.

4 Hours

Unit 3: Transfection and gene expression in animal cells

Transfection of animal cell lines, Selectable Markers, Expression of cloned proteins (Erythropoietin) in animal cell-Expression vector, over production and downstream processing of the expressed proteins.

5 Hours

Unit 4: Applications of Animal biotechnology

Production of vaccines in animal cells. Transgenic Animals: gene transfer methods- Retroviral Vector method, DNA microinjection method, Engineered embryonic stem cell method; Detection of transgenes. Transgenic mice and their applications. Importance of SNTP method.Biopharming, animal bioreactors and their importance.

5 Hours

REFERENCES:

1. M. Butler (2004) Animal Cell Culture and Technology – the basics, 2nd edition, Taylor and Francis.
2. S. Gangal (2010) Principles and Practice of Animal Tissue Culture, Second edition, Universities Press.
3. B. Alberts, A. Johnson, J. Lewis, M. R. K. Roberts and P. Walter (2008) Molecular Biology of the Cell. Garland Science Publishing.
4. L. Houdibine (2003) Animal Transgenesis and Cloning, John Wiley & Sons, Ltd.
5. U. Sathyanarayana (2005) Biotechnology. Books and Allied (P) Ltd., Kolkata.
6. Freshney (2006) Culture of Animal Cells, John Wiley and Sons.

B.Sc **SEMESTER- V**

BIT.P6-5: BIOTECHNOLOGY- VI

(IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY)

Total Units : 15

1. Blood grouping and Differential Count of WBC
   2 units
2. WIDAL Test and VDRL Test 1 unit
3. Dot ELISA 1 unit
4. Ouchterlony Double Diffusion (ODD) and Single Radial Immunodiffusion (SRID) 2 units
5. Rocket Electrophoresis 2 units
6. Separation of Serum from blood and precipitation of immunoglobulin
   2 units
7. Preparation and sterilization of MEM media by membrane filtration
   2 units
8. Isolation of liver parenchymal cells, disintegration by mechanical and enzymatic (trypsinization) and viability test by dye exclusion method
   4 units

B.Sc SEMESTER- VI

BIT.T7-6: BIOTECHNOLOGY- VII
(PLANT BIOTECHNOLOGY)

Objectives:

- To understand the importance and applications of Plant Biotechnology
- To learn the basic and applied concepts of Plant Biotechnology such as various tissue culture techniques with illustrations, transgenic plants and their commercial applications.
- Familiarize about Intellectual Property Right (IPR) and their significance.

Skills to be developed:

- Handling of laboratory equipments and maintenance of aseptic conditions within plant tissue culture lab.
- Preparation of media, culturing techniquesin plant tissue culture laboratory.
- Students will be able to do projects which help them to get confidence over theory as well as practicals.
- Active involvement of students in planning and execution of the experiment

Outcome:

- Understanding current techniques will enable them to find job in R & D lab/ Plant biotechnology industry.
- Students will be motivated to study further advanced level of Biotechnology.
- Promote entrepreneurship skills amongst students to setup as incubator center or start-ups.

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
40	**2**	**3**	**30**	**70**	**100**

Unit 1: Introduction to Plant tissue culture

In vitro methods in plant tissue culture, Aseptic techniques, Different types of Nutrient media, Growth regulators used in tissue culture (Auxins, Cytokinins and Gibberellins).

4 Hours

Unit 2: Micropropagation

Stages of micropropagation, *in vitro* methods in plant tissue culture (Axillary buds, adventitious shoot and callus), clonal propagation using axillary bud*(Gerbera,* Curry leaf), adventitious shoot (*Brahmi*, *Carnation)* and callus(*Chilli*, *Anthurium)*. Role of tissue culture in agriculture, horticulture and forestry.

7 Hours

Unit 3: Organ culture

Haploid production- anther culture, types of androgenesis, ovary and ovule culture. Embryo and endosperm culture.Organogenesis and Somatic Embryogenesis; *in vitro*pollinationand fertilization- Technique and applications.

Somaclonal and gametoclonal variation and its applications.

7 Hours

Unit 4: Somatic hybridization

Protoplast Culture – Isolation, regeneration and viability test, protoplast fusion methods; selection of hybrids, cybridization, applications of somatic hybridization and cybridization.

4 Hours

Unit 5: *In vitro* production of Secondary metabolites

In vitro culturing of roots, *in vitro* production of plant secondary metabolites-methods plant cell culture; hairy root culture and biotransformation.

4 Hours

Unit 6: Transgenic plants

Plant transformation, methods of transformation in plants – *Agrobacterium*-mediated and physical methods (Microprojectile and electroporation), applications of transgenic plants- Bt-cotton, therapeutic proteins, edible vaccines from plants – Banana, watermelon.

7 Hours

Unit 7: Biotechnology and Intellectual property rights

Patents and its significance, trade secrets, Protection of copyright, trademark. Choice of Intellectual property (IPR) and Management; social and ethical aspects of Biotechnology.

3 Hours

Unit 8: Stress in plants

Biotic and abiotic stress, development of biotic and abiotic-stress resistant plants (GM, Classical and Molecular breeding).

4 Hours

REFERENCES:

1. Ravishankar G.A and Venkataraman L.V (1997) Biotechnology Applications of plant Tissue and cell culture. Oxford and IBH publishing Co. Pvt. Ltd.
2. Lincoln Taiz and Eduardo Zeiger (2010) Plant Physiology, Sinauer Associates, Inc.
3. Sathyanarayana B.N and Dalia B Varghese (2007) Plant Tissue Culture, International Publishing House Pvt. Ltd.
4. Gamborg O.L and Philips G.C (1998) Plant cell, tissue and Organ Culture, 2nd reprint, Narosa Publishing House.
5. Chrispeels M.J and Sadava D.E (1994) Plants, Genes and Agriculture, Jones and Barlett Publishers, Boston.
6. LydianeKyte and John Kleyn (1996) Plants from test tubes. An introduction to micropropagation (3rd edition) Timber Press, Partland.

B.Sc SEMESTER- VI
BIT.P7-6: BIOTECHNOLOGY- VII
(PLANT BIOTECHNOLOGY)

Total Units : 15

1. Preparation of plant culture media – MS, Nitsch, White's media 2 Units
2. Production of Callus (Chilli/ *Anthurium*) and Suspension Culture 2 Units
3. Plant protoplast isolation and fusion 2 Units
4. Plant propagation through tissue culture (Curry leaf/ Brahmi/ Carnation using shoot tip/nodal explant) 2 Units
5. Abiotic stress experiment – oxidative stress 2 Units
6. Biotic Stress – chart preparation 1 Unit
7. Anther culture 2 Units
8. *Agrobacterium* culture and selection of transformants 2 Units
9.

The practicals will involve project-based learning to enable students to gain experience in planning and executing a project with focus on teamwork, time-management and effective use of resources.

Evaluation Pattern:

1. Internal assessment …… 10 Marks
2. Project presentation / Viva voce…… 10 Marks
3. Report …… 5 Marks
4. End-semester Practical examination …… 25Marks

TOTAL …… 50 Marks

B.Sc SEMESTER- VI

BIT.T8-7: BIOTECHNOLOGY- VIII
(INDUSTRIAL BIOTECHNOLOGY)

Objectives:

- To understand the importance and applications of Industrial Biotechnology
- To learn the design and applications of various fermenters, techniques involved in large scale production of various products of commercial importance
- Introduction of industrial visit in the curriculum to learn in a broader sense of production processes.

Skills to be developed:

- Lab and pilot scale production of products of commercial importance by microbial fermentation process.
- Hands on experience on working of pilot-scale Fermenter
- Students will be able to do projects which help them to get better understanding on topics and gain interest towards research.
- Industrial visits will gain practical knowledge for students.
- Active involvement of students in planning and execution of the project

Outcome:

- Understanding applications as well as practical knowledge will enable students to find job in R & D lab/ Food/ Pharmaceutical industry.
- Students will be motivated to study further advanced level of Biotechnology.
- Promote entrepreneurship skills amongst students to setup as incubator center or start-ups.

Total Number Of Hours	Credits	Hours/Week	Internal Assessment Marks	End Semester Exam	Total Marks
40	2	3	30	70	100

Unit 1: Introduction to Industrial Biotechnology

Basic principles of fermentation technology, Screening and Isolation of Microorganisms, maintenance of strains, strain improvement (Mutant Selection, Recombinant DNA methods).

3 Hours

Unit 2: Upstream processing

Fermentation types- Solid state, submerged, continuous, fed batch and shake flask fermentation with one example each. Types of media- natural and synthetic media,Inoculum development. Sterilization techniques- heat, radiation and filtration methods. Immobilisation of cells and enzymes

6 Hours

Unit 3: Fermenter

Basic construction of fermenter, process of aeration, agitation, temperature regulation,pH control and foam control. Types of fermenters. Typical, airlift, tower and bubble. Bioreactors for enzyme production- stirred tank, membrane and continuous flow reactors. **6 Hours**

Unit 4: Downstream processing (DSP)

Disintegration of cells, separation, extraction, concentration and purification of products **3 Hours**

Unit 5: Industrial microbial fermentation

Brief account of microbiological fermentation of alcohol, alcoholic beverage- beer, organic acid- citric acid, antibiotic-penicillin, amino acid- glutamic acid, vitamin-

vitamin B12, enzyme-amylase, Microbial polysaccharides and polyesters- xanthan gum and polyhydroxyalkanoates.

10 Hours

Unit 6: Plant, animal and microbial cell culture for industrial production

Plant cell suspension culture - production of food additives (saffron and capsaicin). Animal cell culture - brief account of production of antibodies from Chinese hamster ovary (CHO) cell culture. Single cell protein - Spirulina; Single cell oil- yeast. Brief account of steroid biotransformation.

6 Hours

Unit 7: Bioprocessing

Industrial application of enzymes in Detergents, Leather, Beverage, food and pharmaceutical. Dairy Industry: Yoghurt, buttermilk, Cheese.
Food Industry: oriental foods- Idli, dhokla. Other fermented foods: tempeh and sushi.

6 Hours

REFERENCES:

1. Glick B.R and Pasternak J.J (2010) Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C.
2. Christopher H (1995) Gene cloning and Manipulating, Cambridge University Press
3. Nicholl D. S.T (2008) An Introduction of Genetic Engineering, (3rd edition), Cambridge University Press.
4. Primrose S.B, Twyman R.M and Old R.W (2001) Principles of Gene manipulation (6thEdition) Blackwell Science.
5. Watson J.D (2007) Recombinant DNA : genes and genomes : a short course, W.H. Freeman : Cold Spring Harbor Laboratory Press.

B.Sc SEMESTER- VI
BIT.P8-7: BIOTECHNOLOGY- VIII
(INDUSTRIAL BIOTECHNOLOGY)

Total Number Of Hours	**Credits**	**Hours/Week**	**Internal Assessment Marks**	**End Semester Exam**	**Total Marks**
39	01	03	15	35	50

Total Units: 15

1. Production and estimation of citric acid from *Aspergillus niger*.
   a) Shake flask fermentation
   b) Solid state fermentation 2 units
2. Preparation of wine and estimation of alcohol content by specific gravity method. 2 units
3. Production of Yoghurt and estimation of lactic acid content 2 units
4. Immobilization of yeast cells and determination of invertase activity 2 units
5. Production and estimation of α – amylase from *Bacillus* species 1 unit
6. Production and comparative estimation of protein content in *Spirulina* and yeast 3 units
7. Production of the antibiotic penicillin & its assay(diffusion method) 2 units
8. Study of fermenter 1 unit
9. Visit to fermentation/ enzyme/ dairy industry and report submission

The practical's will involve project-based learning to enable students to gain experience in planning and executing a project with focus on teamwork, time-management and effective use of resources.

Evaluation Pattern:

1. Internal assessment …… 10 Marks
2. Project presentation / Viva voce…… 10 Marks
3. Report …… 5 Marks
4. End-semester Practical examination …… 25 Marks

TOTAL …… 50 Marks