JOINT CSIR-UGC NET COACHING PROGRAM

INTRODUCTION

We are thrilled to introduce and propose an initiative that aligns with our commitment to fostering academic excellence and providing equitable opportunities for all students. We aim to start a **free coaching program for CSIR-UGC NET** (Council of Scientific and Industrial Research-University Grants Commission National Eligibility Test) at Shibli National College, Azamgarh, specifically designed to prepare meritorious students in general and minority students in particular for the Junior Research Fellowship (JRF) and NET in **Physical Sciences, Chemical Sciences, Mathematical Sciences and Life Sciences**.

The Joint CSIR-UGC NET is a prestigious national-level examination that is an essential qualification for the position of Assistant Professor in central and state universities, and postgraduate colleges. Our goal is to support and empower deserving students with emphasis on minority students who have the potential to excel but due to lack of the resources to prepare effectively for this crucial test are denied opportunity.

The Managing Committee of Shibli National College has a keen interest in this initiative and has passed the resolution in its meeting dated 14-07-2024 to start the coaching as soon as possible. It will be a comprehensive coaching that will cover all the aspects of the CSIR-UGC NET syllabus, including subject knowledge, exam strategies, and time management skills. By this coaching, we aim to enhance the academic and professional prospects of our students, enabling them to achieve their aspirations and contribute meaningfully to the academic community.

We believe that with the right guidance and required resources, our students can achieve remarkable success. This program will not only help in uplifting the individual students but also enhance the reputation of Shibli National College, Azamgarh, an institution dedicated to academic excellence and social equity.

PROGRAM OBJECTIVES

Our Free CSIR-UGC NET Coaching Program aims to:

- **Provide Free Coaching:** Provide free coaching to 60 students in each subject, making a total of 240 students. In each group of 60 students there will be 40 internal (from SNC, Azamgarh) and 20 external students. There will be 15 Students from M.Sc. previous year and 25 students from M.Sc. Final year in each subject. In Life Sciences, initially 90students will be inducted, 45 each from Botany and Zoology. Out of which 30 will be internal and 15 will be external. Out of 30 internal candidates, 20 will be from M.Sc. Final whereas 10 will be from M.Sc. Previous years.
- **Support Aspiring Researchers and Educators:** Students will be equipped with the knowledge and skills necessary to excel in the CSIR-UGC NET exam and thus to promote them in higher education, research careers and academic excellence.
- **Enhance Academic Competence:** Provide high-quality coaching to improve test preparation and performance.
- **Foster Equal Opportunities:** Bridge gaps in access to resources and support for students who may face financial or systemic barriers.
- **Induce Supportive Learning Environment:** Create a supportive learning environment that fosters collaboration and a peer learning for students aspiring to go into research and teaching field.

PROGRAM CURRICULUM/HIGHLIGHTS

- **Expert Instruction:** Classes will be held by experienced faculty members and subject matter experts who specialize in CSIR-UGC NET exam preparation.
- **Comprehensive Coverage:** Coaching will include in-depth training in key subjects covered by the exam, including General Aptitude, and subject-specific areas such as Life Sciences, Physical Sciences, Chemical Sciences and Mathematical Sciences.
- **Study Material:** To recommend students standard textbooks and online resources. Moreover, comprehensive study material and previous year's question papers will be provided free of cost to guide their study.
- **Time Management:** To help them make a study plan that allows them to cover all topics of the syllabus systematically.

- **Evaluation/Test of Students:** Students performance in class will be appraised by the Coordinator and Co-Coordinators. If any student is found to be non-productive and their marks obtained in the test are not satisfactory then he/ she will be dropped from the class.
- **Mock Tests:** We shall conduct mock tests that can help the candidates to get used to the exam format and manage time effectively.
- **Personalized Guidance:** Individual mentoring and guidance sessions to address specific queries and provide tailored support.
- **Academic Counseling:** Assistance with exam strategies, study plans and stress management techniques.
- **Community Engagement:** Opportunities for students to participate in seminars and discussions with experts and former CSIR-UGC NET exam passed out.
- **State-of-Art Library facility:** A state-of-art library with 40 seat capacity and latest study material along with essential text books and previous years' question papers for CSIR-UGC NET will be provided to the candidates.
- **Simulated training based mock tests:** Computer based mock test for simulated training by creating exam like environment will be provided to the candidates to gauge the exam and assess their own performance.

INFRASTRUCTURE

Classes will be held in well-equipped classrooms with necessary teaching aids.

HOSTEL FACILITY

Hostel facility will be provided to a maximum 40 meritorious girl students (top 8 female rank holders from each subject).

PROCEDURE FOR ADMISSION

Course of Study: CSIR-UGC NET Coaching

Course details:

Course Name	Duration	Class Schedule	Class Duration	Center	Intake*
CSIR-UGC NET Coaching	1 year	August, 2024	3 hr (02:30-05:30 pm)	SNC, Azamgarh	Life Sciences -90 Physical Sciences-60 Mathematical Sciences-60 **(Chemical Sciences to be started later)**

*25 students from M.Sc. Final year and 15 students from M.Sc. Previous year.

Qualification: Those who have completed their masters and those who are pursuing Previous and Final years of master's course.

Age Limit: There should not be a gap of more than two years from P.G. Final result to join this coaching.

Number of Chances: Each selected candidate will be given a chance of utmost two sessions to study under the coaching programme. The candidates who are consistently good performers during the course of coaching may be given a chance to study in next session, as per the recommendation of the concerned faculty and management committee, for a maximum of two sessions.

Selection Process: Through Entrance Test Conducted by Shibli National College, Azamgarh.

Test Paper Details: There shall be objective type question papers in each subject of 100 marks with 85 questions from specific subject and 15 pertaining to General Aptitude.

Syllabus of Admission Test:

S.No.	Subject	Syllabus
1.	Mathematical Sciences	Complete UG syllabus
2.	Chemical Sciences	
3.	Physical Sciences	
4.	Life Sciences	
5.	General Aptitude	Basic Verbal and Non-Verbal Reasoning

Admission Test Date:

S. No.	Subject	Admission Test Date
1.	Mathematical Science	**To be notified soon**
2.	Physical Science	
3.	Chemical Science	
4.	Life Science	

Test Center: Shibli National College, Azamgarh.

Application Process: Interested students can apply through our online registration link (……..) or visit our admission office assigned for the purpose at Shibli National College, Azamgarh.

Registration Fee: one time registration fee of Rs 1000/- will be charged from the applicants which will be payable through UPI and other modes.

Admission to the coaching programme will be subject to verification of all relevant documents and testimonials.

Organizing Committee and Expert Faculty

Patron:

1. Mr. Abu Saad Shamshi (President, Managing Committee)
2. Mr. Athar Rasheed Khan (Manager, Managing Committee)

Principal/ Coordinator: Prof. Afsar Ali

Co-Coordinator:

1. Prof. Altaf Ahmad
2. Dr. Seraj Ahmad Khan
3. Dr. Shagufta Khanam
4. Dr. Farheen Siddiqui
5. Miss. Aram Almas

Counsellor: Dr. Rahi Prasad Maurya

List of the experts subject-wise:

Life Sciences

1. Prof. Mohd Sultan Ahmad
2. Dr. Jamal Ahmad (Retd)
3. Dr. Ahmad Faraz
4. Dr. Shama Afroz

. + Outsource Faculty

Physical Sciences

1. Dr. Syed Tahir Husen
2. Dr. Azizurrahman
3. Dr. Suhail Ahmad Siddique
4. Dr. Tahir Hasan

+ Outsource Faculty

Mathematical Sciences

1. Prof. Mohd Sadiq khan
2. Dr. Seraj Ahmad Khan
3. Mr. Mohd Javed
4. Dr. Afajal Ahmad Ansari
5. Dr. Abdul Gaffar

+ Outsource Faculty

General Aptitude

1. Miss. Seema Sadiq
2. Dr. Farheen Siddiqui

+ Outsource Faculty

Technical Staff

1. Dr. Jawed Ahmad (B.Ed)
2. Mr. Meraj Ahmad

Supporting Staff

1. Mr. Ramkesh
2. Mr. Irshad

ABOUT CSIR-UGC NET

Joint CSIR UGC NET (Council of Scientific and Industrial Research-University Grants Commission National Eligibility Test) is a test being conducted to determine the eligibility of Indian nationals for Junior Research Fellowship (JRF), Assistant Professor and admission in Ph.D., in Indian universities and colleges. The National Testing Agency (NTA) has been entrusted by the Council of Scientific and Industrial Research (CSIR), with the task of conducting the Joint CSIR-UGC NET Examination in Computer Based Test (CBT) mode.

Here's a brief overview of the exam:

Purpose

- **Junior Research Fellowship (JRF):** Provides financial support to candidates for pursuing research in their chosen field.
- **Lecturer/Assistant Professor:** Assesses eligibility for teaching positions in Indian universities and colleges.
- **Admission to Ph.D**. in Indian universities and colleges and R&D establishments (vide. UGC notification dated 28.03.2024)

Exam Conducting Bodies

- The exam is conducted by the CSIR in collaboration with the UGC. CSIR handles the scientific and technical subjects, while the UGC handles other subjects.

Subjects Covered by our free CSIR UGC NET coaching as follows:

1. **Physical Sciences**
2. **Chemical Sciences (to be started later)**
3. **Life Sciences**
4. **Mathematical Sciences**
5. **General Aptitude**

Exam Format

- **Mode:** Online
- **Sections:**

  Part A: It shall be common to all subjects. This part shall contain questions pertaining to General Aptitude with emphasis on logical reasoning, graphical analysis, analytical and numerical ability, series formation puzzles etc.
  Part B: It shall contain subjects- related convention Multiple-choice questions (MCQs), generally covering the topic given in the syllabus
  Part C: It shall contain higher order questions that may test the candidate's knowledge of scientific concepts and/or application of the scientific concepts. The questions shall be of analytical nature where a candidate is expected to apply scientific knowledge to arrive at the solution to the given scientific problem.

- **Pattern of questions papers:** The test will consist of three parts. All the parts will consist of objective type, multiple choice questions. There will be no break between papers. The subject- wise scheme of examination is as per details below:

CHEMICAL SCIENCES (701)	PART A	PART B	PART C	TOTAL
Total questions	20	40	60	120
Max no of Questions to attempt	15	35	25	75
Marks for each correct answer	2	2	4	200
Marks for each incorrect answer (Negative marking for part A, B & C is @ 25%)	0.5	0.5	1	-
LIFE SCIENCES (703)	PART A	PART B	PART C	TOTAL
Total questions	20	50	75	145
Max no of Questions to attempt	15	35	25	75
Marks for each correct answer	2	2	4	200
Marks for each incorrect answer (Negative marking for part A, B & C is @ 25%	0.5	0.5	1.32	
MATHEMATICAL SCIENCES (704)	PART A	PART B	PART C	TOTAL
Total questions	20	40	60	120
Max No of Questions to attempt	15	25	20	60
Marks for each correct answer	2	3	4.75	200
Marks for each incorrect answer (Negative marking in for part A, B & C is @ 25%; no negative marking in part C)	0.5	0.75	0	-
PHYSICAL SCIENCES (705)	PART A	PART B	PART C	TOTAL
Total questions	20	25	30	75
Max No of Questions to attempt	15	20	20	55
Marks for each correct answer	2	3.5	5	200

Marks for each incorrect answer (Negative marking in for part A, B & C is @ 25%)	0.5	0.875	1.25	-

Eligibility Criteria

- **Educational Qualification:** Candidates should have a Master's degree or equivalent in a relevant subject.
- **Age Limit for JRF:** There is usually an age limit for JRF, often around 30 years, with relaxations for reserved categories.
- **Age Limit for Lectureship:** There is no upper age limit for applying for Lectureship.

Career Prospects

- **JRF:** Candidates who qualify for JRF can work on research projects and pursue doctoral studies with financial support.
- **Lecturer/Assistant Professor:** Those who qualify for Lectureship can apply for teaching positions in universities and colleges.
- **Admission to Ph.D**. in Indian universities and colleges and R&D establishments (vide. UGC notification dated 28.03.2024)

Syllabus

MATHEMATICAL SCIENCES

UNIT – 1

Analysis: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples. Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

UNIT – 2

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations. Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements.

Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory. Topology: basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

UNIT – 3

Ordinary Differential Equations (ODEs): Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function. Partial Differential Equations (PDEs): Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations. Numerical Analysis : Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods. Calculus of Variations: Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations. Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel. Classical Mechanics: Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

UNIT – 4

Descriptive statistics, exploratory data analysis Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (i.i.d. case). Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes. Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range. Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests. Simple nonparametric tests for one and two sample problems, rank correlation and test for independence. Elementary Bayesian inference. Gauss-Markov models, estimability of parameters, best linear unbiased estimators, confidence intervals, tests for linear hypotheses. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics. Logistic regression. Multivariate normal distribution, Wishart distribution and their properties. Distribution of quadratic forms. Inference for parameters, partial and multiple correlation coefficients and related tests. Data reduction techniques: Principle component analysis, Discriminant analysis, Cluster analysis, Canonical correlation. Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods. Completely randomized designs, randomized block designs and Latin-square designs. Connectedness and orthogonality of block designs, BIBD. 2K factorial experiments: confounding and construction. Hazard function and failure rates, censoring and life testing, series and parallel systems. Linear programming problem, simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1

PHYSICAL SCIENCES

PART ‘A’ CORE

I. Mathematical Methods of Physics Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

II. Classical Mechanics Newton’s laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence.

III. Electromagnetic Theory Electrostatics: Gauss’s law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel’s law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV. Quantum Mechanics Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg

uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

V. Thermodynamic and Statistical Physics Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law. VI. Electronics and Experimental Methods Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics. Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting.

PART ‘B’ ADVANCED

I. Mathematical Methods of Physics Green’s function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson’s rule, Solution of first order differential equation using Runge Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

II. Classical Mechanics Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether’s theorem. Hamilton-Jacobi theory.

III. Electromagnetic Theory Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

IV. Quantum Mechanics Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

V. Thermodynamic and Statistical Physics First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

VI. Electronics and Experimental Methods Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

VII. Atomic & Molecular Physics Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. Condensed Matter Physics Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and

relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. Nuclear and Particle Physics Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

CHEMICAL SCIENCES

Inorganic Chemistry:

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.
9. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods.
10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Physical Chemistry:

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.

2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Organic Chemistry:

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
10. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
13. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

Interdisciplinary topics:

1. Chemistry in nanoscience and technology.
2. 2. Catalysis and green chemistry.
3. Medicinal chemistry.
4. Supramolecular chemistry.
5. Environmental chemistry.

LIFE SCIENCES

a. Molecules and their Interaction Relevant to Biology
b. Cellular Organization
c. Fundamental Processes
d. Cell Communication and Cell Signaling
e. Developmental Biology
f. System Physiology – Plant
g. System Physiology – Animal
h. Inheritance Biology
i. Diversity of Life Forms
j. Ecological Principles
k. Evolution and Behavior
l. Applied Biology
m. Methods in Biology

i. MOLECULES AND THEIR INTERACTION RELAVENT TO BIOLOGY

A. Structure of atoms, molecules and chemical bonds.
B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
C. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
D. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
G. Conformation of proteins (Ramachandran plot, secondary structure, domains, and folds).
H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
I. Stability of proteins and nucleic acids.

J. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins. 2. A)

ii. CELLULAR ORGANIZATION

A. Membrane structure and function motif (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport,electrical properties of membranes).
B. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).
C. Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).
D. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).
E. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

iii. FUNDAMENTAL PROCESSES

A. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).
B. RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).
C. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-

identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

D. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

iv. Cell communication and cell signaling

1. Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.
2. Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two- component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.
3. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
4. Cancer Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.
5. Innate and adaptive immune system Cells and molecules involved in innate and adaptive

immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

v. DEVELOPMENTAL BIOLOGY

A) Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

B) Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

C) Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation,

metamorphosis; environmental regulation of normal development; sex determination.

D) Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

E) Programmed cell death, aging and senescence

vi. SYSTEM PHYSIOLOGY - PLANT

A. Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways.

B. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

C. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

D. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

E. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

F. Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

G. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

H. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

vii. SYSTEM PHYSIOLOGY - ANIMAL

1. Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma

function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.

2. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
3. Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
4. Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.
5. Sense organs - Vision, hearing and tactile response.
6. Excretory system - Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
7. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
8. Stress and adaptation
9. Digestive system - Digestion, absorption, energy balance, BMR.
10. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

viii. INHERITANCE BIOLOGY

A) Mendelian principles : Dominance, segregation, independent assortment. B) Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests

C) Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

D) Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

E) Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

F) Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

G) Human genetics : Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

H) Quantitative genetics : Polygenic inheritance, heritability and its measurements, QTL mapping.

I) Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

J) Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

K) Recombination : Homologous and non-homologous recombination including transposition.

ix. DIVERSITY OF LIFE FORMS:

1. Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological

nomenclature, classical & quantititative methods of taxonomy of plants, animals and microorganisms.

2. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.
3. Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.
4. Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Comman Indian mammals, birds. Seasonality and phenology of the subcontinent.
5. Organisms of health & agricultural importance: Common parasites and pathogens of humans, domestic animals and crops.
6. Organisms of conservation concern: Rare, endangered species. Conservation strategies.

x. ECOLOGICAL PRINCIPLES

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.
Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

xi. EVOLUTION AND BEHAVIOUR

1. Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.
2. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular

eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

3. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.
4. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.
5. The Mechanisms: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual
6. Brain, Behavior and Evolution: selection; Co-evolution. Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

12.APPLIED BIOLOGY:

7. Microbial fermentation and production of small and macro molecules.
8. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.
9. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
10. Genomics and its application to health and agriculture, including gene therapy.
11. Bioresource and uses of biodiversity.
12. Breeding in plants and animals, including marker – assisted selection
13. Bioremediation and phytoremediation
14. Biosensors

13.METHODS IN BIOLOGY

A. Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing

methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques

B. Histochemical and Immunotechniques Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as and GISH.
C. Biophysical Method: FISH Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
D. Statisitcal Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X2 test;; Basic introduction to Muetrovariate statistics, etc. E.
E. Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
F. Microscopic techniques: Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes,

different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.

G. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .

H. Methods in field biology: Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.