CATALYST Center of Excellence provides coaching for various examinations like

- **CSIR-UGC JRF/NET**
  1. **Life Sciences**
  2. **Chemical Science**

- **UGC JRF/NET**
  3. **Environmental Science**

CSIR-UGC National Eligibility Test (NET) For Junior Research Fellowship and Lecturer-ship

CSIR will hold the Joint CSIR-UGC Test for determining the eligibility of the Indian **National candidates** for the award of Junior Research Fellowships (JRF) NET and for determining eligibility for appointment of Lecturers (NET) in certain subject areas falling under the faculty of Science. The award of Junior Research Fellowship (NET) to the successful eligible candidates will depend on their finding admission/placement in a university/ national laboratory/ institution of higher learning and research, as applicable.

A candidate may apply either for 'JRF + Lectureship' both or for 'Lectureship (LS) only' He/she may indicate his/her preference in the O.M.R Application Form/Online Application, as the case may be. CSIR may consider candidates applying for 'JRF + LS' for 'Lectureship only" depending on number of fellowships available & performance in the test subject to the condition that they fulfill the laid down eligibility criterion . If a candidate is found to be over-age for JRF (NET) he/she will automatically be considered for Lectureship (NET) only.
Two separate merit lists, one comprising the candidates qualifying for the award of Junior Research Fellowship (JRF - NET) and the second, of those candidates qualifying the Eligibility Test for Lectureship (NET), will be made on the basis of their performance in the above Test. Candidates qualifying for JRF (NET), will also be eligible for Lectureship (NET). The candidates qualifying for Lectureship will be eligible for recruitment as Lecturers as well as for JRF-ship in a Scheme/Project, if otherwise suitable as per the eligibility criteria of that Scheme/Project. However, they will not be eligible for Regular JRF-NET Fellowship. They will be eligible to pursue Ph.D. programme with or without any fellowship other than JRF-NET**.** Candidates qualifying for the award of JRF (NET) will receive fellowship either from CSIR or UGC as per their assignment or from the Schemes with which they may find association. The candidates declared eligible for Junior Research Fellowship under UGC scheme will be governed by UGC rules/regulations in this regard.

EDUCATIONAL QUALIFICATION

M.Sc. or Equivalent degree under the subjects, with minimum 55% marks for General & OBC candidates; 50% for SC/ST candidates, Physically and Visually Handicapped candidates and Ph.D. degree holders who had passed Master's degree prior to 19th September 1991.

A candidate can also apply for the Test **under RA (Result Awaited) category**, if he/she is appearing or has appeared in his/her **final year (Last Semester** where Semester system is there) of M.Sc. **OR** equivalent Degree Examination in subjects **during the ongoing academic Session.** Such candidates will have to submit the attestation format (given at the reverse of the application form) duly certified by the Head of the Deptt./Institute over his/her signature and rubber stamp (with address and name) from where the candidate is appearing or has appeared in the final year(Last Semester where Semester system is there) M.Sc. or equivalent degree examination. However, such candidates shall be admitted to the Test provisionally. They shall only be considered eligible for JRF-(NET)/LS-(NET), if they are able to produce the proof of having passed the Master's Degree examination in the relevant or related subject with the requisite percentage of marks and within the stipulated time frame.

AGE LIMIT & RELAXATION For JRF (NET): Minimum *19 Years and maximum 28 years* (upper age limit may be relaxed up to 5 years as in case of candidates belonging to SC/ST/OBC(Non Creamy Layer), Physically handicapped/Visually handicapped and female applicants).

For LS (NET): Minimum 19 years, *No upper age limit.*

SCHEME OF EXAMINATION

- There will be **single paper MCQ test paper**. The MCQ test paper shall carry a **maximum of 200 marks.**
- **Duration:** The exam shall be for duration of **three hours**.
- The question paper shall be divided in three parts

Part 'A'
This part shall carry **20 questions pertaining to General Science, Quantitative Reasoning & Analysis and Research Aptitude.** The candidates shall be required to **answer any 15 questions**. Each question shall be **of two marks**. The **total marks allocated to this section shall be 30 out of 200.**

Part 'B'
This part shall contain 50 Multiple Choice Questions(MCQs) generally covering the topics given in the syllabus. A candidate shall be

required to **answer any 35 questions**. Each question shall be **of two marks**. The **total marks allocated to this section shall be 70 out of 200.**

Part 'C'

This part shall contain 75 questions that are designed to test a 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 the scientific knowledge to arrive at the solution to the given scientific problem. A candidate shall be required to **answer any 25 questions**. Each question shall be **of four marks.The total marks allocated to this section shall be 100 out of 200.**

PART	Questions		Marks	
	Total	To be attempted	Per Question	Total
A	20	15	2	30
B	50	35	2	70
C	75	25	4	100
Total	-	**75**	-	**200**

- **A negative marking for wrong answers, wherever required, shall be @ 25%**
- **To** enable the candidates to go through the questions, the question paper booklet shall be distributed 15 minutes before the scheduled time of the exam. The Answer sheet shall be distributed at the scheduled time of the exam.
- On completion of the exam i.e. at the scheduled closing time of the exam, the candidates shall be allowed to carry the Question Paper Booklet. No candidate is allowed to carry the Question Paper Booklet in case he/she chooses to leave the test before the scheduled closing time.

1. Life Sciences

Syllabus:-

TOPICS

1. Molecules and their interaction relavent to biology
2. Cellular organization
3. Fundamental processes
4. Cell communication and cell signalling
5. Developmental biology
6. System physiology - plant
7. System physiology - animal
8. Inheritance biology
9. Diversity of life forms
10. Ecological principles
11. Evolution and behaviour
12. Applied biology:
13. Methods in biology

1. 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, tertiary and quaternary structure; domains; motif and folds).
H. Conformation of nucleic acids (A-, B-, Z-,DNA), t-RNA, micro-RNA).
I. Stability of protein and nucleic acid structures.
J. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

2. CELLULAR ORGANIZATION

A. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion 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, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
D. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.
E. **Microbial Physiology:** Growth, yield and characteristics, strategies of cell division, stress response.

3. 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.
B. **RNA synthesis and processing:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, 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, aminoacyltRNAsynthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.
D. **Control of gene expression at transcription and translation level:** Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

4. CELL COMMUNICATION AND CELL SIGNALING

A. **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.
B. **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 signaling systems, bacterial chemotaxis and quorum sensing.
C. **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.
D. **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.
E. **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.

5. 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 *Caenorhabditiselegans;* 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.**

6. SYSTEM PHYSIOLOGY - PLANT

A. **Photosynthesis:** Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2fixation-C_3, $C_4$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; mechanisms of resistance to biotic stress and tolerance to abiotic stress

7. SYSTEM PHYSIOLOGY - ANIMAL

A. **Blood and circulation:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
B. **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.
C. **Respiratory system:** Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
D. **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.
E. **Sense organs:** Vision, hearing and tactile response.
F. **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.
G. **Thermoregulation:** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
H. **Stress and adaptation**
I. **Digestive system:** Digestion, absorption, energy balance, BMR.
J. **Endocrinology and reproduction:** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.

8. INHERITANCE BIOLOGY

A. **Mendelian principles:** Dominance, segregation, independent assortment, deviation from Mendelian inheritance.
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, site-specific recombination.

9. DIVERSITY OF LIFE FORMS

A. **Principles and methods of taxonomy:**Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of plants, animals and microorganisms.
B. **Levels of structural organization:** Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.
C. **Outline classification of plants, animals and microorganisms:**Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.
D. **Natural history of Indian subcontinent:** Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.
E. **Organisms of health and agricultural importance:** Common parasites and pathogens of humans, domestic animals and crops.

10. ECOLOGICAL PRINCIPLES

A. **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions.
B. **Habitat and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
C. **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.
D. **Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
E. **Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
F. **Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax.
G. **Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
H. **Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
I. **Applied ecology:** Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

J. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

11. EVOLUTION AND BEHAVIOUR

A. Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.

B. Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

C. Paleontology and evolutionary history: The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo.

D. 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.

E. 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 and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

F. Brain, Behavior and 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:

A. Microbial fermentation and production of small and macro molecules.
B. Application of immunological principles (vaccines, diagnostics). tissue and cell culture methods for plants and animals.
C. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
D. Genomics and its application to health and agriculture, including gene therapy.
E. Bioresource and uses of biodiversity.
F. Breeding in plants and animals, including marker – assisted selection.
G. Bioremediation and phytoremediation.
H. 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 analysis, 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, floweytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

C. Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

D. Statistical 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; X^2 test;; basic introduction to Muetrovariate statistics, etc.

E. Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; 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.

I. Computational methods: Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation

2. 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, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.

INTERDISCIPLINARY TOPICS

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

3. UGC NET Environmental Science

EXAMINATION PATTERN

The UGC-NET will be conducted in objective mode. The Test will consist of three papers. All the three papers will consist of only objective type questions and will be held on the day of Examination in two separate sessions as under:

Session	Paper	Number of Questions	Marks	Duration
First	I	60 out of which 50 questions are to be attempted	50x2 = 100	1¼ Hours (09.30 a.m. to 10.45 a.m.)
First	II	50 questions all of which are compulsory	50x2 = 100	1¼ Hours (10.45 a.m. to 12.00 Noon.)
Second	III	75 questions all of which are compulsory	75x2 = 150	2½ Hours (01.30 p.m. to 04.00 p.m.)

The candidates are required to obtain minimum marks separately in Paper-I, Paper-II and Paper-III as given below:

Category	Minimum marks (%) to be obtained		
	Paper-I	Paper-II	Paper-III
General	40 (40%)	40 (40%)	75 (50%)
OBC (Non-creamy layer)	35 (35%)	35 (35%)	67.5 (45%) rounded off to 68
PH/VH/SC/ST	35 (35%)	35 (35%)	60 (40%)

- Only such candidates who obtain the minimum required marks in each Paper, separately, as mentioned above, will be considered for final preparation of result.
- Amongst those candidates who have obtained the minimum required marks in each Paper, separatelyI, a merit list will be prepared subject-wise and category-wise using the aggregate marks of all the three papers secured by such candidates.
- Top 15% candidates (for each subject and category), from the merit list prepared above, will be declared NET qualified for eligibility for Assistant Professor only.
- A separate merit list for the award of JRF will be prepared from amongst the NET qualified candidates figuring in the merit list prepared under step III.
- It may be noted that the above qualifying criteria decided by UGC is final and binding.
- However, the final qualifying criteria for Junior Research Fellowship (JRF) and eligibility for Lectureship shall be decided by UGC before declaration of result.
- There will be no negative marking.
- In case of any discrepancy found in the English and Hindi versions, the questions in English version shall be taken as final.

SYLLABUS FOR PAPER II AND PAPER III

UNIT I - FUNDAMENTALS OF ENVIRONMENTAL SCIENCE

Definition, principles and scope of environmental science.Earth, Man and environment. Ecosystems- Pathways in ecosystems. Physico-chemical and biological factors in the environment.Geographical classification and Zones.Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Mass and energy transfer across the various interfaces, material balance. First and second law of thermodynamics, heat transfer processes. Scale of meteorology, pressure, temperature, precipitation, humidity, radiation and wind. Atmospheric stability, inversions and mixing heights, windroses.Natural resources, conservation and sustainable development.

UNIT II - ENVIRONMENTAL CHEMISTRY

Fundamentals of environmental chemistry: Stoichiometry, Gibb's energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

Chemical composition of air: Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere.Oxygen and ozone chemistry.Chemistry of air pollutants.Photochemical smog.

Water chemistry: Chemistry of water, Concepts of DO, BOD, COD, Sedimentation, Coagulation filtration, Redox potential.

Soil chemistry: Inorganic and organic components of soil. Nitrogen pathways and NPK in soils

Toxic chemicals in the environment – Air, Water: Pesticides in water, Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Ozone and PAN pesticides, Insecticides.MIC, Carcinogens in the air.

Principles of analytical methods: Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas chromatography, Atomic absorption spectrophotometry, GLC, HPLC, Electrophoresis, X-ray difiraction, Flame photometry.

UNITIII - ENVIRONMENTAL BIOLOGY

Definition, Principles and scope of ecology. Human ecology and human settlement.Evolution, origin of life and speciation.Ecosystems: Structure and functions. Abiotic and biotic components, Energy flows. Food chains, food webs. Ecological pyramids, types and diversity.Ecological succession. Population, Community ecology and Parasitism, Prey predator relationships.

Common flora and fauna in India-

(i) **Aquatic :** phytoplankton, zooplankton and Macrophytes
(ii) **Terrestrial:** forests

Endangered and threatened species.

Biodiversity and its conservation: Definition "Hotspots" of biodiversity, Strategies of biodiversity conservation, National Parks and Sanctuaries. Gene pool.

Microflora of atmosphere: air sampling techniques, identification of aeroallergens. Air borne diseases and allergies.

Environmental biotechnology: Fermentation technology, Vermiculture technology, Biofertilizer technology.

UNIT IV - ENVIRONMENTAL GEOSCIENCES

Environmental Geosciences: Fundamental concepts.

The Earth Systems And Biosphere: Conservation of matter in various geospheres-lithosphere, hydrosphere, atmosphere and biosphere.Energy budget of the earth.Earth's thermal environment and seasons. Ecosystems flow of energy and mater. Coexistence in communities –food webs, Earth's major ecosystems-terrestrial and aquatic.General relationships between landscape, biomes and climate. Climates of India, Indian monsoon, El Nino, droughts, Tropical cyclones and Western Disturbances.

Earth's Processes And Geological Hazards: Earth's processes; concept of residence, time and rates of natural cycles. Catastrophic geological hazards.The study of floods, landslides, earthquakes, volcanism and avalanche.Prediction and perception of the hazards and adjustments to the hazardous activities.

Mineral Resources And Environment: Resources and Reserves. Minerals and Population.Oceans as new areas for exploration of mineral resources.Ocean ore and recycling of resources.Environmental impact of exploitation, processing and smelting of minerals.

Water Resources And Environment: Global Water Balance, Ice sheets and fluctuations of sea level. Origin and composition of sea water.Hydrological cycle.Factors influencing the surface water.Types of water, Resources of ocean.Ocean pollution by toxic wastes.Human use of surface and ground waters.Ground water pollution.

Landuse planning: The land use plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation.

Environmental Geochemistry : Concept of major , trace and REE. Classification of trace elements.Mobility of trace elements.Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health.Possible effects of imbalance of some trace elements. Diseases induced by human use of land.

Principles of Remote sensing and its application in Environmental Sciences. Application of GIS in Environmental management.

UNIT V – CONVENTIONAL AND NON-CONVENTIONAL ENERGY SOURCES

Sun as source of energy; Solar radiation and it's spectral characteristics. Fossil fuels – classification composition, Physico-chemical characteristics and energy content of coal, petroleum and natural gas; Principles of generation of hydroelectric power, tidal, Ocean Thermal Energy Conversion, wind , geothermal energy; solar collectors photovoltaics, solar ponds; nuclear energy-fission and fusion; magnetohydrodynamic power, bio energy-Energy from biomass and biogas, anaerobic digestion; energy use pattern in different parts of the world.

Environmental implication of energy use: CO_2 emissions, global warming; air and thermal pollution; radioactive waste and radioactivity from nuclear reactors; impacts of large scale exploitation of Solar,Wind, Hydro and Ocean energy.

UNIT VI - ENVIRONMENTAL POLLUTION AND CONTROL

(i) Air: Natural and anthropogenic sources of pollination. Primary and secondary pollutants.Transport and diffusion of pollutants.Gas laws governing the behaviour of pollutants in the atmosphere.Methods of monitoring and control of air pollution SO_2 NO_X CO SPM. Effects of pollutants on human beings, plants , animals, materials and on climate. Acid rain,.Air quality standards.

(ii)Water: Types sources and consequences of water pollution. Physico-chemical and bacteriological sampling and analysis of water quality.Standards, sewage and wastewater treatment and recycling.Water quality standard.

(iii)Soil: Physico-chemical and bacteriological sampling for analysis of soil quality. Soil pollution control.Industrial waste effluents and heavy metals, their interactions with soil components.Soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil. The different kinds of synthetic fertilizers (N,P&K) and their interactions with different components of soil.

(iv)Noise: Sources of noise pollution, measurement of noise and the indices, effect of meteorological parameters on noise propagation. Noise exposure levels and standards.Noise control and abatement measures.Impact of noise on human health.

(v)Marine: Sources of marine pollution and control. Criteria employed for disposal of pollutants in the marine system-coastal management.

(vi)Radioactive and thermal pollution.

UNIT VII - ENVIRONMENTAL IMPACT ASSESSMENT, ECO PLANNING AND SUSTAINABLE DEVELOPMENT

Introduction to environmental impact analysis. Environmental impact statement and Environmental management plan. EIA guidelines 1994, notification of Government of India.Impact Assessment Methodologies.Generalised approach to impact analysis.Procedure for reviewing environmental impact analysis and statement.Guidelines for environmental audit.Introduction to environmental planning.Baseline information and predictions. (land, water, atmosphere, energy etc.)

Restoration and rehabilitation technologies. Land use policy for India. Urban planning for India. Rural planning and land use pattern Concept and strategies of sustainable development.

Cost benefit analysis.

Environmental priorities in India and sustainable development.

UNIT VIII

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes) Recycling of waste material. Waste minimization technologies.

Hazardous Wastes Management and Handling Rules, 1989.Resource Management, Disaster Management and Risk analysis.

Environment Protection-issues and problems, International and National efforts for Environment Protection, Provision of Constitution of India regarding Environment (Article 48A and 58A).

Environmental Policy Resolution, Legislation, Public Policy Strategies in Pollution Control, Wildlife Protection Act, 1972 amended 1991, Forest Conversion Act 1980, Indian Forests Act (Revised) 1982), Air (Prevention and Control of Pollution) Act, 1981 as amended by Amendment Act, 1987 and rule 1982. Motor Vechicle Act, 1988, The Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975. The Environment (Protection) Act, 1986 and Rules 1986.

Scheme of labelling of environmentally friendly products (Ecomark).Public Liability Insurance Act, 1991 and Rules 1991.

UNIT IX

Basic elements and tools of statistical analysis; Probability, sampling, measurement and distribution of attributes; Distribution- Normal, t and x, poisson and Binomial; Arithmetic, Geometric and Harmonic means; moments; matrices, simultaneous linear equations; tests of hypothesis and significance.

Introduction to environmental system analysis; approaches to development of models; linear simple and multiple regression models, validation and forecasting. Modles of Population growth and interactions –lotka-Voltera model, Leslie's matrix model, point source stream pollution model, box model, Gaussian plume model.

UNIT X

Environmental education and awareness.Environmental Ethics and Global imperatives

Global Environmental problems – ozone depletion, global warming and climatic change.

Current Environmental issues in India Context: Narmada dam, Almetti dam, Soil Erosion, formation and reclamation of user,Alkaline and saline soil

Waste lands and their reclamation

Desertification and its control.Vehicular pollution and urban air quality.Depletion of natural resources.Biodiversity conservation and Agenda-21. Waste disposal, recycling and power generation. Flyash utilization

Water crises - Conservation of water Environmental hazards. Eutrophication and restoration of Indian lakes Rain water harvesting Wetlands conservation

Epidemiological issues (eg. Goitre, Fluorosis, Arsenic)