SCHOOL OF NANO SCIENCES

Phd in Nanoscience Entrance Examination Syllabus for 2023-2024

UNIT I

BIOLOGY

Cell organelles and their functions, plant and animal hormones and their actions. Basic human anatomy and physiology. Mendelian genetics and heredity, populations and communities; evolution. Plant anatomy and physiology.

Basic structure and function of biomolecules. Metabolism of amino carbohydrates, proteins, lipids, and nucleic acids. Enzyme classification, kinetics and mechanism, Enzyme activators and inhibitors.

Ecosystem, natural cycles, composition and structure of atmosphere. Hydrosphere, lithosphere and terrestrial environment. Environment pollution and green house effects.

Basic principle of immunology, antigen-antibody interactions, types of immunity, immunological disorders, hypersensitivity reactions, monoclonal antibodies, and immunization. Immunity disorders and treatments.

Classification of microorganisms, microbial growth and nutrition, microbial genetics, microbial diseases and treatments. Laboratory techniques in microbiology e.g Grams staining, Antimicrobial assay etc.

General concept based on molecular biology and techniques Involved like PCR, Types of PCR, Cloning, Vectors, Types of vectors-Expression and Cloning vectors, Blot techniques like Southern, Northern etc. DNA Fingerprinting, DNA Sequencing methods etc.

General concepts related to Translation, Transcription, Restriction enzymes and their types, DNA ligation-Blunt and sticky, DNA transformation-Gene gun, Electroporation etc. Transduction and Conjugation etc.

CHEMISTRY

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory), Concepts of acids and bases, Hard-Soft acid base concept. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms. Chemistry in nanoscience and technology. Catalysis and green chemistry, Characterization of inorganic compounds by IR, Raman, NMR, EPR, UV-vis, MS, electron spectroscopy and microscopic techniques.

Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes, Nernst equation, redox systems, electrochemical cells, 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, Crystal structures; Bragg’s law and applications; band structure of solids.

PHYSICS

Gauss’s law. Laplace and Poisson equations,. Ampere's law. Electromagnetic induction. Maxwell's equations. Scalar and vector potentials. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction of electromagnetic waves. Wavefunctions

and operators. Heisenberg uncertainty principle. Schrodinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, hydrogen atom). Orbital and spin angular momenta. Addition of angular momenta.

Bravais lattices, packing fraction, Millar indices, Reciprocal lattice, types of defect in solids, Defect in solids using X-ray diffraction, calculation of band gap energy, effective mass. Different types of polarizations, Dielectric constant, relaxation time, Dielectric loss.. Hall effect and thermoelectric power. Band theory of solids: metals, insulators, and semiconductors. Magnetism: types of magnetic ordering and Curie-Weiss law. Semiconductor devices (photovoltaics, Super Capacitors, light emitting diodes, junctions, transistors, and field effect devices), device characteristics.

Basics and types of nano-structures and applications, Classification of Nanostructured materials, 0D, 1D, 2D structures – confinement effect and size effects, Surface Energy and Surface area, Optical, Magnetic and Mechanical properties of nanomaterials.

Quantum states of an electron, Quantum numbers, spectroscopic terms and selection rules, Pauli's Exclusion principle, Electron spin, Vector atom model, Spin-orbit coupling (LS and JJ coupling), fine structure, Hund's rule etc. Features of one electron and two electron spectra, hyperfine structure, Lande splitting factor (g), Zeeman effect (Normal and Anomalous). Rotational spectra of diatomic molecule as a rigid and non rigid rotator. Vibrational spectra of a diatomic molecule as a harmonic and anharmonic oscillator. The Franck Condon principle. Dissociation energy. Rotational and Vibrational-Rotation Raman Spectroscopy.

UNIT II

Research methodology and aptitude