बिहार राज्य प्रदूषण नियंत्रण पर्षद्–वैज्ञानिक संवर्ग (नियुक्ति एवं सेवा) विनियमावली, 2023 के अन्तर्गत सहायक पर्यावरण वैज्ञानिक के पद पर नियोजन हेतु लिखित परीक्षा का पाठ्यक्रम (सिलेबस) निर्धारण हेतु आहूत बैठक का वृत्त।

बैठक की तिथि एवं समयः 11.10.2023 को अपराह्न 4:00 बजे।
बैठक स्थलः पर्षद् का संवाद कक्ष।

बैठक में पाठ्यक्रम (सिलेबस) कमिटि के निम्नलिखित सदस्यों द्वारा भाग लिया गयाः–

1) प्रो0 प्रधान पार्थ सारथी, डीन, स्कूल ऑफ अर्थ, बायोलॉजिकल एण्ड इन्वायरमेंटल साइंस, दक्षिण बिहार केन्द्रीय विश्वविद्यालय, गया;
2) डा0 गौतम कुमार, लाईफ साईंस विभाग, दक्षिण बिहार केन्द्रीय विश्वविद्यालय, गया;
3) डा0 अनिल कुमार सिंह, एसोसिएट प्रोफेसर, रसायन विज्ञान विभाग, ए0 एन0 कॉलेज, पटना;
4) डा0 सुभाष प्रसाद सिंह, एसोसिएट प्रोफेसर, रसायन विज्ञान विभाग, ए0 एन0 कॉलेज, पटना;
5) प्रो0 मनोरमा कुमारी, वनस्पति विज्ञान विभाग (इन्वायरमेंटल साइंस), ए0 एन0 कॉलेज, पटना;
6) डा0 अशोक कुमार सिन्हा, एसोसिएट प्रोफेसर, भौतिक विज्ञान विभाग, ए0 एन0 कॉलेज, पटना;
7) डा0 ज्योतिष कुमार, असिस्टेंट प्रोफेसर, भौतिक विज्ञान विभाग, ए0 एन0 कॉलेज, पटना;
8) डा0 आशीष कुमार, असिस्टेंट प्रोफेसर, रसायन विज्ञान विभाग, पटना वीमेंस कॉलेज, पटना;
9) डा0 सुमित रंजन, असिस्टेंट प्रोफेसर, जन्तु विज्ञान विभाग, पटना वीमेंस कॉलेज, पटना;
10) डा0 कविता वर्मा, असिस्टेंट प्रोफेसर, भौतिक विज्ञान विभाग, पटना वीमेंस कॉलेज, पटना; एवं
11) श्री एस0 चन्द्रशेखर, सदस्य सचिव, बिहार राज्य प्रदूषण नियंत्रण पर्षद्, पटना।

बैठक में उपस्थित सभी माननीय सदस्यों को पर्षद् के सदस्य सचिव द्वारा स्वागत् किया गया तथा बिहार राज्य प्रदूषण नियंत्रण पर्षद्–वैज्ञानिक संवर्ग (नियुक्ति एवं सेवा) विनियमावली, 2023 के विभिन्न प्रावधानों के प्रसंग में सभी सदस्यों को अवगत कराया गया। सहायक पर्यावरण वैज्ञानिक पद के उम्मीदवार के पास शैक्षणिक योग्यता–रसायन शास्त्र/जीव–विज्ञान/पर्यावरण विज्ञान/भौतिकी में स्नात्तकोत्तर या समकक्ष डिग्री एवं पर्षद् द्वारा पद के लिए समय–समय पर निर्धारित कोई अन्य योग्यता एवं अनुभव अवश्य होना चाहिए। (A candidate must hold a Post Graduate or equivalent in Chemistry/ Life Science/Environmental Science/ Physics and possess any other qualification and experience as notified by the Board for the post from time to time)।

सहायक पर्यावरण वैज्ञानिक के पद पर नियोजन हेतु लिखित प्रतियोगिता परीक्षा आयोजन के लिए पाठ्यक्रम (सिलेबस) इत्यादि निर्धारण हेतु उपस्थित सदस्यों से विस्तृत विमर्श हुआ एवं उनसे सुझाव आमंत्रित किया गया।

पाठ्यक्रम (सिलेबस) कमिटि के सदस्यों द्वारा सहायक पर्यावरण वैज्ञानिक की नियुक्ति हेतु लिखित प्रतियोगिता परीक्षा के पाठ्यक्रम को निम्नवत् अनुमोदन हेतु सहमति दी गयी:–

1. लिखित प्रतियोगिता परीक्षा का कुल पूर्णांक–400 अंकों की निम्नरूपेण दो पत्रों के होंगे:–

Subject		Duration	No. of objective & Multiple Choice Question	Marks	Negative Marking
Paper-I	**Part-I (50 marks)** • Current events of national and international importance. • History of India and Indian National Movement. • Bihar, Indian and World Geography-Physical, Social, Economic, Geography of India and the World. • Indian Polity and Governance-Constitution, Political System, Panchayati Raj, Public Policy, Rights Issues, etc. • Economic and Social Development-Sustainable Development, Poverty, Inclusion, Demographics, Social Sector Initiatives, etc. • General issues on Environmental ecology, Bio-diversity and Climate Change-that do not require subject specialization. • General Science. **Part-II (50 marks)** • Comprehension; • Interpersonal skills including communication skills; • Logical reasoning and analytical ability; • Decision making and problem solving; • General mental ability; • Basic numeracy (numbers and their relations, orders	2 hrs	100	100	i. There are four alternative answers for the answers to every question. For each question for which a wrong answer has been given by the candidate, one-third (0.33) of the marks assigned to that question will be deducted as penalty. ii. If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happen to be correct and there will be same penalty as above for that question. iii. If a question is left blank i.e. no answer is given by the candidate, there will be no penalty for that question.

	of magnitude, etc) (Class X level), Data interpretation (charts, graphs, tables, data sufficiency etc-Class X level). **Knowledge of Computer Operation:-** Introduction of Computer, Operating System, Computer Network, Computer Devices, Windows, Microsoft Office, MS Word, MS Excel, MS Power Point, Applications of Internet like: e-mail and browsing, Various browsers, Hyperlinks etc. **Note:-**Candidates should be able to answer without special study.				
Paper-II	**Candidates may choose any one of the optional subjects from amongst the following subjects given below:-** 1) Physics-**Annexure-I** 2) Chemistry-**Annexure-II** 3) Environmental Science-**Annexure -III** 4) Life Science-**Annexure -IV**	2 hrs	100	300	i. There are four alternative answers for the answers to every question. For each question for which a wrong answer has been given by the candidate, one-third (0.33) of the marks assigned to that question will be deducted as penalty. ii. If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happen to be correct and there will be same penalty as above for that question. iii. If a question is left blank i.e. no answer is given by the candidate, there will be no penalty for that question.

2. मौखिक जाँच:–लिखित परीक्षा में प्राप्त अंकों के आधार पर चयनित अभ्यर्थियों को मौखिक जाँच हेतु आमंत्रित किया जायेगा। मौखिक जाँच के लिए 50 अंक निर्धारित होंगे।

श्री एस0 चन्द्रशेखर, बिहार राज्य प्रदूषण नियंत्रण पर्षद, पटना द्वारा सभी सदस्यों को धन्यवाद ज्ञापण के बाद बैठक समाप्त की गयी।

अनुलग्नक:– पाठ्यक्रम (सिलेबस)–I, II, III एवं IV.

17/10/23
(प्रवीण कुमार वर्मा)
बायोलॉजिकल एण्ड इन्वायरमेंटल साइंस
दक्षिण बिहार केन्द्रीय विश्वविद्यालय
गया

17.10.2023
(मनोरम कुमारी)
लाईफ साईंस विभाग
दक्षिण बिहार केन्द्रीय
विश्वविद्यालय
गया

17.10.23
(अनिल कमार सिंह)
एसोसिएट प्रोफेसर
रसायन विज्ञान विभाग
ए0 एन0 कॉलेज
पटना

17.10.2023
(सुभाष प्रसाद सिंह)
एसोसिएट प्रोफेसर
रसायन विज्ञान विभाग
ए0 एन0 कॉलेज
पटना

17/10/2023
(मनोरमा कुमारी)
वनस्पति विज्ञान विभाग
ए0 एन0 कॉलेज
पटना

17.10.23
(अशोक कुमार सिन्हा)
एसोसिएट प्रोफेसर
भौतिक विज्ञान विभाग
ए0 एन0 कॉलेज
पटना

17/10/23
(ज्योतिष कुमार)
असिस्टेंट प्रोफेसर
भौतिक विज्ञान विभाग
ए0 एन0 कॉलेज
पटना

17/10/23
(आशीष कुमार)
असिस्टेंट प्रोफेसर
रसायन विज्ञान विभाग
पटना वीमेंस कॉलेज,
पटना

17/10/23
(सुमित रंजन)
असिस्टेंट प्रोफेसर
जन्तु विज्ञान विभाग
पटना वीमेंस कॉलेज
पटना

17/10/23
(कविता वर्मा)
असिस्टेंट प्रोफेसर
भौतिक विज्ञान विभाग
पटना वीमेंस कॉलेज
पटना

16/10/23
(एस0 चन्द्रशेखर)
सदस्य सचिव
बिहार राज्य प्रदूषण नियंत्रण पर्षद
पटना।

बिहार राज्य प्रदूषण नियंत्रण पर्षद, परिवेश भवन, पाटलीपुत्रा औद्योगिक क्षेत्र, पटना

ज्ञापांक: 2625 पटना, दिनांक: 03-11-23

प्रतिलिपि: सिलेबस कमिटि के सभी संबंधित सदस्यों को सूचनार्थ प्रेषित।

02/11/23
(एस0 चन्द्रशेखर)
सदस्य सचिव

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ANNEXURE-I

Syllabus for written examination for the post of 'Assistant Environmental Scientist' in Bihar State Pollution Control Board

Physics

Part-I (Core)

I. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residuesand 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'sequations 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). 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-II (Advance)

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).

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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). 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.

Jyot 17/10/23
(Jyotish Kumar)
Assistant Professor
Deptt. of Physics
A.N. College
Patna

17.10.23
(Ashok Kumar Sinha)
Associate Professor
Deptt. of Physics
A.N. College
Patna

Kavita Verma 17/10/23
(Kavita Verma)
Assistant Professor
Deptt. of Physics
Patna Women's College
Patna

16/10/23
(S. Chandrasekar)
Member Secretary
Bihar State Pollution Control Board
Patna

ANNEXURE-II

Syllabus for written examination for the post of 'Assistant Environmental Scientist' in Bihar State Pollution Control Board

Chemistry

Inorganic Chemistry

1. Periodicity of properties of elements.
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. s- & p- 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 ofsolids.

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 andreactions.

4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

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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.

16/10/23
(S. Chandrasekar)
Member Secretary
Bihar State Pollution Control Board
Patna

17/10/23
(Ashish Kumar)
Assistant Professor
Deptt. of Chemistry
Patna Women's College
Patna

17/10/2023
(Subhash Prasad Singh)
Associate Professor
Deptt. of Chemistry
A.N. College
Patna

ANNEXURE-III

Syllabus for written examination for the post of 'Assistant Environmental Scientist' in Bihar State Pollution Control Board

Environmental Science

Fundamentals of Environmental Sciences:-

Definition, Principles and Scope of Environmental Science.

Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.

Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance.

Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses.

Interaction between Earth, Man and Environment. Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable development.

Natural resources and their assessment (Application of remote sensing and GIS in land cover/land use planning and management, waste management); Satellite (Polar and Geo-stationery).

Environmental education and awareness. Environmental ethics.

Environmental Chemistry:-

Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.

Composition of air. Particles, ions and radicals in the atmosphere. Chemical

speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, .Oxygen and Ozone chemistry. Photochemical smog. Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).

Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.

Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O_3, PAN, VOC and POP. Carcinogens in the air.

Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.

Ecology:-

Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement.

Ecosystem Structure and functions: Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession. Species diversity, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability and factors affecting stability. Ecosystem services.

Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.

Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest.

Population ecology: Characteristics of population, concept of carrying

capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species.

Community ecology: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions.

Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: *in situ*, *ex situ* and *in vitro* conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, biopiracy and bio-prospecting. Concept of restoration ecology. Extinct, Rare, Endangered and Threatened flora and fauna of India.

Concept of Industrial Ecology.

Toxicology and Microbiology: Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, biotransformation. Major water borne diseases and air borne microbes.

Environmental Biotechnology: Bioremediation – definition, types and role of plants and microbes for *in situ* and *ex situ* remediation. Bioindicators, Biofertilizers, Biofuels and Biosensors, C3 and C4 plants.

Environmental Geosciences:-

Origin of earth. Interior of the earth, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Igneous, sedimentary and metamorphic rocks. Energy budget of the earth. Seasons, Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind. Climates of India, western disturbances, Indian monsoon, droughts, *El Nino*, *La Nina*. Geophysical fields.

Weathering erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation,Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements. Paleoclimate.

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India. Hydrological cycle, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Natural resource exploration and exploitation and related environmental concerns. Renewable and non-renewable resources.

Bihar State specific natural hazards: Droughts, floods, cyclone, earthquakes. Prediction of hazards, mapping and mitigation of their impacts.

Energy and Environment:-

Sun as source of energy; solar radiation and its spectral characteristics. Fossil fuels: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value.

Principles of generation of hydro-power, wind power, geothermal energy, solar energy (solar collectors, photo-voltaic modules, solar ponds).

Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types.

Bioenergy: methods to produce energy from biomass.

Environmental implications of energy use; energy use pattern in India and the world, emissions of CO_2 in developed and developing countries including India, radiative forcing and global warming. Impacts of large scale exploitation of solar, wind, hydro and nuclear energy sources.

Environmental Pollution and Control:-

Air Pollution:

Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

Noise Pollution:

Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, L_{DN}, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

Water Pollution:

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.

Soil Pollution:

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

Air Pollution Meteorology, Heat Island.

Solid and Hazardous Waste Management:-

Solid Waste - types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes.

Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation.

Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

e-waste: classification, methods of handling and disposal.
Fly ash: sources, composition and utilisation.
Plastic waste: sources, consequences and management.

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Environmental Assessment, Management and Legislation:-

Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines. Impact Assessment Methodologies. Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost- benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series). EIA Notification, 2006 and amendments from time to time. Eco-labeling schemes.

Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1983, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988, The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2022, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Battery Waste Management Rules, 2022 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, The Bihar (Procedure for Immersion of Idol after Puja) Rules, 2021, National Green Tribunal: Constitution and Powers & functions, The Biological Diversity Act, 2002, amended from time to time.

National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

Statistical Methods and Computer Application:-

Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Sampling theory, Distributions - Normal, log-normal, Binomial, Poisson, t, x^2 and F-distribution. Correlation, Regression, tests of hypothesis (t-test, x^2-test ANOVA: one-way and two-way); significance and confidence limits.

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model.

Computer application: R Softwater, Metlab.

Contemporary Environmental Issues:-

Global Environmental Issues–Biodiversity loss, Climate change, Ozone layer depletion. International efforts for environmental protection.

National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change), Bihar State Action Plan on Climate Change and its missions.

Current Environmental Issues in India: Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.

Water conservation-development of watersheds, Rain water harvesting and ground water recharge.

National river conservation plan – Namami Gange and Yamuna Action Plan.

Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India.

Soil erosion, reclamation of degraded land, desertification and its control.

Climate change-adaptability, energy security, food security and sustainability.

Forest Conservation– Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register.

Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Carbon sequestration and carbon credits.

Waste Management – Swachha Bharat Abhiyan.

Sustainable Habitat: Green Building, GRIHA Rating Norms. Vehicular emission norms in India.
Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue, JE, AES.

Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

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ANNEXURE-IV

Syllabus for written examination for the post of 'Assistant Environmental Scientist' in Bihar State Pollution Control Board

Life Science

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, E.T.S., chemo-osmotic theory.

F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes

G. Conformation of proteins (Ramachandran plot, secondary structure, domains, motifand folds).

H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

I. Stability of proteins and nucleic acids.

J. Metabolism (Catabolism & Anabolism) 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, membrane pumps, mechanism of sorting and regulationof 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)

3. FUNDAMENTAL PROCESSES

A) **DNA replication, repair and recombination** (Unit of replication, enzymes involved, replication origin and replication fork, DNA damage and repair mechanisms.

B) **RNA synthesis and processing** (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation,and termination), 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 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).

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 systems, light signaling in plants, 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 duringbacterial (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 andformation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

C) **Morphogenesis and organogenesis in animals :** axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, 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; phyllotaxy; transition to flowering and floral development in *Arabidopsis* and *Antirrhinum*.

6. SYSTEM PHYSIOLOGY - PLANT

A. **Photosynthesis** - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways, photorespiration.

B. **Respiration and photorespiration** –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, Auxine, cytokine, ABA, Ethylene.

E. **Sensory photobiology** - Structure, function and mechanisms of action of phytochromes, 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.

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, gametogenesis, ovulation, neuroendocrine regulation.

8. 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, 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.

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.

9. DIVERSITY OF LIFE FORMS:

A. **Principles & methods of taxonomy:**

Concepts of species and hierarchical taxa, biological nomenclature, classical & 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& systems. Comparative anatomy, adaptive radiation, adaptive modifications.

C. **Outline classification of plants, animals & 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. Comman Indian mammals, birds. Seasonality and phenology of the subcontinent.

E. **Organisms of health & agricultural importance:**
Common parasites and pathogens of humans, domestic animals and crops.

F. **Organisms of conservation concern:**
Rare, endangered species. Conservation strategies.

10. 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).

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; Experiement of Miller (1953).

Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic 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 multi cellular 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.

E. The Mechanisms:

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Sexual selection; Co-evolution.

F. Brain, Behavior and Evolution:

Approaches and methods in study of behavior; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality;

Mating systems, 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. Tissueand cell culture methods for plants and animals.

C. Transgenic animals and plants, molecular approaches to diagnosis andstrain identification.

D. Genomics and its application to health and agriculture, including genetherapy.

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.
Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.
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 moleculesRFLP, 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 FISHand GISH.

C **Biophysical Method:**
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; X^2 test;; Basic introduction to Muetrovariate statistics, etc.

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 **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.

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