**Syllabus for the Technical Assistant Posts at ICMR NITM Belagavi.**

**Details of posts advertised are tabulated below**

| Sr. No. | Name of the post and discipline | No. of Post |
|---|---|---|
| 1 | Technical Assistant (Pharmacology & Toxicology) | 1Post (OBC) |
| 2 | Technical Assistant (Natural Product Chemistry) | 1 Post (UR) |
| 3 | Technical Assistant (Ethnomedicine / Medicinal Plants) | 1 Post (UR) |
| 4 | Technical Assistant (Computer Science - Maintenance of LAN & Network) | 1 Post (SC) |

The proposed category of syllabus is as below:

| Sl. No. | Subject | Marks |
|---|---|---|
| 01 | General Knowledge | 50 Marks |
| | Test of Reasoning | |
| | General Aptitude | |
| | Basic English | |
| | Basic Mathematics / Basic Computer | |
| 02 | ICMR Related | 10 Marks |
| 03 | Subject Syllabus | 40 Marks |
| | **Total** | **100 Marks** |

## I. Syllabus for Technical Assistant (Pharmacology & Toxicology)

1. Fundamentals of Human Anatomy, Physiology, Pathophysiology, Microbiology and Pharmacology
   - Structure and functions of the various systems of the human body and homeostatic mechanisms
   - Carbohydrate and lipid metabolism: Pathway, energetics and significance
   - Basic principles of Cell injury and Adaptation
   - Basic pharmacological principles: Pharmacokinetics (Absorption, Distribution, Metabolism, Excretion)
   - Pharmacodynamics/ Mechanisms of drug action: Receptors, enzymes, and signaling pathways
   - Dose-response relationships and therapeutic indices
   - pH, buffers and Isotonic solutions
   - Sterilization of glassware, preparation, and sterilization of media
   - Drug metabolism principles- Phase I and Phase II

2. Drug Discovery and Development Process
   - Experimental models (in vitro, ex-vivo and in vivo) for pharmacological & toxicity testing
   - Drug screening techniques for various therapeutic areas: Analgesics, anti-inflammation, CVS, CNS, etc.
   - Toxicological evaluations: Acute, subacute, and chronic toxicity studies. OECD guidelines
   - Drug discovery and development process

3. Traditional Herbal Medicines

- Indian Traditional Systems of Medicine: Ayurveda, Unani, Siddha, and Homeopathy
- Phytochemistry: Key active constituents of medicinal plants & their characterization techniques (chromatographic and spectroscopic)
- Challenges in standardization and quality control of herbal medicines
- Regulatory frameworks for traditional medicine (e.g., AYUSH, WHO guidelines)

4. Traditional knowledge and developing pharmaceutical/nutraceutical products
   - Bioprospecting: Exploration of plant biodiversity for pharmaceutical/nutraceutical use

5. Basic Research Methodology, Bioethics, and Good Laboratory Practices
   - Design, conduct, and reporting of preclinical studies. Standard guidelines.
   - Basics of biostatistics: Statistical tests, data interpretation, and reporting
   - Ethical considerations in preclinical research, alternate model organisms, and alternative to animal experiments. CCSEA guidelines
   - Knowledge of chemistry including the safe use and disposal of chemicals
   - Documentation and compliance with GLP (Good Laboratory Practices)

6. Intellectual Property and Regulatory Aspects
   - Intellectual Property Rights (IPR).
   - Regulatory requirements for Phase I clinical trial initiation
   - Drugs & Cosmetics (D&C) Act 1940 and Rules, 1945 with special reference to ASU and Phytopharmaceutical drugs, Schedule-Y

## II. Syllabus for Technical Assistant (Natural Product Chemistry)

- **Atomic structure and Chemical bonding**
- Postulates of quantum mechanics. Operators. Time dependent and time independent Schrödinger equations. Born interpretation. Dirac bra-ket notation. Particle in a box: infinite and finite square wells; concept of tunnelling; particle in 1D, 2D and 3D-box; applications. Harmonic oscillator: harmonic and anharmonic potentials; hermite polynomials. Rotational motion: Angular momentum operators, Rigid rotor. Hydrogen and hydrogen-like atoms: atomic orbitals; radial distribution function. Multi-electron atoms: orbital approximation; electron spin; Pauli exclusion principle; slater determinants. Approximation Methods: Variation method and secular determinants; first order perturbation techniques. Atomic units. Molecular structure and Chemical bonding: Born- Oppenheimer approximation; Valence bond theory and linear combination of atomic orbitals – molecular orbital (LCAO-MO) theory. Hybrid orbitals. Applications of LCAO-MO theory to $H_2^+$, $H_2$; orbital theory (MOT) of homo and heteronuclear diatomic molecules. Hückel approximation and its application to annular π – electron systems.
- **Main Group Elements**
- Hydrides, halides, oxides, oxoacids, nitrides, sulfides–shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon, phosphorous and sulphur. Industrial synthesis of compounds of main group elements. Chemistry of noble gases, pseudohalogens, and interhalogen compounds. Acid-base concepts and principles (Lewis, Brønsted, HSAB and acid-base catalysis).
- **Transition Elements**

- Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, CFSE, applications of CFT, Jahn- Teller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel and Tanabe-Sugano diagrams, nephelauxetic effect and Racah parameter, charge-transfer spectra. Magnetic properties of transition metal complexes. Ray-Dutt and Bailar twists, Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions. Metal-metal multiple bonds. Recovery. Periodic properties, spectra and magnetic properties of Lanthanides and Actinides.
- **Organometallics**
- 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal- carbene complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis – Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis – Fischer- Tropsch reaction, Ziegler-Natta polymerization.
- **Bioinorganic Chemistry**
- Ion (Na+ and K+) transport, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes containing magnesium, molybdenum, iron, cobalt, copper and zinc.
- **Solids**
- Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, $AX_2$, $ABX_3$ type compounds, spinels, band theory, metals and semiconductors.
- **Kinetics**
- Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Unimolecular reactions. Potential energy surfaces and classical trajectories, Concept of Saddle points, Transition state theory: Eyring equation, thermodynamic aspects. Kinetics of polymerization. Catalysis concepts and enzyme catalysis. Kinetic isotope effects. Fast reaction kinetics: relaxation and flow methods. Diffusion controlled reactions.
- **Thermodynamics and Equilibrium**
- Laws of thermodynamics. Standard states. Thermochemistry. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, Gibbs-Duhem equation, van't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Ideal and Non-ideal solutions, Raoult's Law and Henry's Law, Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Nernst Equation and its application, relationship between Electrode potential and thermodynamic quantities, Potentiometric and conductometric titrations. Phase rule. Clausius-Clapeyron equation. Phase diagram of one component systems: CO2, H2O, S; two component systems: liquid- vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics. Statistical thermodynamics: microcanonical, canonical and grand canonical ensembles, Boltzmann distribution, partition functions and thermodynamic properties.

- **Surfaces and Interfaces**
- Physisorption and chemisorption. Langmuir, Freundlich and Brunauer– Emmett–Teller (BET) isotherms. Surface catalysis: Langmuir- inshelwood mechanism. Surface tension, viscosity. Self-assembly. Physical chemistry of colloids, micelles and macromolecules.
- **Stereochemistry**
- Chirality and symmetry of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism and optical isomerism.
- **Reaction Mechanisms**
- Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through kinetics, identification of products, intermediates and isotopic labelling. Linear free-energy relationship – Hammett and Taft equations. Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N and O) multiple bonds. Elimination reactions. Reactive intermediates – carbocations, carbanions, carbenes, nitrenes, arynes and free radicals. Molecular rearrangements.
- **Organic Synthesis**
- Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, Li, Cu, B, Zn, P, S, Sn and Si based reagents in organic synthesis. Carbon-carbon bond formation through coupling reactions – Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry. Concepts of multistep synthesis – retrosynthetic analysis, strategic disconnections, synthons and synthetic equivalents. Atom economy and Green Chemistry, Umpolung reactivity – formyl and acyl anion equivalents. Selectivity in organic synthesis – chemo-, regio- and stereoselectivity. Protection and deprotection of functional groups. Concepts of asymmetric synthesis – resolution (including enzymatic), desymmetrization and use of chiral auxiliaries, organocatalysis. Carbon-carbon and carbon-heteroatom bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Stereoselective addition to C=O groups (Cram, Prelog and Felkin-Anh models).
- **Heterocyclic Compounds**
- Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.
- **Biomolecules**
- Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, chemical structure determination of peptides and proteins, structural features of proteins, nucleic acids, lipids, steroids, terpenoids, carotenoids, and alkaloids.
- **Methods of Chemical Analysis**

- **Volumetric Analysis**: Introduction, principles of titrimetric analysis, requirement of titrimetric analysis, primary and secondary standards. Requirement of a primary standard solution, units of standard solutions- Definition of normality, molarity, molality, mole fraction, ppm.
- **Instrumental methods of analysis**: Introduction, Theory, Instrumentation and applications of Colorimetry, Flame Photometry, Potentiometry, Conductometry (Strong acid with strong base, weak acid with a strong base, mixture of strong acid and a weak acid with a strong base)
- **Experimental techniques in organic chemistry**
- Optical rotation (polarimetry). Applications of various chromatographic techniques such as thin-layer, column, HPLC and GC. Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.
- **Spectroscopy**
- Atomic spectroscopy; Russell-Saunders coupling; Term symbols and spectral details; origin of selection rules. Rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Line broadening. Einstein's coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Basic principles of nuclear magnetic resonance: gyromagnetic ratio; chemical shift, nuclear coupling.
- **Instrumental Methods of Analysis**
- UV-visible, fluorescence and FTIR spectrophotometry, NMR and ESR spectroscopy, mass spectrometry, atomic absorption spectroscopy, Mössbauer spectroscopy (Fe and Sn) and X-ray crystallography. Chromatography including GC and HPLC. Electroanalytical methods-polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.
- **Sensors and Energy Systems**
- **Sensors**: Introduction, working, principle and applications of Conductometric sensors, Electrochemical sensors, Thermometric sensors (Flame photometry) and Optical sensors (colorimetry). Sensors for the measurement of dissolved oxygen (DO). Electrochemical sensors for the pharmaceuticals. Electrochemical gas sensors for Sox and NOx. Disposable sensors in the detection of biomolecules and pesticides.
- **Energy Systems**: Introduction to batteries, construction, working and applications of Lithium ion and Sodium ion batteries. Quantum Dot Sensitized Solar Cells (QDSSC's)-Principle, Properties and Applications.
- **Self-learning**: Types of electrochemical sensor, Gas sensor-$O_2$ sensor, Biosensor-Glucose sensors.
- **Engineering Materials**
- **Polymers**: Introduction, Synthesis and applications of Polyurethanes. Polymer composites Introduction, synthesis, properties & applications of Kevlar Fibre.
- **Conducting Polymers**: Introduction, Synthesis & Mechanism of conduction in polyaniline and factors influencing conductivity of organic polymers.
- **Biodegradable polymers**: Introduction and their requirements. Synthesis, properties and applications of Poly lactic acid. Nanomaterials: Introduction, size dependent properties (Surface area, Electrical, Optical and Catalytic properties). Synthesis of nanomaterials: Top down and bottom-up approaches, Synthesis by Sol-gel, and precipitation method.
- **Nanoscale materials**: Fullerenes, Carbon nanotubes and graphenes –brief Explanation, properties and applications.

- **Green Chemistry and Alternative energy resources**
- **Green Chemistry**: Introduction, definition, Major environmental pollutants - Oxides Nitrogen, Sulphur and Carbon (Mansion the impact of these pollutants on environment), Basic principles of green chemistry -brief discussion on 12 principles of green chemistry. Various green chemical approaches – Microwave synthesis, Bio catalysed reaction (only explanation with examples), Solvent-free reactions- advantages and conditions Synthesis of typical organic compounds by conventional and green route; i) Adipic acid – Conventional synthesis from Benzene, Green synthesis from glucose. ii) Paracetamol- Conventional and Green synthesis from Phenol Industrial applications of Green Chemistry.
- **Green fuel**: Hydrogen-production (Photo electrocatalytic and photo catalytic water splitting) and applications in hydrogen fuel cells. Construction, working and applications of Methanol-Oxygen fuel cell (H2SO4 as electrolyte).
- **Water Chemistry, chemical analysis and Instrumental methods of analysis**
- **Water chemistry**: Introduction, sources and impurities in water, Potable water; meaning and specifications (as per WHO standards), Hardness of water, types, determination of hardness using EDTA titration, numerical problems on hardness of water. Definition of Biological oxygen demand (BOD) and Chemical Oxygen Demand (COD), determination of COD of waste water sample and Numerical problems on COD.

## III. Syllabus for Technical Assistant (Ethnomedicine / Medicinal Plants)

1. General Botany
    - Plant Morphology: Structure of root, stem, leaf, flower, fruit, and seed.
    - Plant Anatomy: Tissue systems, primary and secondary growth, anatomy of monocots and dicots.
    - Photosynthesis: Mechanisms (C3, C4, and CAM pathways).
    - Water Relations: Absorption, transport, and transpiration.
    - Nutrient Uptake: Role of macro- and micronutrients.
    - Plant Adaptations: Xerophytes, hydrophytes, and halophytes.
    - Plant Tissue Culture: Micropropagation, somatic embryogenesis, and applications in medicinal plants.
2. Basics of Medicinal Plants and Traditional Medicine
    - Introduction to Medicinal Plants: Importance, scope, and history.
    - Classification of Medicinal Plants: Based on habitat, habit, and therapeutic use.
    - Medicinal Plant Resources: Forests, home gardens, and commercial cultivation.
    - Codified and non-codified systems of traditional medicine.
    - Indian Traditional Systems of Medicine: Ayurveda, Unani, Siddha, Sowa Rigpa and Homeopathy.
3. Cultivation and Processing and Quality standards of Medicinal Plants
    - Agronomy of Medicinal Plants: Soil, climate, and irrigation requirements.
    - Cultivation Practices: Propagation techniques, pest, and disease management.
    - Post-Harvest Processing: Drying, storage, and packaging.
    - Quality Standards: Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP).
    - Standardization: WHO guidelines on quality control of medicinal plants.
4. Ethnobotany and Traditional Knowledge
    - Ethnobotany: Definitions, Role of plants in traditional healthcare practices.

- Indigenous Medicinal Plants: Uses of plants in tribal and rural communities.
- Conservation of Traditional Knowledge: Intellectual Property Rights (IPR) and benefit-sharing.
- Bioprospecting: Exploration of plant biodiversity for pharmaceutical use.

5. Taxonomy and Plant Identification
    - Plant Taxonomy: Principles and systems of classification (Bentham and Hooker, APG systems).
    - Conventional and modern Methods of plant identification
    - Plant Identification: Techniques and tools (Identification Characters, Taxonomical keys).
    - Herbarium Preparation: Techniques for collection and preservation.
6. Conservation of Medicinal Plants
    - Threats to Medicinal Plant Biodiversity: Habitat loss, overexploitation, and climate change.
    - Conservation Strategies: In-situ (sacred groves, biosphere reserves) and ex-situ (seed banks, botanical gardens).
    - Sustainable Utilization: Agroforestry models and community-based conservation.
    - Role of National and International Organizations: CITES, IUCN, and NMPB.
7. Research Methods in Medicinal Plant Studies
    - Microscopy: Types and applications.
    - Methods of Extraction: Solvent extraction, distillation, and maceration.
    - Spectrophotometry: Basics and its use in plant sciences.
    - Chromatography: Principles and types (TLC, HPLC).
    - Field Techniques: Sample collection, preservation, and data documentation.
    - In vitro and in vivo studies: Methods to evaluate antimicrobial, anti-inflammatory, anticancer, antioxidant, and adaptogenic properties of medicinal plants.
    - In vivo studies: Animal models to evaluate safety and efficacy of medicinal plants.

Selected References


1. Plant Physiology by Taiz and Zeiger.
2. Principles of Genetics by Snustad and Simmons.
3. Introduction to Plant Taxonomy by Jeffrey.
4. Economic Botany by S.L. Kochhar.
5. Plant Biotechnology by H.S. Chawla.
6. Pharmacognosy by C.K. Kokate, A.P. Purohit, and S.B. Gokhale.
7. Medicinal Plants: Chemistry and Properties by Lyle E. Craker and James E. Simon.
8. Ethnobotany and Medicinal Plants of India and Nepal by V. Singh.
9. Medicinal Plants of the World by Ivan A. Ross.
10. Textbook of Pharmacognosy and Phytochemistry by Biren Shah and Avinash Seth.


## IV. Technical Assistant (Computer Science - Maintenance of LAN & Network)

- Computer Organization: - Functional blocks of Digital Computer – Stored program concept – Fixed-point, Floating-point number representations – Instruction formats - Addressing modes– Memory hierarchy – Virtual memory, Associative memory – Cache memory – I/O Organization – Modes of data transfer –Programmed I/O, DMA, Interrupt initiated I/O–Pipeline and Vector processing– Flynn's classification.

- Computer Network: - OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation

and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email, IP address classes, IP Sub-netting, Linux commands.

- Operating Systems: - Operating System concepts, Services, Types, System calls– Process Management– CPU - Inter Process Communication – Deadlocks - Memory Management – Overlays, Paging, Segmentation, Virtual memory.

- Data backup, Data security, Server Management, Data retrieval, FTP Management

- Network Security: -Firewalls, Antivirus, and Anti-malware Tools, Virtual Private Networks (VPNs), Basics of Cryptography and Network Security, Cybersecurity Threats and Countermeasures.

- Hardware and Troubleshooting: - Assembling and Troubleshooting Computer Systems, Peripheral Devices and Maintenance, Server Installation and Maintenance, Diagnostic Tools and Methods.

- Network Monitoring and Tools: - Monitoring Tools like Wireshark, Nagios, or SolarWinds, Bandwidth Management, Troubleshooting Network Latency Issues, Log Management and Analysis.

- IT Policies and Standards: -Understanding IT Security Policies, Compliance with Standards (ISO 27001, GDPR, etc.), Disaster Recovery and Business Continuity Planning, Recent Trends in Networking Technologies (5G, IoT, Cloud Computing), Latest Updates in Cybersecurity.