

Detailed Syllabus for the post of Research Assistant (Microbiology) in Ayurveda Medical Education

Category No.012/2025

Total – 100 Marks

Module 1: Foundations of Microbiology (10 marks)

- Historical developments in microbiology: major contributions of Louis Pasteur, Robert Koch, Antonie van Leeuwenhoek, Edward Jenner, Joseph Lister and Alexander Fleming.
- Morphology and Structure of Bacteria, viruses, fungi, protozoa - Its unique properties.
- Microbial growth & nutrition: growth curve, factors affecting growth, enumeration & quantification methods. Nutritional categories (photoautotrophs, chemoautotrophs, heterotrophs, etc).
- Isolation, identification, preservation of microbes; culture methods and media.
- Antimicrobial agents: types, mechanism of action, pharmacokinetics/dynamics, resistance mechanisms.
- Microscopy & imaging techniques: light microscopy (bright field, phase contrast), electron microscopy (TEM/SEM), fluorescence microscopy.

Module 2: Biochemistry (10 marks)

- Biomolecules: proteins, carbohydrates, lipids, nucleic acids; their structure, classification, properties, and functions.
- Pathways of carbohydrate metabolism: glycolysis, TCA cycle, pentose phosphate pathway, glyoxylate cycle.
- Fatty acid and lipid metabolism in microbes. Amino acid and nucleic acid biosynthesis and degradation.
- Enzymology: Classification, properties, and mechanisms; Regulation of enzyme activity and metabolic pathways; Industrial and environmental applications of microbial enzymes.
- Phytochemistry: plant secondary metabolites- alkaloids, flavonoids, terpenoids, phenolics, and glycosides; Phytochemicals & antimicrobial pathways.

Module 3: Biophysics and Bioinstrumentation (10 marks)

- Bioenergetics: energy absorption, storage and transformation in cells.
- Physical principles underlying biological molecules and cellular processes- Osmosis, Diffusion, Surface tension, Dialysis.
- Principles and applications of spectroscopy: UV-Visible, fluorescence, atomic absorption, Raman, NMR, ESR. Electrophoresis techniques – AGE and PAGE. Separation techniques- Paper, TLC, HPTLC, Column Chromatography (Ion exchange, affinity, HPLC), GC-MS, LC-MS.
- Operations and applications of common biological instruments: centrifuges, pH meter.

Module 4: Molecular biology

(10 marks)

- Structure of nucleic acids (DNA, RNA), gene expression, regulation in microorganisms.
- Recombinant DNA technology: cloning, vectors, CRISPR/Cas, gene editing in microbes.
- Genomics, transcriptomics, proteomics in microbial systems; genome sequencing, bioinformatics basics.
- Microbial genetics: mutation, recombination, mobile genetic elements, gene transfer, operons, plasmids, phages.
- Molecular diagnostics: PCR, RT-PCR, real-time PCR, sequencing etc.
- Applications: microbial biotechnology, synthetic biology, microbial engineering.

Module 5: Immunology

(10 marks)

- Structure and function of the immune system: innate vs adaptive immunity; immune cells; organs of immune system.
- Antigens, immunogens, haptens, adjuvants; immunoglobulins — classes, structure, functions.
- Complement system: pathways, regulation, role in disease.
- Hypersensitivity reactions (Type I-IV); autoimmune disorders; immunodeficiency states.
- MHC complex, antigen presentation, cytokines, cell-mediated immunity, mucosal immunity.
- Immunological techniques: agglutination, precipitation, complement fixation, immunofluorescence, ELISA, RIA, Western blot.
- Immunology of malignancy, Immunotherapy of cancer.
- Transplantation immunology; immunohaematology (blood groups, transfusion reactions).
- Vaccines: types, mechanism, development, current trends.

Module 6: Medical Microbiology

(10 marks)

- Normal microbial flora / human microbiome, host-microbe interactions in health and disease.
- Emerging infectious diseases; epidemiology of microbial diseases.
- Pathogenesis of bacterial infections; laboratory diagnosis & identification (culture, biochemical tests, molecular methods).
- Laboratory diagnosis of viral infections: serology, PCR, next-gen sequencing, culture techniques, viral vaccines & antiviral therapy mechanisms, emerging viruses, zoonoses, viral epidemiology and control strategies. Oncogenic viruses, viral genomics, viral evolution & mutation (HIV, influenza, SARS-CoV-2, etc).
- Laboratory diagnosis of fungal infections: culture, microscopy, antigen/antibody tests.
- Parasitology: protozoa (e.g., Plasmodium, Giardia, Entamoeba), helminths (nematodes, cestodes, trematodes), arthropod vectors. Life cycles, pathogenic mechanisms, epidemiology, diagnosis, control of parasitic diseases.
- Microbial toxins, virulence mechanisms.
- One-Health concept (linking human, animal and environment).

Module 7: Bioprocess Technology

(10 marks)

- Recombinant protein production, fermentation technology, bioprocess engineering, single-cell protein, bioplastics.
- Microbial metabolism in industrial context, scale-up of fermentation, upstream and downstream processing.
- Microbial production of antibiotics, enzymes, biofuels.
- Quality control in microbial processes, biosafety, regulation.
- Immobilization of cells and enzymes.

Module 8: Environmental Microbiology

(10 marks)

- Population and community interactions; extreme environments and extremophiles.
- Conventional and molecular techniques for studying microbial diversity.
- Water pollution sources, biological indicators, sewage and wastewater treatments, BOD, COD.
- Microbiology of air, water, and solid waste; biodegradation and bioremediation.
- Microbial role in pollution control, composting, waste utilization, and treatment of industrial effluents.
- Genetically-modified microorganisms; biosafety and bio-ethics.

Module 9: Food-Associated Microbes

(10 marks)

- Sources of microorganisms in food, perishable, semi perishable and non- perishable foods, intrinsic and extrinsic parameters influencing microbial content of food.
- [Food borne pathogens](#) and [their control](#). Microbial infection and intoxication. Food intoxication- Staphylococcal intoxication, botulism. Food infection- *Salmonellosis*, *Clostridium perfringens*, *Bacillus cereus* gastroenteritis, *E. coli* infection.
- [Sampling methods for microbial analysis of foods, testing methods, total plate count \(TPC\), coliform count, MPN techniques, Enumeration and detection of Salmonella and Shigella](#).
- Functional foods and nutraceuticals, Concept of antioxidants. Probiotic & Prebiotic. Microbiome research – gut microbiome.

Module 10: Soil-Plant-Microbe Interactions

(10 marks)

- Microbial biodiversity in bulk soil, rhizosphere and phyllosphere. Methods for quantitative and qualitative estimation of soil microbial populations.
- Biogeochemical cycles - Carbon, Nitrogen, Sulphur, Phosphorus, Iron.
- Nitrogen metabolism - Biological nitrogen fixation-Physiology, Biochemistry and genetics of nitrogen fixation. Mechanism and regulation.
- Plant-microbe interactions - Different interfaces of interactions -soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal), associative, endophytic and pathogenic interactions. Mechanisms of plant growth promotion and biocontrol properties and applications - Biofertilizers, Biopesticides and Bioherbicides.
- Plant microbiome research: techniques and applications.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.