DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR

Syllabus

Ph.D. Entrance Test - 2024

Subject: MICROBIOLOGY

Ph.D. Entrance Test 2024

Subject: Microbiology

	Title
Section -I	Research Methodology
Section -II	Microbiology

Section – I RESEARCH METHODOLOGY

RESEARCH AND AWARENESS TO SCIENTIFIC LITERATURE

Definition and process of research; Types of research: application perspective, objectives perspective and mode of enquiry perspective

The research problem - The importance of formulating a research problem, Sources of research problems, Steps in formulating a research problem, The formulation of research objectives

Constructing hypothesis: Hypothesis – definition, functions, testing , characteristics, Types , Errors in testing a hypothesis

Literature survey by Manual, Snow ball, Online information access, reference management software (e.g. Mendeley, Reference manager), Study of available literature for the problem statement

Scientific paper (review, research paper, short communication), white paper, research report and patent, bibliography, citation, impact factor, h and I indexing; Plagiarism : Reasons for Plagiarism, Types of Plagiarism;

Intellectual property- Difference between Industrial property and Intellectual property, Significance of intellectual property rights; Types of IPR - patent, copyright, trademarks, collective marks, industrial design, and geographical indications

RESEARCH DESIGN

Definition, Necessity, Approaches, Design and methods, Qualitative versus quantitative research

Types of research designs (explanatory research design , descriptive research design, diagnostic research design, experimental research design, exploratory research design, hypothesis-testing research design), Principles of experimental design (Block, Replication, and Randomization), Design of experiments in microbiology - OVAT (one variable at a time) and Factorial design (Response surface methodology; screening of factors by Plackett–Burman designs and optimisation of factor by central composite design)

STATISTICS

Measures of central tendency and dispersion; 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; X2 test; Basic introduction to Multivariate statistics, etc.

TECHNIQUES AND INSTRUMENTATION

Calibration of instruments, Centrifugation, types of centrifuges; Microscopy (Compound, phase contrast, dark filed, fluorescence SEM and TEM) 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; Principle, methodology and microbiological applications of Chromatography techniques (TLC, Affinity, ion exchange, GC, HPLC and HPTLC), Principle, methodology and microbiological applications of electrophoresis techniques (Agarose gel, SDS-PAGE, native gel/Zymography **)**

LABORATORY BIOSAFETY

Biosafety guidelines and regulations: Indian, NIH recombinant DNA guidelines, biosafety in Microbiological and biomedical laboratories, OSHA occupational exposure to blood borne pathogens rule

Biosafety practices, personal hygiene, rules for the possession use and transfer of samples and cultures, Institutional Biosafety committee

Biosafety principles and facility features

Biosafety practices - personal hygiene, pipetting, hypodermic syringes and needles, opening containers, centrifuging, mixing and disruption, handling animals, vacuum systems and miscellaneous operations

Biosafety cabinets: class I cabinets and class II cabinets

Biosafety during disinfection and sterilization

Section –II Microbiology

MICROBIAL DIVERSITY AND BIOCHEMISTRY

MICROBIAL DIVERSITY

Characteristics, structure and significance of Viruses, Bacteria, Archea, Eukaryotic microbes (fungi, algae and protozoa); Scope and significance of microbiology, Newly emerging disease -Covid-19

Microbial taxonomy – morphological, phenotypic, biochemical, cultural and molecular methods of identification (ribotyping etc.)

Characteristics and significance and commercial applications of Extremophile - Acidophile, alkalophile, halophile, and Pizeophile

CHEMISTRY OF MICROBE

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics,

thermodynamics, colligative properties). Structure and classification of Carbohydrate Carbohydrate, amino acids, protein, Nucleic acids and lipids. Structural conformation of protein (Primary, secondary and tertiary structures, domains, motifs and folds).

BIOENERGETICS

Redox reaction and electron carriers, An overview of carbohydrate metabolism; Glycolysis; Pentose-phosphate pathway; Entner-Doudoroff pathway; Glyoxalate pathway; Metabolism of lipids, amino acids and nucleotides. Oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. The citric acid cycle; Fermentation; Aerobic and anaerobic respiration; Chemolithotrophy; Photosynthesis; Calvin cycle; Common regulatory mechanisms in synthesis of amino acids; Regulation of major metabolic pathways; lipid metabolism

ENZYMOLOGY

Classification of enzyme as per EC, Characteristics of enzyme, isozymes, ribozymes, abzymes Effect of pH, temperature, activators, inhibitors, and substrate concentration, Enzyme kinetics (Michaelis-Menten equation , Line weaver Burke equation), Enzyme inhibition and enzyme regulation (allosteric enzymes- Co-operatively, Hill equation, Adair Model, KNF model, Aspartate transcarbamoylase; Mechanism of enzyme catalysis (Lysozyme, Ribonuclease and Chymotrypsin); Concept of enzyme units, specific activity and total enzyme activity, enzyme purification methods, purification fold, percentage purity; enzyme engineering; Enzymes immobilisation, methods of immobilisation; ; principle and types of biosensors; Therapeutic, diagnostic and industrial applications of enzyme.

Fermentation Technology and Pharmaceutical Microbiology

FERMENTATION

Characteristics of Industrial Strain microbial culture screening and selection for fermentation processes; strain development. Preservation, Formulation of medium, oxygen requirements, antifoams. Media sterilization, sterilization of fermenter and other ancillaries, filter sterilization of air and media. Inoculum production, Microbial growth kinetics, batch culture, continuous culture, fed-batch culture.

DESIGN AND TYPES OF BIOREACTORS

Basic criteria of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Validation of fermenter. Types of bioreactors: airlift reactor, packed bed, fluidized bed, trickle bed, solid state fermenter, animal and plant cell bioreactors.

MICROBIAL FERMENTATIONS

Microbial production, purifications, characterisation and applications of: citric acid, glutamic acid, penicillin, streptomycin, bacterial and viral vaccines, enzymes (amylase, protease, lipase, therapeutic enzymes), recombinant proteins, bioethanol, single cell proteins.

MICROBIAL PHARMACEUTICALS

History and development of chemotherapeutic agent, types of chemotherapeutic agents, Types of antibiotics with their properties and mode of action; antibacterial, antifungal, antiviral, antiprotozoal. Regulatory Requirements and GMP Associated with their manufacture will Antibiotic resistance, mechanism of antibiotic resistance. Preservatives, New drug discovery, drug delivery system, Design of sterile product manufacturing unit,

QUALITY CONTROL AND QUALITY ASSURANCE

Quality control in pharmaceuticals: In-process and final product control, Sterilization control and sterility validation

US and Indian pharmacopeia, FDA regulation, GMP, GLP. Sterility testing of products, Microbial limit test, Ames test, MIC, MBC, Assays and Validation of Antibiotics and vitamins by microbiological assay, Shelf-life and Stability Testing.

GENETICS AND IMMUNOLOGY

GENETICS

Concept of Gene, genome, chromosome, plasmid (properties, types and significance of plasmids,

Central dogma of Molecular biology, Replication, transcription and Translation in prokaryotic and eukaryotic systems

Mutation – Mechanism and types of mutation, Spontaneous and induced mutations, Physical and chemical mutagen

Bacterial Recombination – transformation, Conjugation, Transduction, Bacterial transposons-

DNA Repair-Photo repair, Dark-repair, Excision, mismatch, SOS repair

Gene regulation (Induction, Repression), Lac operon (Positive and negative regulation), Genetic attenuation (tryptophan operon),

Viral genetics – Structure T4, M13, and lambda phage, Viral multiplication cycle (Lytic and lysogenic cycle)

TECHNIQUES IN MOLECULAR BIOLOGY

Isolation and purification of DNA (genomic and plasmid), RNA and proteins, Analysis of DNA, RNA and proteins by gel electrophoresis (Horizontal and Vertical), Isoelectric focusing gels, DNA sequencing methods, strategies for genome sequencing, In-vitro gene amplification, PCR principle, process, and applications., Variant methods of PCR (RT-PCR, Inverse, asymmetrical , multiplex, Hot start, ligation mediated, Real-time quantitative PCR, DD PCR and Immuno PCR); RFLP, RAPD and AFLP techniques

GENETIC ENGINEERING

Concept of genetic engineering, Core technique of genetic engineering, Restriction endonucleases; Cloning vectors Plasmid (Types of Plasmid), Cosmids, phagemid, Shuttle vectors; pBR 322 and YAC, Hosts used in genetic engineering; Methods for gene introduction, screening and selection of recombinants, Construction of genomic and cDNA library, Blotting technique Southern, Northern, Applications of genetic engineering: Insulin production, recombinant vaccines, transgenic plants and Gene therapy.

IMMUNOLOGY

Innate and adaptive immune system, Active and passive Immunity, Herd immunity, Cells and organs of the immune system, Cytokines and Interleukins Characteristics and Types: Antigen, Immunogen, Allergen.

Antibody: Types, structure, Antibody diversity (Somatic gene recombination, Genesis of light and heavy chain) Immunogenetics, antibody diversity

Major Histocompatibility Complex: properties of MHC genes, structure, properties and cellular distribution of MHC molecules, binding of peptides to MHC Cell mediated Immune response : T-cell, Types of T cells, T cell activation Humoral Immune response: B cell, Plasma cell, B cell activation (T dependent and T-independent pathway), regulation of humoral immune responses by Fc receptors

Complement system, Opsonisation, Inflammatory response, Immunologic tolerance: General features of immunologic tolerance , T and B lymphocyte tolerance , tolerance induced by foreign protein antigens, Graft rejection: Immunological basis, First set and second set of reaction, Significance of HLA and MHC, Immunological Tolerance, Hypersensitivity : types and mechanism with example

Immunity against viral infections , Cancer immunology : Types of tumors, oncogenesis and tumor antigens (TATAs, TSTA) and Autoimmune diseases: Mechanisms for induction of autoimmunity, Organ specific and systemic, Treatment of autoimmune diseases

IMMUNO-TECHNIQUES

Antibody generation; Precipitation, Agglutination, ELISA, RIA, western blot, , flow-cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

APPLIED AND ENVIRONMENTAL MICROBIOLOGY

FOOD MICROBIOLOGY

Fermented foods, dairy products, methods for food preservation, foodborne infections and intoxication. GMO food, application of enzymes in food.

MICROBIAL ECOLOGY

Concept of habitat and ecological niches, Limiting factors, Energy flow, food chain, food web and trophic levels, Ecological pyramids and recycling, Biotic community—concept, structure, dominance, fluctuation and succession, N.P.C. and S Cycles.

Basic microbial ecology; Microbial communities; Methods to quantitative microbial ecology, Microbial interactions, interaction with abiotic and biotic environment, Anatomy and significance of : Phyllosprere, Rhizosphere; Mycorrhizae (VAM, OM, EM, Ectomycorrhizae); and Leguminous root nodules (Nodulation process and mechanism of nitrogen fixation

MICROBIAL BIOCONTROL AGENTS AND BIO-FERTILISERS

Plant defence mechanisms (structural and biochemical); Microbial pathogenicity mechanisms in virus, bacteria, fungal pathogens; Genetic basis of plant-pathogen interactions; General symptoms etiology, and control of plant infections; Microbial technology for restoration of degraded lands, Strategies for plant disease management; Bio pesticides, Trichoderma; Pseudomonas; Bio-control of post-harvest diseases; Application of Plant Growth Promoting Rhizobacteria (PGPR), Azotobacter, Rhizobium, siderophore bio-fertilisers

MICROBIOLOGICAL TREATMENT OF WASTE

Microbiological treatment of waste water -Principles and need for biological waste water treatment, Conventional treatment process Aerobic and anaerobic treatment: suspended-growth, attached-growth (TF, RBC, PBR), tertiary treatment process, Measurement of Pollution; DO, BOD and COD: Principal, working and significance, Schemes for effluent treatment for distillery and antibiotic industries

Microbiological solid waste management - Sludge digestion, Composting: Principle, chemistry and biology of composting, technology of composting, criteria of compost maturity, applications of compost; biomethanation, biochemistry of methane synthesis.

Composition, structure of lignocelluloses and issues; Pre-treatment of lignocellulosic material: Physical, Chemical and Biological, Concept of biodegradability and bioconversion

MICROBIAL PROCESSING OF XENOBIOTICS

Mechanism of biodegradation, bioremediation, Bio-stimulation, and Bio-augmentation; Xenobiotic compounds, problems in degradations. Biodegradation of xenobiotic; Persistent organic pollutant, major sources of xenobiotic, fate of xenobiotic, bio-magnification and bio-amplification, bioremediation of DDT and toxic metals

REFERENCE BOOKS:

: RESEARCH METHODOLOGY

- Ranjeet Kumar (2011) Research Methodology: A Step by Step Guide for Beginners, (3ed), SAGE Publications Ltd
- Vinayak Bairagi and Mousami V. Munot (Editors) (2019) Research Methodology:A Practical and Scientific Approach CRC Press Taylor & Francis Group, New York
- C. A. Reddy, (2007) Methods for General and Molecular Microbiology (3 ed.) ASM Washington, DC
- Prasanth K (2017) Guide to Research Methodology and Biostatistics 2017, CBS Publishers and Distributors.
- A.K. Sharma (2005) Text Book of Biostatistics I; Discovery Publishing House Pvt. Ltd.
- P. N. Arora and P. K. Malhan (1998). Biostatistics. Himalaya Publishing House
- Guillaume E. Vanot and Michelle Sergent (2005) Experimental Design in Microbiology, In Book Microbial Processes and Products pp 25-39, Humana Press Inc
- Robert A. Day (1998) How to write & publish a scientific paper (5e) Oryx Press
- Avinash Upadhyay; Kakoli Upadhyay; Nirmalendu Nath (2009) Biophysical Chemistry Principles and Techniques, Himalaya Pub. House Mumbai
- Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2016) Principles of Instrumental Analysis; 7e; Cengage Learning
- K. Wilson and J. Walker (2005) Practical Biochemistry: Principles and techniques (6e) by. Cambridge University Press, Cambridge,
- Mikkelsen SR, Corton E. (2016) Bioanalytical Chemistry (2e),Wiley Interscience, NY, USA
- Friefelder D. (1993) Physical Biochemistry 2nd Edn. W. H. Freeman & Co., USA.

: MICROBIAL DIVERSITY AND BIOCHEMISTRY

- Gerard J. Tortora, Berdell R. Funke and Christine L. Case (2016) Microbiology An Introduction (12 e) Pearson Education, Inc.
- Michael T Madigan; Kelly S Bender; Daniel Hezekiah Buckley; W Matthew Sattley; David Allan Stahl (2019) Brock Biology of Microorganisms (15 e) Pearson Education, Inc.
- Lisheng Wang, Yiru Wang, Dawei Ye , Qingquan Liu (2020) Review of the 2019 novel coronavirus (SARS-CoV-2) based on current evidence, International Journal of Antimicrobial Agents (https://doi.org/10.1016/j.ijantimicag.2020.105948)
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2017) Foundations in Microbiology, (9 ed) Nirali Prakashan, Pune
- Judith G. Voet, Charlotte W. Pratt Donald Voet (2005) Fundamentals of Biochemistry: Life at the Molecular Level, Wiley Press
- Lehninger A., Nelson D.L., Cox M.M. (2008) Principles of Biochemistry, Freeman New York.
- Rampelotto, Pabulo Henrique (Ed.) (2016) Biotechnology of Extremophiles: Advances and Challenges, Springer Publications
- Koki Horikoshi and William D. Grant, Ediitor (1998) Extremophiles: Microbial Life in Extreme Environments, Wiley Publications

- Kushner, D.J. (ed.) 1978. Microbial life in extreme environments. Academic Press, London.
- Ravi Durvasula; D. V Subba Rao (2017) Extremophiles: From Biology to Biotechnology Taylor and Francis
- Trevor Palmer, Philip L. Bonner (2007) Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2e) Woodhead Publishing

: FERMENTATION TECHNOLOGY AND PHARMACEUTICAL MICROBIOLOGY

- Stephen J. Hall, Peter F. Stanbury, Allan Whitaker (2017) Principles of fermentation technology (3 ed) Butterworth Heinemann
- Pauline M. Doran (2012) Bioprocess Engineering Principles (2 ed) Academic Press
- Satyanaraya, U. (2005) Biotechnology, Books and Allied (P) Ltd., Kolkata.
- Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore (2011)Hugo and Russell's Pharmaceutical Microbiology (8 ed) Blackwell Science, Oxford, UK.
- Tim Sandle, (2015) Pharmaceutical microbiology : essentials for quality assurance and quality control, Woodhead Publishing
- Ashutosh Kar, (2007) Pharmaceutical Microbiology, New Age International (P) Limited, Publishers, New Delhi
- Pharmaceutical biotechnology, S. P. Vyas & v. K. Dixit.. (2003) CBS publishers & distributors, New Delhi
- Bhatia R and Ichhpujani RL (1995) Quality Assurance in Microbiology, CBS Publishers, New Delhi
- Indian Pharmacopoeia (2018) 8th Edition

: GENETICS AND IMMUNOLOGY

- T.A. Brown (2016) Gene Cloning And DNA Analysis- An Introduction (7 ed) Weily Blackwell
- Lewin B. (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA
- Dominic W. S. Wong (2018) The ABCs of Gene Cloning, (3e) Springer Publication
- Clark, David P. and Nan Pazdernik (2013) Molecular biology, (2e) Academic Press and Elsevier
- Malacinski GM (2003) Freifelder'S Essentials of Molecular Biology, 4th edn., Jones & Batiett, London
- David Freifelder (2004) Molecular Biology, Narosa Publishing House.
- Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2004) Molecular Biology of the Gene, Benjamin Cummings- CSHL Press, USA.
- Berg JM, Tymoczko, JL, Stryer, L (2012) Biochemistry 7th edn. W. H. Freeman & Co.New York.
- Wink M. (2006) An Introduction to Molecular Biotechnology, Wiley-VCH Verlag Gmbh & Co., Weinheim, Germany
- Weaver, RF (1999) Molecular Biology, WCB McGraw-Hill Co. Inc., NY (ISBN: 0-697-14750-9).
- Nelson DL & Cox MM (2005) Lehninger's Principles of Biochemistry, 4th edn., McMillan Worth Publ. Inc. NY.

- Russell, PJ (1998) Genetics, 5th edn, Benjamin-Cummings Publ. Co. Inc., NY
- Klug, WS and Cummings, MR (2003) Concepts of Genetics, 7th edn., Pearson Education Inc.,
- Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen (2018) Kuby Immunology (8e) W. H. Freeman
- Anil K Sharma, (2019) Immunology: an introductory textbook, Pan Stanford Publishing;CRC
- Gabriel Virella (editor) (2020) Medical immunology (7e) CRC Publications
- Paul, W. E (2014) Fundamental Immunology, (7 ed) Wolters Kluwer Health
- Roitt, I. (2000) Essentials of Immunology, (5 ed) Blackwell ELBS Science Publication, Oxford.
- Tizard, I. R. (1995) Immunology: An Introduction, Saunders College Publishing, Philaldelphia
- Banerjee, A. K. and Banerjee, N. (2006) Fundamentals of Microbiology and Immunology, New Central Book Agency (Pvt.) Ltd., Kolkata

: APPLIED AND ENVIRONMENTAL MICROBIOLOGY

- Arun Bhunia,; Bibek Ray, (2013) Fundamental Food Microbiology, (5 ed) CRC Press David L. Kirchman (2018) Processes in Microbial Ecology (2nd) Oxford University Press
- Elmer H. Marth (2001) Applied Dairy Microbiology (2 ed) Marcel Dekker, Inc
- Singh, A. and Ward, O. P. (2004) Biodegradation and Bioremediation, Springer- Verlag,, Berlin
- Hurst, C.J. (2002) Manual of Environmental Microbiology, ASM Press, Washington D.C.
- Demain, A. L. and Davies, J. E. (1999) Manual of Industrial Microbiology and Biotechnology, ASM Press, Washington D.C. (ISBN: 1-55581-128-0).
- Martin, A. M. (1998) Bioconversion of waste materials to Industrial Products, Blackie Academic and Professional, London
- Harrigan, W. F. and McCance, M.E. (1994) Laboratory Methods in Food and Dairy Microbiology. Academic Press, London.
- Mossel, D.A.A., Correy, J.E.L., Struijk, C.B. and Baird, R. M. (1995) Essentials of the Microbiology of Foods, John-Wiley and Sons Inc., New York.
- Hobbs, B & Roberts, D. (1993) Food Poisoning & Food Hygiene, Edward Arnold, London.
- Baker, K.H. and Herson, D. S. (1994) Bioremediation, Mc-Graw Hill Inc., New York.
- Pandey, A. (2004) Concise Encyclopedia of Bioresource Technology, Food Products Press, The Haworth Reference Press, New York (ISBN: 1-56022-980-2).
- Rehm, R. G. and Reed, G. (1984) Biotechnology, Vol.1-8, Verlag-Chemie, Weinheim.
- Forster, C. F. (1985) Biotechnology and waste water treatment, Cambridge Univeristy Press, Cambridge.
- Maier, R. Pepper, I. L. and Gerba, C. P. (2000) Environmental Microbiology, Academic Press, London.