PAPER 304/404: ELECTIVES/OPTIONAL FOR SEMESTER III & IV

Elective – 1

Research Methodology And Scientific Writing

Unit II: **Research Methodology (15L)**
Meaning of Research;
Objectives of research, motivation in research;
Types of research – Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of Research;
Research Approaches; Research Methods vs. Methodology;
Research and Scientific Method;
Research Process: Steps of research process; Criteria of Good Research;
Sampling, Sample size determination, Plan for data collection,
Methods of data collection, Plan for data processing and analysis;
Ethical considerations during research

Unit II Scientific writing (15L)
Meaning of Scientific and non scientific writings; Structures of Research proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary, Conclusion, Bibliography etc);
Presentations: Graphical, Tabular, Animation, Power point etc

References:

1. The Oxford Book of Modern Science Writing (Oxford Landmark Science) 2009 by Richard Dawkins (Author, Editor)
2. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded (2012) by Joshua Schimel (Author)
3. The Best of the Best of American Science Writing (The Best American Science Writing) 2010 by Jesse Cohen (Author)
4. From Research to Manuscript A Guide to Scientific Writing (Second Edition) By Katz**,** Michael J. (Springer Publication)
5. Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal (Author), Imperial College Press, London, UK
6. Scientific Writing and Communication by Angellka Hofmann, Oxford University Press (2014)

Elective-2
Drug Development (2 Credits)

Unit I: Natural products

History of natural drugs, Sources of natural drug ie Plants, Animals, Micro organisms**;** Primary metabolites: carbohydrates, proteins, nucleic acids and lipids and their importance to plants**;** Secondary metabolites: Types, mechanism of synthesis, Importance in plants and for mankind as fragrance, pigments, flavours and medicines

Unit II: Activity Guided Drug Development

Plant collection and Extract preparations: Methods of Plant collection, solvent extraction (cold, hot, critical fluid extraction etc), screening of medicinal properties; Natural products: methods of identification (Qualitative and Quantitative), isolation and purification (Chromatography), Characterization (LC-MS**,** GC-MS, NMR, XRD, Elemental analysis etc); Bio efficacy studies: *In vitro* testing- Antimicrobial, Antidiabetic, Antioxidant, Antiinflammatory, antilarvicidal etc. Pre clinical and clinical trials.

References :

1. Chemistry of Natural Products by Sujata V. Bhat , B.A. Nagasampagi , Meenakshi Sivakumar (Springer Publication)
2. Indian Uses of Native Plants by Edith Van Allen Murphey
3. Plant Taxonomy (2nd Edition) by Sharma
4. Plant Drug analysis by H. Wagner
5. Biochemistry and Molecular Biology of Plants by Bob B. Buchanan
6. Plant Secondary Metabolites
   Volume 1: Biological and Therapeutic Significance
   Volume 2: Stimulation, Extraction, and Utilization by Kamlesh Prasad,
7. VasudhaBansalHerbal Cosmetics &Ayurvedic Medicines by P. K. Chattopadhyay
8. Textbook of Clinical Trials by David Machin, Simon Day, Sylvan Green
9. Plant Bioactives and Drug Discovery: Principles, Practice, and Perspectives 1st Edition Valdir Cechinel-Filho (Author), Wiley Publication.
10. Drug Discovery from Plants By Angela A. Salim, Young-Won Chin, A. Douglas Kinghorn (Springer publication)
11. Bioassay Methods in Natural Product Research and Drug Development By Lars Bohlin, Jan G. Bruhn (Springer Publication)

Elective – 3

Industrial Quality Management System

Unit I: ISO (15L)
Introduction: Over View of standards in ISO9000 Family
Key principles: Key principles of ISO 9000- Quality Management System
ISO 9001: Detailed study on ISO 9001:2015 standard, based on a seven principles of quality management, including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement
Application: Sector specific Application of ISO 9001- Quality Management System adapted by various industries

Unit II: GMP/ GLP (15L)
Introduction: Good Manufacturing Practices (GMO) and Good Laboratory Practices (GLP) in Pharmaceutical Industries.
Overview of GMPs is enforcement by the U.S. Food Drug Administration (US FDA) under Title 21 CFR
Documentation requirement for GMP and GLP
Case studies for Documentation related to SOP preparation and CAPA (Corrective action Preventive Action).

References:

1. ISO 9000 quality systems handbook fourth edition by David Hoyle
2. International standard iso9001 : quality management systems — requirements fifth edition 2015-09-15.
3. Pharmaceutical quality assurance for students of pharmacy, @nd edition Dec.2007.by Mr. manohar a. Potdar. NiraliPrakashan.
4. How to Practice GMPs 7th ed. by P.P. Sharma ,Seventh edition 2015.
5. Hand Book, Good Laboratory Practices: Quality practices for regulated non-clinical research and development, 2nd Edition, 2009.

Elective – 4

Biochemical Interactions and Diseases (2 Credits)

Unit I: Protein Structures and Synthetic Protein Modification (15L)

Structure and Stability of Proteins: Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin; Conformation of proteins by Ramachandran plot; N and C terminal analysis of proteins.

Covalent modification of proteins: Acetylation, phosphorylation, adenylation, methylation, ribosylation, lipidation.

Synthetic protein modifications: Protein-based hybrid structures and protein polymer systems; applications of protein polymer systems; Amino acid targeting for synthetic protein modification; Synthetic approaches for polymer-protein hybrid structure; Non-covalent approaches for polymer-protein conjugates; Protein-nanopartcle hybrids via surface conjugation; Biocatalytic approaches for biohybrid structures.

Unit II :Biomolecular Structure and Diseases (15L)

Structural and functional aspects of proteins and DNA:Relationships between structure and function and their role in human disease; DNA-protein interactions; Protein-RNA interactions; Protein-protein interactions; Protein aggregation; Non-enzymatic glycosylation (Protein-sugar interaction).

Molecular basis of disease: methods for prevention, diagnosis, and treatment; Advanced techniques used in the diagnostics of diseases due to structural alteration.
Diseases: Huntington's disease, Sickel-cell anemia**;** Cataract;Alzheimer's disease; p53 in cancer**;** Von Hippel-Lindau syndrome; Metabolic syndrome (Diabetes).

References:

Elective – 5

Protein Trafficking, Folding and Engineering (2 Credits)

Unit I: Protein Trafficking and Targeting (15L)

N-glycosylation in the ER and Golgi (quality control, UPR, ERAD and proteosomal degradation Intracellular and membrane protein trafficking and targeting; Secretory pathways in prokaryotes and eukaryotes; Endocytic pathways; Signal sequences; Co-translational transport (protease protection assay); Targeting of mitochondrial, chloroplast, peroxisomal and nuclear proteins; Vesicle biogenesis and ER to Golgi transport; ER translocation of polypeptides (soluble and transmembrane); ER chaperons; SNAPs and SNAREs; Methods of studying Protein Transport; Disorders of protein transport.

Unit II: Protein folding and Engineering (15L)

Protein Folding: Folding pathways; Intermediates of protein folding; Compact Intermediates; Hierarchical and non-heirarchical folding mechanisms; Molten globule structure; Role of chaperons (trigger factor, prefoldin), heat shock proteins (Hsp70, Hsp90), chaperonins (Group I & II) and enzymes in protein folding (PDI, PPI). Protein folding disorders.

Protein Engineering: Design and construction of novel proteins and enzymes using site-directed mutagenesis and Random/directed evolution strategies; Conformation of proteins in general and enzymes in particular; Effect of amino acids on structure of proteins; Energy status of a protein molecule, Structure- function relations of enzymes.
Basic concepts for design of a new protein/enzyme molecule; Specific examples of enzyme engineering – DihydrofolatereductaseandSubtilisin.

References:

Elective - 6

Environmental toxicology and monitoring (2 credits)

Unit I: Environmental toxicology (15L)

Toxic chemicals in the environment (air and water): their effects and biochemical interactions

Biochemical aspects: of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN pesticide; Mode of entry of toxic substance, its breakdown and detoxification; biotransformation of xenobiotics; Insecticides / Pesticides in environment, MIC effects.

Carcinogens: in environment, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing.

Epidemiological issues of toxic compounds and metal poisoning.

Unit II: Environmental monitoring (15L)

Basics: Definition and environmental monitoring process; Sampling – land (site) sampling, water sampling, air sampling.

Analysis: physical, chemical and biological analysis methods and process.

Monitoringpollution: Bioindicators, Biomarkers.

Toxicity: testing using biological material.

Biosensors: mechanism, principle and working.

Environment Impact Assessment: EIA complete process, Importance of EIA.

Principles of environmental mitigation and monitoring.

Remote sensing: Principles and its applications in Environmental Monitoring.

Geographical Information System (GIS): Concept of GIS; Types of Geographical Data.Importance of Geographical Information System in environmental studies.

References:

1. An Introduction to environmental toxicology: Michael H.Dong.
2. Environmental biotechnology: Alan Scragg.

3. Remote Sensing and GIS: BasudevBhatta

Elective - 7

Aquarium Fish Management (2 Credits)

UNIT I Aquarium management (15L)
Aquarium keeping: Design and construction of tanks, heating, lighting, aeration and filtration arrangements, decoration used, common aquarium plants and their propagation, feed, health and water quality management, prophylaxis, quarantine

UNIT II Aquarium species, Breeding & Marketing
Aquarium species: freshwater, marine water and brackish water fish and plants
Aquarium fish trade: Present status, potential, major exporting and importing countries, species wise contribution of freshwater and marine fishes, marketing strategy
Breeding techniques: Reproductive biology, breeding and rearing of freshwater, brackish water, marine ornamental fishes

Suggested Readings

1. Handbook of Fisheries and Aquaculture. ICAR 2006.
2. Ornamental Fish Farming ICAR. Saroj K. Swain, Sarangi N. and Ayyappan S. 2010.
3. Aquarium Fishes. Kingfisher Books By Mills D. 1981.
4. The Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide to More Than 600 Freshwater Fish and Plants By Vincent Hargreaves (Author), Thunder Bay Press, San Diego California (2007)
5. The Inspired Aquarium: Ideas and instructions for living with aquariums By Jeff and Mike Senske Publisher: Quarry Books (2006)
6. Manual of Fish Health Everything You Need to Know About Aquarium Fish, Their Environment and Disease Prevention By Chris Andrews - Firefly Books Ltd. (2003)
7. Choosing Fish for Your Aquarium: A complete guide to tropical freshwater brackish and marine fishes By Mary Baily and Gina Sandford, Anness Publishing Ltd. (2000)
8. Aquarium Plants Manual Selecting and Maintaining Water Plants in Large and Small Aquariums By Ines Scheurmann, Barron's Educational Series (September, 1993)

Elective- 8

Fermentation technology (2 Credits)

Unit I: Fermentation Process I (15L)

Isolation and Screening of microorganisms: Isolation of microorganisms from various sources, Preservation, Primary and Secondary Screening of microorganisms.

Microbial growth: General parameters, growth kinetics for various fermentation and types of stock culture, scaling up of culture for fermentation.

Fermentation Media: Definition, Criteria, Various components, Types: crude and synthetic, sterilization, rheology of various components of media.

Fermenter design: Components of the fermenter, sterilization, aeration and agitation.

Types of Fermenters: batch, continuous, air lift, fluidized bed, stirred tank

Product recovery: Product: internal, external, cell disruption methods: physical, chemical and biological, precipitation, filtration, centrifugation, extraction and purification, drying.

Unit II: Fermentation process II (15L)

Single Cell Protein, Biomass and Immobilization: Need of single cell production, production of bacteria, yeast, algae, fungi. Immobilization: cells and enzymes, methodsof immobilization, applications.

Commercial Fermentations: Cheese: Culture, Fermentation process, Applications.

Alcohol: Wine, Commercial Ethanol (by product fusel oils): Culture, Process and Applications

Acids: Lactic acid industrial production and applications.

Carbohydrate: Commercial starch production.

Flavour/ fragrance production, **catalytic antibodies**.

References:

1. Principles of Fermentation Technology, Stanbury and Whitaker
2. Industrial Microbiology by Casida
3. Industrial Microbiology by Prescott and Dunn
4. Role of Biotechnology in Medicinal and Aromatics Plants by Khan and Khanum all volumes

Elective – 9

Food Technology (2 Credits)

Unit I: Food Constituents and Nutrition **(15 L)**

Food constituents, sources and function: Carbohydrate, lipids, proteins, vitamins, minerals and water; RDA and ICMR recommendations for calorie requirement of food for men, women and children; Food spoilage (chemical, biochemical and microbial); Methods of food preservation (dehydration, chemical, freezing, canning); Food additives – classes and safety; Food poisoning – chemical and microbial

Unit II: Food Technology **(15 L)**

Cereals and pulses; Milling process, Nutritive loss; Indian cereal products; Bakery and Pasta products; Types of Milk and milk products; Fruits – products and confectionaries; Food beverages; Food analysis and nutritional labeling; Food processing – history, objectives and quality control; Food packaging – types and functions; Health foods - Functional foods, Prebiotics, Probiotics, Neutraceuticals, organic foods, GM foods

References:

1. Sumati R Mudambi , Rajagopal M V. Fundamentals of Food and Nutrition. New Age International Publishers
2. Potter NN , Hotchkiss JH. Food Science. CBS publishers and distributers
3. S. Manany, N S. Swamy Food Facts and Principles. New Age International Publishers
4. Pomrenz Y& Meloan CE 1996 Food Analysis Theory and Practice CBS
5. Jay JM, Loessner MJ & Golden D A 2005. Modern Food Microbiology .Springer Verlag

Elective – 10

Tissue Culture technology

Unit I: **Plant Tissue Culture I (15L)**
Basics of plant tissue culture: totipotency, macro and micro nutrients, media.
Culture: micropropogation, Callus culture, Somaclonal variation, Suspension cell culture, Protoplast culture, Somatic hybridization, Cybrids, Somatic embryogenesis and synthetic seed production. Cryopreservation.
Recombinant technology: Plant transformation by *Agrobacterium tumfaciens*[including mechanism of T DNA transfer in wild type Agrobacterium], *A. rhizogenes*its plasmid, Biolistics: chloroplast transformation: advantages and disadvantages of the technique.
Applications of transgenics: vaccine subunits, edible vaccines, from hairy root cultures.
Transgenic plants: Stress resistance [salt, water, temperature], Improved nutrition , shelf life and Novel applications for industrial purpose, biodegradable plastics, novel horticultural traits [flower colour, varigation].
Examples of secondary metabolite production (industrial scale**)**: [shikonin, taxol (biosynthesis and bioreactor production) capsasin/ berbrine].

Unit II: Animal Tissue culture I (15L)
Basic of animal tissue culture: Methods of cell dissociation/separation and preparation of primary cell culture, characteristics of cells *in vitro*, cell culture growth parameters, detection, prevention and determination of contamination in tissue culture.
Culture: Short term culture, Specialized cells: bone marrow myogenesis,*in vitro* skin cell culture, ethrogenesis- leukemia cells, chondriogenesis- *in vitro*, cryopreservation of tissues and cell lines.
Analysis and Production: cell synchronization, cell transformation *in vitro*, Mass cultivation-cytodex and biofermentors. cell cloning and Transgenic animals.
Applications: Stem cells & therapeutic cloning, Tissue engineering and 3D printing

References:
1. Industrial Biotrasformations by A. Liese, K. Seelbach and C. Wandrey; Wiley – VCH.
2. Role of Biotechnology in Medicinal and Aromatics Plants by Khan and Khanum Vol. 1 to 4.3. Plant Tissue Culture by M. K. Razdan.
4. Animal Cell Culture by Ian Freshney
5. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
6. Animal Cell Culture SudhaGangal

Elective – 11

Genetic Engineering (2 Credits)

Unit I: Microbial Cell Factories and their modification **(15L)**

Strain Improvement: Physical, Chemical and Biological Methods (Site-directed Mutagenesis Methods, Molecular Evolution/Random mutagenesis, *de novo* Sequence design, Expression-Display technologies, , Analysis and detection, applications.
Technologies: Genome editing, RNAi technologies, Metabolic Engineering and modelling, Systems Biology and Synthetic Biology for strain improvement.
Model Expression Systems: Prokaryotic:*E. coli*: Expression systems,Expression of Foreign Genes in Bacteria – Problems, optimization of expression: host, transcriptional, translational, post translational compatibility, solubility and purification, transport and localization, Modification of gene – codon optimization, host strain modification Expression of Native Proteins, , Detecting Expression of Foreign Genes
Lower eukaryotes: Yeasts: Yeast Selectable Markers andVector Systems, commercially used yeast strains (*S. cerevisiae*and *Pichia*) and their expressionsystems
Heterologous Protein Production - Design parameters: Source of DNA, Heterologous mRNA and protein levels and downstream applications, humanization of yeast for post translational compatibility.

Unit II: Applications of Genetic Engineering (15L)

Applications- modifying activity, substrate specificity, cofactor requirement, increasing stability, pH and temperature optima, Construction of deregulated mutants resistant to feed back inhibition and repression.
Uses of Industrial Enzymes: Food and Feed biotechnology: Nutraceuticals,Biopreservation, Biotransformations and other industries.
Uses in Medical Research: Analysis of Genes, Genomes and Protein-Protein Interactions - YACTechnology, Constructing Gene Knockouts and Novel Reporter Systems, synthesis of commercially compounds.Therapeutic proteins, vaccines and alternate therapies.

References:

1. Molecular Biology and Biotechnology,5th and 4th edition by J. M. Walker and R. Rapley
2. Biotechnology, Concepts and Applications by R. R. Vittal and R. Bhat
3. Biotechnology, Principles and Applications by S. C. Rastogi
4. More Gene Manipulations in Fungi by J. W. Bennette and Linda L. Lasure
5. Microbial Metabolism and biotechnology, e-book by Horst Doelle
6. The Metabolic Pathway Engineering Handbook- Fundamenals Christina D Somlke
7. Systems Biotechnology for strain improvement. Trends in Biotechnology. Volume 3 (7), 2006.