MOTHERHOOD UNIVERSITY, Roorkee

ENLIGHTENING WORLD

Doctor of Philosophy (Ph.D.)
COURSE WORK SYLLABUS

FACULTY OF SCIENCES
(Zoology)

Implemented from June, 2017 onwards

Roorkee-Dehradun Road, Village Karoundi
Post Bhagwanpur, Tehsil Roorkee
District Haridwar, Uttarakhand

Compulsory Course - I

PAPER I- Research Methodology and Computer Applications

Section I: Research Methodology **Max. Marks: 100**

6 Credits (70 External+30 Internal)

Objective:

- To enable to student to understand and work methods and concepts related Research.
- To enable the student to develop research proposal and to work with research problem.
- To develop broad comprehension of research area.

UNIT –I : Concept of Research **10 hrs (20 Marks)**

Meaning, Concept, nature steps types and characteristics of research., Types and approaches , Ethics in Research and Plagiarism, Scientific Inquiry, Philosophical and Sociological foundations of research, Interdisciplinary approach and its implications in various research area.

Unit II: Types and Methods of Research **10 hrs (20 Marks)**

Qualitative and quantitative methods of research like Descriptive, Historical, Case study, Ethnography, Ex-post facto, documentary and content analysis, survey field and laboratory experimental studies. Characteristics of methods and their implications in research area.

Unit III: Development of research proposals **10 hrs (20 Marks)**

Research proposal and its elements, Formulation of research problem-criteria of sources and definition, Development of objectives and characteristics of objectives, Development of hypothesis and applications.

Writing a Research Paper, Choosing a Topic, Preparing a Working Bibliography, Outlining and need to write a Research Paper

Unit IV: Methods of data collection & data analysis **10 hrs (20 Marks)**

Concept of sampling and other concepts related to sampling. Probability and non-probability samples, their characteristics and implications. Tools of data collections, their types, attributes and uses. Redesigning, research tools-like questionnaire, observation, interviews, scales and tests etc.

Analysis of qualitative data based on various tools. Analysis of quantitative data and it presentation with tables, graphs etc. Statistical tools and techniques of data analysis-measures of central tendency, dispersion. Decision making with hypothesis testing through parametric and non-parametric tests.

Validity and delimitations of research findings.

Section II: Computer Applications

Unit V: **20 hrs (20 Marks)**

Basic Knowledge of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, acquiring technical skills, drawing inferences from data, Use of technology and other equipment in Research, Research publishing tool-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Application of Internet in research : INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries.

References:

- Best, J.W. (1995) & Kahan, J.V. – Research Education, Prentice Hall of India Pvt. Ltd., New Delhi.
- Edwards, A.L. (1960) – Experimental Design in Psychological Research, New York, Holts (revised Ed.).
- Ferguson, G.A. and Takane Yoshio (1989) – Statistical Analysis in Psychology and Education.
- Garrett, H.E. (1986) – Statistics in Psychology and Education, Vikils Feffers and Simmons Pvt. Ltd.
- Kaul Lokesh (1984) – Methodology of Educational Research, Vikas Publishing House Pvt. Ltd., New Delhi.
- Sukhiya, S. P. : Melhotra P.V., Elements of Educational Research, New Delhi, Allied Publishers.
- Tuckman, B.W. (1972) – Conducting Educational Research, Harcourt Brace, Javanovich.
- Verma, An Introduction to Educational and Psychological Research, Bombay, Asia Publishing House.
- Lindquist, E.F. (1960) – Elementary Statistical Methods in Psychology and Education, Oxford Book Company, New Delhi.
- Sharma, A.R. (1984) Fundamentals of Educational Research, Loyal Book Depot, Meerut.
- Sanders, D.H., Computer Today, NY: McGraw Hill, 1981
- Sinha, P.K., Computer Fundamentals, New Delhi: BPB Publications, 1992
- Cox, J. And Urban, P. “Quick Course in Microsoft Office. Galgotia Publications, New Delhi,
  1990.
- Jain, Satish: “Introduction to Computer Science and basic Programming.” BPB Publications,
  New Delhi, 1990.
- Rajaraman, V., “Fundamental of Computers”, Prentice Hall of India, New Delhi, 1996.
- Saxena, S., “A First Coursein Computers”, Vikas Publishing House Pvt. Ltd., New Delhi,
  1998.

COURSE WORK SYLLABUS
CORE PAPER –II

1. Recent Advances in Biology

Total Credits : 6 **Max. Marks 100**

UNIT I: MOLECULAR BIOLOGY
Control of gene expression in Prokaryotes and Eukaryotes. Environmental gene regulation – Mechanism of Hormonal action. Cell Signalling -Molecular basis of apoptosis and cancer.

UNIT II: IMMUNOLOGY
Cells and molecules involved in immunity & and immunogenicity. Antigen - Structure and functions of different classes of immunoglobulin – Mechanism of immune response and generation of antibody diversity - T-Cell and B-Cell activation - Monoclonal antibodies - MHC –Complement system – Hypersensitivity –Autoimmunity – Immunodeficiency.

UNIT III: ENVIRONMENTAL POLLUTION
Different types of pollutant – acute and chronic toxicity; Bioassay LC50 and LD50 values- Environmental pollution and their impact on animals – Biomagnification, biodegradation and bioremediation. Environmental Impact Assessment.

UNIT IV: MICROBIAL GENETICS
Methods of genetic transfer – Transformation, Conjugation, Transduction and Sexduction - fine structure analysis of gene. Plasmids and bacteriophage based vectors. DNA and genomic libraries. Microbial fermentation and production of bio-molecules. Waste management & Biogas

UNIT V: BIOTECHNOLOGY
Isolation of DNA and RNA. DNA fingerprinting, Sanger sequencing and NGS. Transgenic animals; Animal cell & Tissue culture – Cell lines – Artificial enzymes – Immobilisation – Cryopreservation - Bioremediation - Genomics in health & agriculture.

REFERENCES*

UNIT I: MOLECULAR BIOLOGY
1. Dupraw E.J. 1969: Cell and Molecular Biology, Academic press, Oxford & IBH.
2. Kavitha B Ahluwalia 1991: Genetics – Wiley Eastern Ltd., New Delhi.
3. Beyer, A.L. et al. 1979: Molecular genetics, part III: Chromosome structure (ed) Taylor, J.H. Academic Press, New York.
4. Freifelder, D-1987: Molecular Biology 2nd ed. Jones & Bartlett, Publ. Boston.

UNIT II: IMMUNOLOGY
1. Capeuter, P.L. 1975, Immunology and serology 3rd ed. W.B. Sawnders Co. Philadelphia.
2. Bellanti, J.A. 1971: Immunology, W.B. Sawnders Co. Philadelphia.
3. Eisen., H.N. 1973: Immunology, Harper and Row publishers, Inc., Hagerstown, Maryland.
4. Dutcherlony, O. 1968: Hand Book of Immunodiffusion and Immunoelectrophoresis. Ann.

Arbor science publishers, Ann. Arbor Michigan.
5. Power, C.B. and H.T. Daginawala 1990; General Microbiology, Vol. I and III Himalaya Publishing House, New Delhi.

UNIT III: ENVIRONMENTAL POLLUTION

1. Bernard J. Nebel: 1987: Environmental Science. The way world works 2nd ed. Prentice Hall Inc. Englewood, Cliffes, New Jersey.
2. Smith, R.L. 1977: Elements Ecology and field biology, Harper and Row publications, New York.
3. Monney H.A. and M. Goddon – 1983: Disturbance and ecosystems. Springer Verlag, New York.
4. Moran, J.M. Moran, M.D. and J.H. Wiersma 1980: Introduction to Environmental Science, H.W. Freeman and Co. Sanfrancisco, U.S.A.
5. Stewart, C.P. and A. Stola man 1962: Toxicology: Mechanism and Analytical methods, Vol. I Academic press New York.
6. Chawlett, E.T. 1975: Environmental protection, Tata Mc Graw Hill, New Delhi.

UNIT IV MICROBIAL GENETICS

1. R.C. Duby and D.K, Maheswari 1999: A text book of microbiology, S. Chand and Co., New Delhi.
2. M.J. Pelczar, JR., Chan, E.C.S. and N.R. Krieg 1996: Microbiology in Tata Mc Graw – Hill publishing Co., Ltd., New Delhi.
3. Moat, A.G. and Foster, J.N. 1995: Microbial Physiology, 3rd ed., Wiley – Liss New York.
4. Friefelder, D. 1987: Microbial genetics Jones and Bartlett publication, Boston.
5. Freeman, B.A., 1979: Text book of Microbiology W.B., Saunder and Co.
6. Dulbuco D and Ginsberg, E 1980-Microbiology, Harper & Co.

UNIT V: BIOTECHNOLOGY

1. Primrose, S.B. 1991: Molecular biotechnology, 2nd ed. Oxford, Blackwell Scientific publishers.
2. Morgan, J. and Welan, W.J. 1979: Recombinant DNA and Genetic experimentation. Pergamum press, Oxford, New York.
3. Beers, R.F. and Basset E.G. 1977. Recombinant Molecules, Raven Press New York.
4. R.H. Pritchand & Holland, I.B. 1985: Basic cloning Techniques a Manual of experimental procedures procedures. Blackwell Scientific publications, Oxford, London.
5. Williams, J.C. 1981: The preparation and screening of cDNA clone bank. Genetic Engineering Vol. I (ed. Williamson, K) Academic press, London.
6. Kashav Trehan 1990: Biotechnology Wiley Eastern Ltd., New Delhi, Bangalore.
*Refer recent edition

2. CRUSTACEAN ENDOCRINOLOGY AND REPRODUCTION

UNIT-I: GENERAL BIOLOGY OF CRUSTACEA

General characters of the phylum Arthropoda – Class Crustacea: General characters; Classification; Types – Various body systems – Osmoregulation – Feeding mechanisms – Diversity and conservation of Crustacea.

UNIT-II: NEURO-ENDOCRINE SYSTEM OF CRUSTACEA
Neurosecretory system of crustacean brain – Sinus gland X-organ complex – Y-organ – Hormonal regulation in molting, growth and reproduction – Hormonal manipulation of crustacean reproduction – Mechanism of vitellogenin synthesis – Fertilization – Various types of
parental care of eggs - Stages of embryonic development – Metamorphosis – Different larval forms.

UNIT-III: AQUACULTURE OF CRUSTACEA
Prawn culture – Crab culture (fattening) – Lobster culture – Site selection and preparation of culture ponds – Physicochemical factors – Hatchery production of seeds – Food: Live feed; Artificial feed; Balanced diet (iso-nitrous and iso-caloric) – Predators and Parasites in aquaculture - Economics of Aquaculture.

UNIT-IV: TOXICOLOGY AND PATHOLOGY OF CRUSTACEA
Xenobiotics substances and their toxic effects on crustacean - Toxicity tests – Causes for different diseases - Disease causing pathogens and their preventive measures in aquaculture of crustacea – Cellular stress and Immune responses – Defence and Detoxification systems – Wound healing - Apoptosis - Probiotics in health and growth of crustacean.

UNIT-V: GENETIC ENGINEERING AND BIOTECHNOLOGY OF CRUSTACEA
Molecular Cytogenetics of Crustacea – Isolation and Purification of DNA and RNA - Isolation and Purification of Enzymes and Hormones – Recombinant DNA technology – Blotting techniques – PCR techniques – Gel documentation – Proteomics, Genomics and Bioinformatics of crustacea.

REFERENCE BOOKS
1. Crustacean Aquaculture, Mc Vey, J (Ed.), CRC Press.
2. Disease of Cultured Penaeid Shrimp in Asia and The United States, Fulks, W & Main, K.L (Eds.), Argent Laboratories Press.
3. Intensive Shrimp Production Technology, Wyban, J.A. & Sweeney, J.N. (Eds.), Argent Laboratories Press.
4. Standard Method for the Nutrition and Feeding of Farmed Fish and Shrimp, Albert GJ Tacon (Ed.), Argent Laboratories Press.
5. Gene Expression and Manipulation in Aquatic Organisma, Ennion, S.J. & Goldspink, G (Eds.), Cambridge University Press.
6. Molecular Biology and Toxicology of Metals, Rudolfs K Zalups & James Koropatnick (Eds.), Taylor and Francis
7. Crustacean Farming: Ranching and Culture, John F. Wickins & Daniel O.C. Lee (Eds.), Blackwell Science.
8. Microscopic Anatomy of Invertebrates, Vol. 10. Decapod Crustacean, Harrison, F.W. & Humes, A.G. (Eds.),
9. Advances In Molecular Ecology, Gary R Carvalho (Ed.), ISO Press, Ohmsha NATO Science Series. M.Phil. / Ph.D. Zoology (2018-19 onwards) Page 6 of 19
10. Practical Handbook of Biochemistry and Molecular Biology, Gerald D. Fasman (Ed.), CRC Press.
11. Aquaculture Principles and Practices, Pillay, TVR (Ed.), Fishing News Books, USA.

12. Fish and Fisheries of India, Jingran, VG. (Ed.), Hindustan Publishing Corporation, New Delhi.
13. Arthropoda Crustacea, In: Reproductive Biology of Invertebrates, Adiyodi K.G & Adiyodi, R.G. (Ed.), Wiley.
14. Chemical Contamination in the Human Environment, Lippman, M & Schles Esger, R.B. (Ed.), Oxford Press.
15. Toxicology Testing Handbook, Jacobson-Kram, D & Keller, K.A. (Ed.), Dekker Inc.
16. Environmental Chemistry, 7th edition, Manahan, S.E (Ed.), Lewis Publishers
17. Handbook of Eco-toxicology, Holfman, D.J., Rattner, B.A., Burton (jr.), G.A., & Cairns (jr.), J. (Eds.), Lewis Publishers.
18. Biodiversity, Rallapalli, R & Bali, G (Ed.), APH Publishing Corporation.
19. Environmental Biotechnology: Principles and Applications, Rithmann, BE & McCarty, PL (Ed.), McGraw-Hill.

3.HUMAN GENETICS

UNIT – I

Identification of human chromosome – characterization. Various Banding techniques (G, C, Q, R). Designating structural chromosomal abnormalities by break points and band composition and
sister chromatid exchange studies.

UNIT – II

Chromosomal syndromes; Autosomal abnormalities – Down syndrome, Edward syndrome, Patau syndrome, Cri-du-chat syndrome. Sex chromosomal syndrome; Klinefelter's syndrome, Turners syndrome, multiple XXX syndromes, XYY male. Prenatal diagnosis: Buccal smear test,
Amniocentesis – Chorionic villi and fibroblast cultures.

UNIT – III

Human Biochemical Genetics - Inborn errors of metabolism – Amino acid metabolism, Phenylketonuria. Disorders of Purine metabolism: Lesh Nyhan syndrome. Disorders of carbohydrate metabolism – Galactosemia. Immunogenetics – Introduction to immune response –
the cellular basis of immune responses – Immune deficiency disorders.

UNIT – IV

Endocrine Genetics - General principles of hereditary diseases: Gene action in Endocrine glands.
Pituitary – Diabetes mellitus. Parathyroid – Hypoparathyroidism. Adrenal – Congenital Adrenal Hyperplasis. Sexual development – Testicular feminization syndrome, Male Hypogonadism.

UNIT – V

Mutation: Types of mutations, Molecular basis of mutations. Genetic Engineering: gene manipulation – Techniques – Cutting and joining DNA molecules. Cloning in E.coli – Plasmids as cloning vehicle for use in E.coli of cloned DNA. Cloning in organisms other than E.coli – Cloning in Yeast. Application of recombinant DNA technology in biology and medicine.

REFERENCES

1. Textbook of Endocrinology – Robert H. Williams. (1974 & 1985) W.B. Saunder's co., Philadelphia
2. Duncan's Disease of Metabolism – P.K. Bondy and L.E. Rosenberg (1974) W.B. Sounders

Co., Philadelphia.
3. Vogel R and Rohroborn C (1970): Chemical, mutagenes in mammals and man – Springer – Verlag, Berlin.
4. Buick, D (1980): Principles of genetic toxicology, - Plenum Press.
5. Benetic Engineering & Biotechnology – V.L. Chopra and Auswar Nasim, Oxford & IBM Publishing Co., Pvt. Ltd., New Delhi, 1990
6. Biotechnology – Keshav Trehan. Wiley Eastern Limited, New Delhi, 1990.
7. Reproductive Genetics & Law: Sherman Elias & George J. Annas year book Medical Publishers Inc., Chicago, 1987.
8. Human chromosomes – Orlando J. Miller, Eeva Therman – Springer Pub. (2001)
9. Principles of Medical Genetics –Thomas d. Gelebrter Francis S. Collins, Williams & Wilkin's IB

4.POLLUTION BIOLOGY

UNIT – I
Environmental Xenobiotics – source – factors responsible for distribution – accumulation and their effects of plants and animals.
UNIT – II
Effect of environmental chemicals – species diversity – mutagenicity – teratogenicity – carcinogenicity.
UNIT – III
Toxicology – synergism and antagonism of ions – Bioassay of toxicity using animals – effect of ecological factors of the aquatic medium on toxicity – toxic substances of aquatic medium.
UNIT – IV
Ecotoxicology of terrestrial organisms – Effect of ecological conditions of terrestrial environment on toxicity – Evaluation of terrestrial toxicity by using soil invertebrates.
UNIT – V
Methodological problems of aquatic and terrestrial toxicity – Toxicological statistics – Environmental risk assessment.

REFERENCES
1. Smith, J.M. 1974, Models in Ecology, The University Cambridge.
2. Patten B.C.1971, 1977 Systems analysis and simulation ecology 4 vols. Academic Press, New York.
3. Pitts J.N. Jr. and Metcalf R.L. (Eds.) 1969 Advances in environmental Sciences and Technology Vol.1 Wiley – Interscience.
4. Butler G.C. (ed) 1978 Principles of Ecotoxicology John Wiley and sons New York.
5. Moriathy F, 1975, Pollutions and animals A factual perspective Allen and Unwin, London.
6. Warren, C.E. 1971, Biology (and water pollution control W.B. Saunders Co., Philadelphia, U.S.A.
7. Meoney H.A. and M. Godron (Ed) 1983 Disturbance and Ecosystems Springer – verlag.
8. Levins, R. 1968, Evolution in changing Environment Princeton University Press.
9. Mastumura F, 1980, Toxicology of insecticides plenum press, London.
10. Edwartds, C.A. (ed) 1973 Environmental pollution by pesticides plenum press – London.
11. Stewart, C.P. and A. Stalman (eds.) 1961. Toxicology – Mechanisms and Analytical methods Vols. II Academic Press – London.
12. Karmondy, E.J. 1974 Concepts of Ecology prentice Hall, New Delhi.

13. Suess, M.J. (ed) 1982 Examination of water for pollution control Vol. I. II and III Pergamon Press, New York.
14. Woodward F.I. and J.E. Shely 1983. Principles and measurements in environmental Biology Butler Worths – London.
15. Poole, R.W. 1974. An introduction to quantitative Ecology, McGraw Hill Book Co., Tokyo.
16. Smith R,Z. 1980, Ecology and field Biology Harper and Row Publication, New York.
17. Usha M.B. and M.H. Williamson (eds.) 1974 Ecology stability champion and Hall London.
18. Davis, D.E. (ed) 1974, Behaviour as an ecological factors Hutchinson and Ross Inc. U.S.A.
19. Cairns, J. (ed) 1980. The recovery process in damaged ecosystems Ann Arbor Science, Inc. Ann. Arbor Michigan.
20. V.V. Metelev. A.I. Kanaev and N.G. Dzasohova 1971 Water Toxicology, Amerind Publishing Co., New Delhi.

5. ENVIRONMENTAL PHYSIOLOGY

UNIT – I: ENVIRONMENT

Major biomes with reference to India - Renewable and non-renewable resources - Physico-chemical aspects of rivers, estuaries and terrestrial environments - Problems of water pollution in India.

UNIT – II: ENERGETICS

Plant animal interaction and stability of the environment - Ecological energetics: Food chain, food webs, energy transfer through trophic chains and ecological efficiencies in aquatic ecosystems. Plant microbial interaction - Physiological adaptations of animals to the limiting factors – oxygen, pressure, temperature and light.

UNIT – III: MONITORING OF POLLUTION

Solid, sewage, effluents – their sources, disposals and their treatments, recycling of waste water. Toxic inorganic and other constituents affecting water quality – such as colour, turbidity, BOD, COD, alkalinity, hardness, TSS, chlorinity – their estimations and their levels on monitoring water pollution. Exposure to pollutants and risk assessment, exposure assessment, etc. assessing carcinogenic and non-carcinogenic risks. Eutrophication and problems of weeds and their control.

UNIT – IV: DYNAMICS OF POLLUTANTS

Absorption, distribution and excretion of toxic substances. Biodegradation of organic compounds such as pesticides, heavy metals and toxic organics - Toxic effects of pollutants such as pesticides, heavy metals and toxic organics on biological systems. Food intoxication by pollutants and microbes; food spoilage, diseases, food preservation processes.

UNIT – V: INDUSTRIAL APPLICATIONS OF MICROBES

Microbes in the synthesis of amino acids, organic acids & antibiotics - Microbial insecticides, biopolymers and biosensors - Microbial role in bioleaching and recovery of minerals and metals Plant biomass to fuels - Biodeterioration management.

REFERENCES

1. Alabaster and Lloyd., Water quality criteria for freshwater fish
2. Alison Leadlay Brown., 1971. Ecology of freshwater., Heineman Educational Books Ltd., London

3. Allen, H. Benton and W.E. Warner., 1976, Field Biology and ecology, Tata Mc. Graw Hill Publ. Co., New Delhi.
4. Bell Davidson and Emglie Smith. Text Book of Physiology
5. Brown, A.W.A., Ecology of Pesticides
6. Butler, G.C. (Ed.) Principles of Ecotoxicology, John Wiley and Sons, New York.
7. Dara, S.S., A text Book of Environmental Chemistry and Pollution Control
8. Eckert, R., and D. Randall., 1983. Animal Physiology. II Edition W.H. Freeman and Co.
9. Frederic, W. Oeheme and Marcel Dekker (Ed) Toxicology of Heavy Metals in the Environment. Part I & II, IVC, New York.
10. Goel, P.K., Water pollution, Causes, effects & Control
11. Hoar, W.S. 1983. General and Comparative Animal Physiology. III. Edition., Prentice Hall IWC
12. Hutchinson, G.E. 1978. An Introduction to Population Ecology., Yale Univ. Press, New Haven., CT. USA.
13. John Vernberg and N. Bernberg., Pollution and Physiology of Marine Organisms.
14. Kannan, K., Fundamentals of Environmental Pollution.
15. Matsumura, F., 1980. Toxicology of Insecticides. Plenum Press, London.
16. Monney, H.A. and M. Goddon, 1983. Disturbance and Ecosystems., Springer Verlag, New York.
17. Nebel., 1987. Environmental Sciences. The way world works: II. Ed. Prentice Hall Iunc., Englewood, Cliffs, New Jersey.
18. Philips, J.G. 1975. Environmental Physiology. Blackwell Sci. Publ.,
19. Prosser, C.L. (Ed) 1973. Comparative Animal Physiology, /W.B.S. Aunder co.,
20. Ralph Mitchell. 1972. Water Pollution Microbiology, John Wiley & Sons, INC, New York.
21. Robert Lew Smith, 1977. Elements of Ecology and field Biology., Harper and Row Publ., New York., London
22. Satake, M., et. al., Environmental Toxicology
23. Schmiddt, J.G. 1975. Environmental Physiology. Adapting of Environment., III Edition, Cambridge Univ. Press.
24. Smith, R.L. 1980. Ecology and Field Biology. Harper & Row Publ., New York.
25. Warren, C.E.,1971.Biology and Water Pollution Control. W.B. Saunders Co., Philadelphia,USA.

6. LIMNOLOGY

UNIT – I
a. Origin of lakes, ponds and estuaries
b. Classification of lentic and lotic environments
UNIT – II
a. Physico-Chemical Character of ponds, lakes and rivers
b. Characteristics of estuarine environment
UNIT – III
a. Productivity and energy flow in the freshwater environment
b. Cycling of nutrients in the freshwater environment
UNIT – IV
a. Pollution of the Freshwater environment and its effects on organisms
b. Water borne pathogens and diseases
UNIT – V

a. A general study of freshwater organisms (Plankton, Nekton & Benthos)
b. Freshwater fisheries of India
c. Major carps of India and recent trends in their culture practices

REFERENCES

1. Limnology Charles R. Goldman and Alexander J. Horns 1983, McGraw Hill International Book Co., New Delhi.
2. Elements of ecology and Field Biology, Robert Lew Smith, 1977, Harper and Row Publishers,, New York, London
3. Environmental Protection, Emil T. Chanlett, 1973 McGraw Hill Co., New Delhi
4. Field Biology and ecology Allend H Benton and William, E Warner Jr. 1976. Tata McGraw Hill Publishing Co., New Delhi.
5. Modern concepts of ecology H.D. Kumar 197 Vikas Publishing House Pvt. Ltd., New Delhi.
6. Ecology of Freshwater, Alison Leadlay Brown 1971, Heinemann Educational Books Ltd., London.
7. Introduction to Ecology, Papul A. Colinvaux, 1978 John Wiley and Sons, Inc., New York.
8. Environmental Pollution, Mastumura, M. 1972 Academic Press, London
9. Sewage Biology, Metcoff and Eddy 1970 McGraw Hill Co., New York.
10. Water Pollution Microbiology, Ralph Mitchell, 1972. John Wiley & Sons. Inc, New York, London.
11. An Introduction to Freshwater Organisms, A. Tonapi.
12. Fish and Fisheries of India V.G. Jhingram, 1980 Hindustan Publishing Co., New Delhi.

7. ADVANCES IN INSECT BIOLOGY AND PEST MANAGEMENT

UNIT – I

Biology: Overioles and testis follicles, their number in different orders and basic histomorphology: male & female accessory, glands, their secretion and modes of sperm transfer and reception (spermatophores & spermathecae) Viviparity & Viviparious insects – factors regulating parthenogenesis and polymorphism with special reference to homoptera: Isoptera and Hymenoptera.

UNIT – II

Ecology: Abiotic & Biotic factors in biology, Abundance & distribution of insects with special reference to diapause. Interspecific and intraspecific interactions with special reference to insect migration & pest outbreak. Insect life table and its application methods of assessing insect pest/populations – plant resistance.

UNIT – III

Chemical control of Insect Pests: Classification of insecticides, modes of action of insecticides – Mechanism of insecticide resistance: Chitin inhibitors and their efficacy in pest management: recent trends in pesticide application technology.

UNIT IV

Non-chemical control and Insect pests: Dynamics of prey-predator interaction and host-parasite/parasitoid inter-actions-1 genetic and semi-chemical bases of insect pest control –

Neurophormone Juvenodids and Ecdysoids in insect's pest management.
UNIT – V
Integrated Pest Management (IPM): Principles of IPM programme its objectives, strategy and tacties ecological basis to pesticide application. Systems analysis. Recent trends in IPM.
REFERENCES
1. The ecology of insect populations in theory and practice – Clark, L.R. Geiger, P.W. Hughes, R.D. and Morris, R.F.
2. The Distribution and abundance of animals – Andrewarthan, H.G. and Brioh I.C.
3. Recent advances in Entomology in India – Ed. Ananthakrishnan T.N.
4. Biological control of Insect pests and Weds – Paul e. Bach
5. Agricultural Insect pests of the tropics and their control – Hill, D.S.
6. New Technology of pest control – Ed. C.B. Huggaker
7. Pesticides application methods – Mathews, G (1979)
8. Ecological effects of pesticides – Perring, F.H. and Mellamby K, (1979)
9. Pest Management: - G.M. Mathews (1984)
10. Basic principles of Insect suppression and Management – E.F. Kpipling (1979)
11. Migration and dispersal of insects by flight – C.G. Johnson
12. Insect Ecology – Peter W. Price (1975)
13. Genetic control of Insect pests – G. Davidson (1974)
14. Ecology of Pesticides – A.W.A. Brown (1978)
15. Breeding plants resistant to insects – (1980) F.G. Max R.B. Jennings
16. Introduction to insect pest management (1971) R.L. Metcalfe and W.H. Luckman
17. Biological Insect Suppression (1977) H.C. Copal and J.W. Mertins
18. Insect Pheromones (1972) M. Jacobson
19. Chemical control of insect behaviour (1977) Shorey H.H. and Kchelvy, J.J.
20. Ecological methods with particular reference to the study of Insect population – TRE Southwood (1975)
21. Development and Physiology of the Oocyte – Nurse cell. Syncytium – Telter W.H. 1975. Advances in Insect Physiology Vol. II
22. Insect Hormones – V.J.A. Novak 1975 Chamoman & Hall
23. Physiology of Insect reproduction – F. Englemann Pergamon Press
24. Comparative Insect Physiology. Biochemistry and Pharmacology – Vols. 1 & 2 & 12 – 1985 Eds. G.A. Kerkut & L.I. Gilbert Pergamon Press.

8. INSECT PESTS CONTROL AND TOXICOLOGY

UNIT – I
Insect pests, Types of Damage to Plants by insects, Pest surveillance and forecasting pest Outbreak, Assessment of insect population, Estimation of damage caused by insect pests to crops.
UNIT – II
Insect pest control – Natural control – Biological methods, Microbial methods, Chemical methods, Chemosterilant, Insect attractants, repellents, Antifeedants, Integrated pest control.
UNIT – III
Insecticides, Insecticides formulation, Classifications, Mode of action, Inorganic insecticides, Organic insecticides, Insecticides of Plant Origin.
UNIT – IV
Principles of toxicology of insecticides, General Bioassay of pesticides, Insecticide residues, Resistance of insecticides, Factors influencing effectiveness of insecticides.

UNIT – V
Statistics of Toxicology: Median Lethal Dose – Behren's methods, Graphical method, Rapid approximate method by Huson, Finney's Method, Abbott's method.
REFERENCES
1. Destructive and Useful Insects. Their Habits and control, Metcalf, C.L. and Flint, W.P (1967)
2. General and Applied Entomology. Nayyar, K.K., Ananthakrishnan, T.N. and David B.V. (1976)
3. Pest Management, Mathews, G. (1979)
4. Toxicology of insecticides Matsumura (1985)
5. Statistics Workbook for Insecticide Toxicology. Regupathy, A. and Dhamu, K.P. (1990)
6. The Scientific Principles of Crop Protection. Martin, H.
7. Neem for the Management of Crops Diseases (Ed). Mariappan, V
8. Neem and Environment, Vol. I & II (Ed) Singh, P.P. Chari, M.S., Raheja, A.K. and Kraws, W. (1996)
9. Elements of Economic Entomology Vasantharaj David, B. and Kumarasamy T. (1998)
10. Agricultural insect pests of tropics and their control. Hill D.S.
11. New Technology of Pest control. Ed. C.B. Huggaker.
12. Pesticide application method – Mathews, G (1979)
13. Pest Management, G.M. Mathews (1984)

9. ECO TOXICOLOGY

UNIT – I
Importance and scope of eco physiology – present environmental status – water, air and land pollution – Bioaccumulation – Bio magnification – Bio degradation. Biotransformation of pollutants – Environmental mutagenes and carcinogens – water borne pathogens and diseases.
UNIT – II
Water, soil and biological analyses for pollution study – insecticides – heavy metals – industrial effluents – sewage – mode of action of xenobiotics – entry, absorption, distribution excretion and metabolism.
UNIT – III
Toxicity of pollutants – safety evaluation – acute and chronic toxicity – Bioassays (LC50 / LD50 determination) – selection of test animals – probit analysis – Dose response – behavioral aspects– (Mouth patterns – Histopathology with reference to toxicology.
UNIT – IV
Impact of pollutants on physiology of organisms – Feeding energetics (rate of food intake, digestion, absorption, assimilation and metabolism) haemopoiesis and hematology and oxygen consumption in fishes – Biochemical constituents – activity levels of different enzymes – xenobiotics and nervous system.
UNIT – V
Environmental monitoring of pollutants – Environmental pollution with special reference to inland fisheries – Techniques for residual analysis – water quality standards and recycling procedures.
REFERENCES
1. Butler, G.C. 198\78, Principles of Ecotoxicology. John Wiley and Sons, Chichester.
2. Fumi Matsumura, 1980. Toxicology of Insecticides. Plenum Press, New York and London.

3. Sambasiva Rao K.R.S. 1999. Pesticide impact on fish metabolism. (Eds.) Discovery Publishing House, New Delhi.
4. Thomas J. Haley and William O. Berndt, 1987. Handbook of toxicology. Hemisphere Publishing Corporation, Washington.

10. AQUACULTURE AND FISHERIES

UNIT-I Basics of Aquaculture

Introduction-Indian and World Aquaculture- Role, Constraints, remedial measures and other related problems - Importance of Aquaculture – Fish products and by-products.
UNIT-II Capture fisheries Major inland capture fishery resources in India- Lake and reservoir fisheries – Nursery system in Estuaries and Brackish water and its fishery resources in India- Marine major and minor fishery resources in India and World - fin and shell fishes.

UNIT-III Culture fisheries
Monoculture- Polyculture- extensive, intensive- Integrated fish farming – Paddy cum fish culture– fish and prawn culture in fresh water ponds – Fin fish and shell fish culture in Brackish water ponds – Ornamental fish culture.

UNIT-IV Live Feed Culture
Taxonomy of Live feeds – General collecting methods- Culture and Nutritional value of Rotifers, Artemia, Copepods and Daphnia – Molluscan culture and its status- Culture of zooplankton –Seaweeds and their importance.

UNIT-V Recent Techniques in Aquaculture
Cryopreservation techniques for Live feeds – Bio-enrichment technique – Applied Genetics of cultivated fishes – Regulation of vitellogenesis in shell and finfishes.

REFERENCES
1. Fisheries research planning and Management in developing countries-V.R.P.Sinha - International Books and Periodicals services (IBS)- New Delhi.
2. Live feeds in Marine Aquaculture – L.A.McEvoy and J.G.Stottrup-Blackwell publishing company, UK.
3. Aquaculture principles and practices-T.V.R.Pillay, Fishing News Books, USA.
4. Fish and fisheries of India-V.G.Jingran-Hindustan publishing Corporation, Delhi.
5. Biology of finfish and shellfish-SCSC publishers-Howrah.
6. Seaweed research and utilization in India – CMFRI bulletin 41 (1987)
7. Fishery Management-S.C.Agarwal – Ashish publishing house-New Delhi.

11. PROTEOMICS AND MOLECULAR CELL PHYSIOLOGY

Unit I
Structural organization of Prokaryotic and eukaryotic cells with all cell organelles and their functions- Principle and applications of : Electron Microscopy- SEM, TEM and AFM; Multi-photon Confocal microscopy, Inverted Microscopy, Fluorescent microscopy and Immuno-histo-chemistry. Basic Principles and applications of animal and microbial cell culture media types, preparation and their applications. Speciman preparation, collection, transport and maintenance.

Current scenario of Stem cell Research.

Unit II

Outline of Chromosome, Genome, Gene and DNA – DNA as genetic material, DNA replication- DNA Damage- DNA repairing Mechanisms – Gene Cloning Strategies. Transfer of animal gene into bacterial cell for over expression. Molecular cloning Vectors used in Animal Biotechnology and Over expression system of prokaryotes (pET series). RNAi technology and its impact in medical sciences. Gene therapy and its application. DNA Micro array technology and its application.

Unit III
Comparison of Transcription and translational process between prokaryotes and eukaryotes. RNA Splicing mechanism – Principles and methods of Chromosomal and Plasmid DNA and RNA isolation and purification from bacteria and mammalian cells, Agarose gel electrophoresis and DNA sequencing methods - Molecular biology of Cancer: Types and Current status of cancer diagnostic tools and treatment strategies. Outline about Apoptosis.

Unit IV
Introduction to Bioinformatics and applications of bioinformatic tools in protein science. Proteomics – types and applications. Proteome of Normal and Cancer cells. Significance of Cancer proteomics, Pharmacoproteomics and Toxicoproteomics. Proteomics techniques: Principle, method and applications of SDS PAGE, Native gel electrophoresis, Immuno electrophoresis, Western blotting, Mass Spectrometry, MALDI TOF analysis, Peptide sequencing: Edman's methods. Applications of Amino acid analyzer.

Unit V
Proteomic Databases- types – Primary and secondary databases. Significance of protein sequence comparison in evolutionary studies. Prediction of secondary structure of protein and their related proteomic databases and packages. Proteome of Escherichia coli and Homo sapiens. Current status of proteomic research in human health diseases.

REFERENCE BOOKS
1. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. 2006 Molecular Cell Biology, : W. H. Freeman & Co. Publisher, NY
2. Brown T.A., 2009. Genomes. Garland Science Publications, London.
3. Cooper, G.M., 2007 The Cell - A Molecular Approach, Sinauer Associate Publications, Sundarland
4. Priscott et al., 2008. Introduction to Microbiology. Freeman Publications, USA
5. Trends in Microbiology Trends in Biotechnology series and other related journals are available on line.
6. Lesk, A., 2009 Introduction to Bioinformatics. Oxford press, UK.

12. CONSERVATION BIOLOGY

UNIT: -I- SYSTEMATIC BIOLOGY
Taxonomy-Definition- Terms and History; Importance of Taxonomy- Species concept- Kinds of species. Zoological classification- Hierarchy of categories: Linean hierarchy, keys and higher

taxonomy- Zoological nomenclature- Molecular taxonomy- barcoding.

UNIT: -II- CONSERVATION BIOLOGY
Introduction to Conservation Biology- Ethical issues of Conservation Biology. Biodiversity – Species diversity – Genetic Diversity – Ecosystem diversity – Population Genetics – Loss of Biodiversity – importance of biodiversity -Ethical role of biodiversity – Threats to biodiversity. Economics of biodiversity conservation – sustainable utilization; Species-habitat and prey-predator relationship and its role in conservation.

UNIT: - III- CONSERVATION: TOOLS IN ANIMAL CONSERVATION
Conservation Methods – In situ and Ex situ conservation of Indian Animals (Case Studies) – Population Management – Project Tiger and Elephant- Captive breeding programme- people participation in conservation – Successes and failures of conservation actions in India (Case Study) – Tools in Conservation: Interpretation of various data on wildlife – IUCN Redlist categories – GIS – Remote sensing – Landscape model. Human-animal conflicts and Mitigation.

UNIT: -IV- ANIMAL LAWS AND POLICIES IN INDIA; ECONOMICS OF BIODIVERSITY CONSERVATION

Wildlife (Protection) Act of India (1972) – Protected Area Network – Forest Policy – Prevention
of cruelty to Animal Act – Convention on Biological Diversity, International Trade in Endangered species- Zoo policy- Laws and their applications in Zoological Parks, Wildlife Sanctuaries and Biosphere Reserves – Wildlife Management and Animals Welfare – Role of NGO's in Conservation.
UNIT: -V- TECHNIQUES IN CONSERVATION BIOLOGY
Ecological Census- Basic Techniques- Shannon Weiner index to measure diversity of Animal Species Plotless Sampling-Population indices – Sampling methods for invertebrates – Fishes-Amphibians- Reptiles-Birds-Mammals. Line transect- Quadrate sampling -Point Count- Capture & Recapture techniques Camera Trap technique -Uses of Indirect evidences of species; Scan and Focal Animal sampling in behaviour food habits.

REFERENCES:
1. Anon 2004. Indian Wildlife Protection Act 1972. Natraj Publishers, Dehra Dun. 104p.
2. Anon. 1992. Convention on Biological Diversity - Text and annexes. World Wide Fund for Nature - India.
3. Anon. 1997. Wildlife (Protection) Act of India, Nataraj Publishers, Dehradun
4. Caughley, G., and A. Gunn. 1995. Conservation Biology in Theory and Practice. Blackwell Publishers.
5. Cody, M.L. and J.M. Diamond 1975. Ecology and Evolution of Communities. Harvard University Press. Cambridge. 545p.
6. Gaston, K. J. 1996. Biodiversity- A Biology of Numbers and Difference. Blackwell Science, Oxford. 396 p.
7. Giles, H. 1984. Wildlife Management Techniques. Natraj Publishers, Dehra Dun.
8. Gopal, R. 1992. Fundamentals of Wildlife Management. Justice Home. Allahabad. 668p.
9. Groombridge, B.1992.Global Biodiversity. Status of the Earth's Living Resources. Chapman and Hall, London.

10. Handa, S.K. 1999. Principles of Pesticide Chemistry. Agrobios Publishers, Jodhpur. 309p.
11. Heyer, W.R. et al 1994. Measuring and Monitoring Biological Diversity, Standard methods for Amphibians. Smithsonian Institution Press. Washington. 364p.
12. Huffaker, C.B. and A.P. Gutierrez 1999. Ecological Entomology. John Wilely and Sons, New York. 756p.
13. International Commission of Zoological Nomenclature 1999. International code of zoological nomenclature. 4th Edition. International Trust for Zoological Nomenclature, London. 306p.
14. IUCN, The World Conservation Union. http://www.iucn.org/.21
15. Kikkawa, J. and D.J. Anderson 1986. Community Ecology: Pattern and Process. Blackwell Scientific Publications, Oxford. 432p.
16. Meffe, G. K. and C. R. Carroll 1994.Principles of Conservation Biology, Sinauer Associates, USA
17. Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGrawHill Publishing Company Limited, New Delhi. 404 p.
18. Odum, E.P. 1996. Fundamentals of Ecology. Natraj Publishers, Dehra Dun 574p.
19. Reaka, M.L., Kudla, D. E. Wilson and E. O. Wilson 1997. Biodiversity II: Understanding and Protecting our Biological Resources. Joseph Henry Press, Washington, DC.
20. Rodgers, W.A. and H.S. Panwar 1988. Planning a Protected Area Network in India. Wildlife Institute o India, Dehra Dun.
21. Soule, M. E. 1986. Conservation Biology: The Science of Scarcity and Diversity, Sinauer Associates Inc., USA.
22. Southwood, T. R.E. and P.A. Henderson 2000. Ecological Methods. Blackwell Science. Oxford.575 p
23. Sutherland, W. J., 1998. Conservation science and action. Blackwell Science, Oxford, England.
24. William J. Sutherland 1996. Ecological census: techniques, (Cambridge University press.
25. William Morris, Daniel Doak, Martha Groom et al., 1999. A Practical handbook for Population Viability Analysis, The Nature Conservancy.
26. Wilson, E. O., and D. Perlman. 2000. Conserving earth's biodiversity. Island Press, Washington, D.C.

13.TOXICOLOGY

Unit –I
General Principles of Toxicology: Definition – Scope of Toxicology – Different areas of Toxicology- Classification of Toxic Agents –Route and Site of Exposure-Duration and Frequency of Exposure – Dose Response.
Unit –II

Disposition of Toxicants: Introduction- Absorption – Distribution – Excretion – Bio-transformation -Bioactivation.

Unit – III
Testing Procedures: Introduction – Bioassay – LC 50/LD 50 Determination-Acute Toxicity –Short-term and long term Studies – Experimental Design – Selection of Species.
Unit – IV
Target Organs: Gill - Liver – Kidney – Testing Procedures – Evaluation –Hematology –

Biochemical – Histopathology Biomarkers.
Unit – V
Toxic Substances and Risk Assessment: Food additives and Contaminants – Toxicity of Pesticides – Metals – Types and Common Effects – Environmental Pollutants – Air, Water and Soil Pollutants – Endocrine Disruption - Assessment of Safety and Risk

REFERENCE BOOKS:
1. Frant C.L.V. 1991, Basic Toxicology II (Eds.), Hemisphere publishing corporation, Washington, London
2. Casarett and Doulls's 1980. Toxicology: The Basic Science of Poisons.. II (Eds.)
3. Macmillan publishing co., Inc, New York.
4. Butler, G.C. 198\78, Principles of Ecotoxicology. John Wiley and Sons, Chichester.
5. Fumi Matsumura, 1980. Toxicology of Insecticides. Plenum Press, New York and London.
6. Foster L. Mayer, Donald J. Versteeg, Michael, J. McKee and Barnett A. Ratlner, 1992, Biomarkers, physiological and non-specific biomarkers. Lewis publishers, London.
7. Sambasiva Rao K.R.S. 1999. Pesticide impact on fish metabolism. (Eds.) Discovery Publishing House, New Delhi.
8. Thomas J. Haley and William O. Berndt, 1987. Handbook of toxicology. Hemisphere Publishing Corporation, Washington.
9. Bio-pesticides in Insect Pest Management 1999. S. Ignacimuthu and Alok Sen, Phoenix Publishing House Pvt., Ltd., New Delhi.
10. Water Toxicology V.V. Metelev, Kanaev, N.G. Dzasokhova-Amerind Publishing Co., Pvt., Ltd., New Delhi.

14. VERTEBRATE ENDOCRINOLOGY

UNIT I. OVERVIEW OF VERTEBRATE ENDOCRINE SYSTEM
Structure, hormone synthesis, metabolism, control and functions of endocrine glands - hypothalamus, pituitary, pineal, thyroid, parathyroid (calcium and phosphate homeostasis), GI tract (gastrin, secretin and cholecystokinin, GIP, ghrelin, leptin), pancreatic islets.

UNIT II CLASSES OF HORMONES AND MECHANISMS OF HORMONE ACTION
Peptide, steroid, neuro-transmitters, neuropeptides, chalones, peptide-growth stimulating factors,
eicosanoids; Receptors - membrane receptors, nuclear receptors; receptor regulation and signal transduction, second messengers and kinase cascade.
UNIT III ENDOCRINOLOGY OF ADRENALS & GONADS
Structure, hormone synthesis, control, functions of adrenals, male and female gonads, seasonal breeding, pregnancy, placenta and parturition, lactation, contraception and pathophysiology of adrenal and gonadal hormones, stress response.
UNIT IV ENDOCRINE METHODOLOGIES
Ablation and replacement, bioassays, immunoassays, Immunocytochemistry, autoradiography, electrophysiological and pharmacological methods, hormone-receptor interactions, cloning techniques; Imaging and nuclear medicine in endocrine disease and hormone-replacement therapies.
UNIT V ENDOCRINE APPLICATIONS IN TOXICOLOGY
Endocrine disruptors or modulators, sources (plant derived, environmental and xenobiotic),

assessment of disruptor activity (in vitro assays, in vivo assays), Indirect mechanisms of action - effects on hormone metabolism, thyroid function, adrenal function, CNS function and behavior.

REFERENCE BOOKS:

1. Patricia E. Molina (2004) Endocrine Physiology (4th ed.). Mac Graw Hill Lange.
2. David G. Garner and Dolores Shobark (2007) Greenspan's Basic and Clinical Endocrinology (9th ed.). Mac Graw Hill Lange.
3. Sastry K.V. (2005) Endocrinology and Reproductive Biology. Rastogi Publications.
4. Larry J. Jameson (2006) Harrison's Endocrinology (3rd ed.). Mac Graw Hill Education.
5. Mac E. Hadley and Jon E. Levine (2009) Endocrinology (6th ed.). Pearson Education.
6. Chandra S. Negi (2009) Introduction to Endocrinology. Prentice Hall India Learning Pvt. Ltd.
7. Mala Dharmalingam (2010) Textbook of Endocrinology (1st ed.). Jaypee Publications.
8. Matthew J. Neel (2016) How the Endocrine system works (2nd ed.). Wiley Blackwell.
9. Bernherd Kleine and Winfried G. Rossmanith (2015) Hormone and Endocrine system- TB of Endocrinology. Springer Publications.
10. Shlomo melmed, Kenneth S. Polansky, Reed P. Larson and Henry M. Kronberg (eds.) (2015)
Williams Textbook of Endocrinology (13th ed.). Elsevier.
11. Antonio Belfiore and Derek LeRoith (eds.) (2018) Principles of Endocrinology and Hormoneaction (1st ed.). Springer Publications.

15. ADVANCES IN NEMATOLOGY

Unit 1
History and development of nematology in India and abroad – Position of nematode in animal kingdom – Importance of nematodes to plants and animals.
Unit 2
Structure of nematode cuticles, sense organs, digestive, reproductive and nervous system. General characters of class Secernentea. Tylenchoidea– General characters of Tylenchidae, Pratylenchidae, Hoplolaimidae, Heteroderidae, and Tylenchoidea with examples. Classification of plantparasitic nematodes based on feeding habits.
Unit 3
General characters of class Adenophorea. Nematodes of human and animals - Threadworms, Hookworms, Lungworms, Gape worms, Guinea worms, Eye worms, Wuchereria, Heartworms, Ascaris and pinworms. Biology of Entomopathogenic nematodes.
Unit 4
Principle of nematode management – physical methods (soil solarisation, hot water treatment, seed cleaning), cultural methods (deep ploughing, fallowing, crop rotation), biological control (antagonistic crops), chemical control – soil fumigants and nematode management.
Unit 5
Major nematode parasites and their symptoms in Rice (Aphelenchoides besseyi, Hirschmaniella oryzae); Wheat (Anguina tritici, Heterodera avenae); Cotton (Rotylenchulus reniformis); Tomato (Meloidogyne incognita and M. javanica); potato (Globodera rostochiensis, Globodera pallida); Banana (Pratylenchus coffeae, Radopholus similis). Nematode sample collection – nematode extraction (Cobb's technique, centrifugal floatation, Cyst extraction).

REFERENCES

1. Maggenti, A.1981: General Nematology. Springer-Verlag, NewYork Heidelberg Berlin.
2. Swarup, G and Dasgupta. 1986: Plant Parasitic Nematodes of India, Problems and progress. Indian Agricultural Research Institute, New Delhi-110012.
3. Khan, M.R.2008: Plant Nematode Methodology, Morphology,
4. Systematics, Biology and Ecology. Science Publisher, Eden bridge Ltd.