**ANNEXURE - III**

1. **Approval of Pre. Ph.D. course work from the academic year 2024-25 onwards.**

As per the University Grants Commission (Minimum Standards and Procedures forAward of Ph.D. Degree) Regulations, 2022provisions laid down under the Sub-Clause of 1 read with main Clause 9 of the Regulations The Credit requirement for the Ph.D. coursework is a minimum of 12 credits, including a “Research and Publication Ethics” course as notified by UGC vide D.O. No. F.1- 1/2018(Journal/CARE) in 2019 and a research methodology course.

Based on the above Department proposed Pre. Ph.D. Examination Pattern is as follows from the academic year 2024-25 onwards

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Paper | Paper Title | Marks | | Credits |
| External Exam | Internal  Exam |
| I | Research and Publication Ethics | 50 | 00 | 2 |
| II | Research Methodology | 70 | 30a | 4 |
| III | Subject Concerned | 70 | 30b | 4 |
| IV | Literature Survey Report (LSR) | 00 | 50c | 2 |
|  | Total Marks | 190 | 110 | 12 |

a**Participation Certificate**: The research scholar has to present his/her research work (Oral/Poster) in a conference/seminar/workshop and submit certificate of participation to Controller of Examinations (CoE) for valuation. Please make sure to participate conference/seminar/workshop during April-July/August 2024.

b**Research Proposal:** The research scholar has to submit a 5-7 pages “Research Proposal” on his/her research topic under the following headings (1) Title of the Ph.D., thesis, (2) Introduction, Review of Literature, Objectives, (3) Materials & Methods, (4) Time-Line of Research work (1st year…, 2nd Year….3rd year…..etc.,) (5) Budget Estimate (in Rs.) (Recurring and Non-recurring) and (6) References; He/she has to submit the same to HoD for evaluation.

c**Research Survey Report** -The research scholar has to collect published works on his/her research topic, critically analyse them, find gaps in the research work done and formulate 2-3 objective/s for his/her Ph.D., and submit the same to HoD for evaluation.

The matter is placed before the BoS for consideration and approval

**CHAITANYA (DEEMED TO BE UNIVERSITY)**

**Pre-Ph.D. (Agriculture)**

**Paper-I**

**Research and Publication Ethics**

**Hours per week: 02 Credits: 02**

**UNIT-I:**

1. Philosophy and Ethics: Introduction to Philosophy – definition – nature and scope – concept – branches – Ethics: definition – moral philosophy – nature of moral judgements and reactions.
2. Scientific Conduct: Ethics with respect to science and research – Intellectual honesty and research integrity – scientific misconducts: Falsification – Fabrication and Plagiarism – Redundant publications: Duplicate and overlapping publications – salami slicing – Selective reporting and misrepresentation of data.
3. Publication Ethics: Definition – introduction and importance – Best practices / standards setting initiatives and guidelines : COPE – WAME etc - Conflicts of interest – Publication misconduct : Definition – concept – problems that lead to unethical behavior and vice versa – types – Violation of publication ethics – authorship and contributorship – Identification of publication misconduct – complaints and appeals – Predatory publishers and journals.

**UNIT – II:**

1. Open Access Publishing: Open access publications and initiatives – SHERPA / RoMEO online resource to check publisher copyright & self – archiving policies – Software tool to identify predatory publications developed by SPPU – Journal finder / journal suggestion tools viz., JANE, Elsevier journal finder, Springer journal suggester, etc.
2. Publication Misconduct:
3. Group Discussions: Subject specific ethical issues - Falsification – Fabrication and Plagiarism (FFP), authorship – Conflicts of interest- Complaints and appeals : examples and fraud from India and abroad.
4. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.
5. Databases and Research Metrics:
6. Databases: Indexing databases – Citation databases: Web of Science, Scopus, etc.
7. Research Metrics: Impact factor of journal as per journal citation report, SNIP, SJR, IPP, and Cite Score – Metrics: h – index, g index, i10 index, altmetrics.

**References:**

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics, London.
3. P.Chaddah, (2018) Ethics in Competitive Research: Do not get scooped: do not get plagiarized, ISBN: 978-9387480865.
4. National Academy of Science, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible Conduct in Research: Third Edition. National Academy Press.
5. Resnik, D.B. (2011). What is ethics in research & why is it important, National Institute of Environmental Health Sciences, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resoureses/bioethics/whatis/index.cfm>.
6. Bcall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.https://doi.org/10.1038/489179a.
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN: 978-81-939482-1-7, https://www.insaindia.res.in/pdf/Ethics\_Book.pdf.

**PAPER – II: RESEARCH METHODOLGY**

**(Common for all Specializations)**

**PART-A**

**Unit-I: Research Design & Ethics**

1. **Objectives and types of research**: Motivation in research. Approaches and significance of research. Research and scientific methods. Selecting the problem. Technique involved in defining a problem (hypothesis). Interpretation and report writing. Significance of report writing. Different steps in writing report. Stages of writing. Designing illustrations, tables, figures, general guidelines for illustrations. Oral presentation. Citation methods. Impact factor.
2. **Research Ethics**: Ethics in research. Misconduct and consequences. Forms and consequences of plagiarism. Intellectual property rights. Copy right regulations and patents.

**Unit-II: ICT in Research and Data Analysis**

1. **Use of ICT for research purposes** – Internet and web-based resources. Search engines. Advanced search techniques. Use of web as a tool for scientific literature survey.
2. **Data Analysis –** Types of errors. Accuracy and Precision. Least square analysis, average and standard deviations. Correlation and Regression analysi**s.** Methods of least squares. Regression versus correlation. Correlation versus determination. Types of correlation and their specific applications.

**PART-B**

**Pre-Ph.D. (Agriculture)**

**Paper-IV**

**Analysis of Published research papers / scientific literature**

**Hours per week: 02 Credits: 02**

A research scholar should submit analysis of published research papers / scientific literature in the form of dissertation.

**Ph.D Agriculture: Horticulture - Specialization in Vegetable science**

**PAPER – III: Recent Trends in Vegetable Production (VSC 601)**

**I. Course Title :** Recent Trends in Vegetable Production

**II. Course Code :** VSC 601

**III. Credit Hours :** (3+0)

**IV. Why this course ?**

India is the second largest producer of vegetables in the world, next only to China. Most challenging task is to ensure for continuous and enough supply of vegetables to growing population. Urban areas are experiencing substantial increase in population; this growth is accompanied with change in food habits and rising concerns for food quality. Here, food quality refers to the optimum levels of the nutrition in the food along with the minimized amount of the chemical (pesticides/ fertilizers) residues used in the production of the vegetables. Vegetables are being highly seasonal, perishable are also capital and labour intensive and need care in handling and transportation. Environmental stress (climate change) and shortage of water and land resources are major constraints haunting the production. Though the advances in science and information technology has resulted in more comfortable world with global linkages, these advances has led to changes in production practices. Thus, the students of vegetable science need to have an understanding of recent trends in production technology of vegetable crops and their management.

**V. Aim of the course**

To keep abreast with latest developments and trends in production technology of vegetable crops.

The course is constructed given as under:

**No. Block Unit**

1 Recent trends in vegetable 1. Solanaceous crops

production 2. Cole crops

3. Okra, onion, peas and beans, amaranth

and drumstick.

4. Root crops and cucurbits

5. Tuber crops

**VI. Theory**

Present status and prospects of vegetable cultivation; nutritional, antioxidant and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; Hi-tech nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies/ disorders and correction methods; different cropping systems; mulching; Protected cultivation of vegetables, containerized culture for year round vegetable production; low cost polyhouse; nethouse production; crop modelling, organic gardening; vegetable production for pigments, export and processing of:

**Unit I**

Solanaceous crops: Tomato, brinjal, chilli, sweet pepper and potato.

**Unit II**

Cole crops: Cabbage, cauliflower and knol-khol, sprouting broccoli.

**Unit III**

Okra, onion, peas and beans, amaranth and drumstick.

**Unit IV**

Root crops and cucurbits: Carrot, beet root, turnip and radish and cucurbits

**Unit V**

Tuber crops: Sweet potato, Cassava, elephant foot yam, Dioscorea and taro.

**VII. Teaching Methods/ Activities**

• Classroom Lectures

• Assignment (written and speaking)

• Student presentation

• Group discussion

**VIII. Learning outcome**

After successful completion of this course, the students are exposed to:

• Acquire the knowledge about recent trends in production technology of vegetable crops

**IX. Suggested Reading**

Bose TK and Som NG. 1986. Vegetable crops of India. Naya prokash. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III.

Naya Udyog.

Brewster JL. 1994. Onions and other vegetable alliums. CABI.

Chadha KL and Kalloo G (Eds.). 1993-94. Advances in horticulture Vols. V-X. Malhotra Publ.

House.

Chadha KL (Ed.). 2002. Hand book of horticulture. ICAR.

Chauhan DVS (Ed.). 1986. Vegetable production in India. Ram prasad and Sons.

Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol.

II. Kalyani.

FFTC. Improved vegetable production in Asia. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN and Nair RG. 1988. Tuber crops. Oxford and

IBH.

Gopalakrishanan TR. 2007. Vegetable crops. New India Publ. Agency.

Hazra P and Som MG. 2015. Seed production and hybrid technology of vegetable crops. Kalyani

publishers, Ludhiana.

Hazra P. 2016. Vegetable science. 2ndedn, Kalyani publishers, Ludhiana.

Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.

Kallo G and Singh K. (Ed.). 2001. Emerging scenario in vegetable research and development.

Research periodicals and Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S and Pallai SV. 1996. Tropical

tuber crops, problems, prospects and future strategies. Oxford and IBH.

Rana MK. 2008. Olericulture in India. Kalyani Publishers, New Delhi.

Rana MK. 2008. Scientific cultivation of vegetables. Kalyani Publishers, New Delhi.

Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and

nutritive values. Chapman and Hall.

Saini GS. 2001. A Text Book of oleri and flori culture. Aman Publishing House.

Salunkhe DK and Kadam SS. (Ed.). 1998. Hand book of vegetable science and technology:

production, composition, storage and processing. Marcel Dekker.

Shanmugavelu KG. 1989. Production technology of vegetable crops. Oxford and IBH.

Sin MT and Onwueme IC. 1978. The tropical tuber crops. John Wiley and Sons.

Singh DK. 2007. Modern vegetable varieties and production technology. International book

distributing Co.

Singh NP, Bhardwaj AK, Kumar A and Singh KM. 2004. Modern technology on Vegetable

production. International book distr. Co.

Singh PK, Dasgupta SK and Tripathi SK. 2006. Hybrid vegetable development. International

book distr. Co.

Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. Comm. Res. Centre.

Thamburaj S and Singh N. (Eds.). 2004. Vegetables, tuber crops and spices. ICAR.

Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw-Hill.

**PAPER – III: Advances in Breeding of Vegetable Crops (VSC 602)**

**I. Course Title :** Advances in Breeding of Vegetable Crops

**II. Course Code :** VSC 602

**III. Credit Hours :** (3 +0)

**IV. Why this course ?**

The improvement of vegetable crops has until recently, been largely confined to conventional breeding approaches and such programmes rely on hybridization of plants which have desirable heritable characteristics and on naturally or artificially induced random mutations. The introduction of new genetic information can result in increased resistance to insect pest, diseases tolerance to environmental condition, improved quality, etc. The modern biotechnological tools like molecular assisted selection, double haploidy, genetic engineering, etc. can be of immense importance for rapid development of superior varieties with desirable qualitative and quantitative traits. Therefore, conventional breeding in conjunction with molecular biology has bright prospects of developing high yielding vegetable varieties with high nutraceuticals and bio active compounds suitable for fresh as well as processed market. The students of vegetable science who are having breeding as major subject need to have an understanding of recent technologies in vegetable crops.

**V. Aim of the course**

To impart knowledge on the recent research trends and advances in breeding of vegetable crops.

The course is constructed given as under:

**No. Block Unit**

1 Advances in Breeding of vegetable I. Solanaceous crops and okra

crops II. Cucurbits and Cole crops

III. Legumes and leafy vegetables

IV. Root crops and onion

V. Tuber crops

**VI. Theory**

Evolution, distribution, cytogenetics, Genetics and genetic resources, wild relatives, genetic divergence, hybridization, inheritance of qualitative and quantitative traits, heterosis breeding, plant idotype concept and selection indices, breeding mechanisms, pre breeding, mutation breeding, ploidy breeding, breeding for biotic and abiotic stresses, breeding techniques for improving quality and processing characters, biofortification, in-vitro breeding, marker assisted breeding, haploidy, development of transgenic

**Unit I**

Solanaceous crops—Tomato, Brinjal, Hot Peeper, Sweet Pepper, Okra and Potato

**Unit II**

Cucurbits and Cole crops

**Unit III**

Legumes and leafy vegetables—Peas and Beans, Amaranth, Palak, Chenopods and Lettuce.

**Unit IV**

Root crops and onion—Carrot, Beetroot, Radish, Turnip, Onion

**Unit V**

Tuber crops—Sweet potato, Tapioca, Elephant foot yam, Colocasia, Dioscorea

**VII. Teaching Methods/ Activities**

• Classroom Lectures

• Assignment (written and speaking)

• Student presentation

• Group discussion

**VIII. Learning outcome**

After successful completion of this course, the students are exposed to:

• Breeding objectives and trends

• Recent Adavnces in vegetable breeding

**IX. Suggested Reading**

Allard RW. 1999. Principle of plant breeding. John Willey and Sons, USA.

Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.

Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural

crops. Narosa Publ. House.

Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: Breeding and seed production.

Vol. I. Kalyani.

Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.

Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.

Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. Plant Breeding-principles and

prospects. Chapman and Hall.

Hazra P and Som MG. 2015. Vegetable science (Second revised edition), Kalyani publishers,

Ludhiana, 598 p

Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised

edition), Kalyani Publishers, Ludhiana, 459 p

Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.

Kalloo G. 1998. Vegetable breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.

Kumar JC and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro

Botanical Publ.

Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid

technology in Asia-Pacific Region. FAO.

Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. Revised, ICAR.

Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium press LLC, P.O. Box

722200, Houston, Texas 77072, USA, 678p.

Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II.Studium Press LLC,

P.O. Box 722200, Houston, Texas 77072, USA, 509p.

Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III.Studium Press LLC,

P.O. Box 722200, Houston, Texas 77072, USA, 634p.

Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.

Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi.

Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding.

Kalyani Publishers, New Delhi.

Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi.

Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International

Book Distributing Co.

Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

**PAPER – III: Seed Certification, Processing and Storage of Vegetable crops (VSC 604)**

**I. Course Title :** Seed Certification, Processing and Storage of Vegetable Seeds

**II. Course Code :** VSC 604

**III. Credit Hours :** (2+1)

**IV. Why this course ?**

Every farmer should able to access healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds plays a vital role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient certification procedures plays a major role in the increase of food production of our country. To ensure this, the Government has prescribed standards and has brought in seed production techniques, testing, certification and marketing procedures through the Seeds Act, 1966. In the current scenario, the demand for good quality certified seeds far exceed the availability in the market. This manual provides details about production and procurement of good quality seeds.

**V. Aim of the course**

To impart the knowledge on seed certification, processing and storage of vegetable seeds

**VI. Theory**

**Unit I**

Seed certification, history, concepts and objectives, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, Planning and management of seed certification programmes.

**Unit II**

Principles and procedures of field inspection, seed sampling, testing and granting certification, OECD certification Schemes.

**Unit III**

Principles of seed processing, Methods of seed drying and cleaning, seed processing plant- Layout and design, seed treatment, seed quality enhancement, packaging and marketing.

**Unit IV**

Principles of Seed Storage, orthodox/ recalcitrant seeds, types of storage (open, bulk, controlled, germplasm, cryopreservation), factors affecting seed longevity in storage (Pre and post harvest factors).

**Unit V**

Seed aging and deterioration, maintenance of seed viability and vigor during storage,

storage methods, storage structures, transportation and marketing of seeds.

**VII. Practical**

• General procedures of seed certification;

• Field inspection and standards;

• Isolation and rouging;

• Inspection and sampling at harvesting, threshing and processing;

• Testing physical purity, germination and moisture, grow-out test; Visit to regulatory seed testing and plant quarantine laboratories;

• Seed processing plants and commercial seed stores.

**VIII. Teaching Methods/ Activities**

• Classroom Lectures

• Assignment (written and speaking)

• Student presentation individual or in group

• Hands on training of different procedure

• Group discussion

**IX. Learning outcome**

After successful completion of this course, the students are expected to:

• Acquire the knowledge on seed certification

• Acquire the knowledge on seed processing and storage

**X. Suggested Reading**

Agarwaal PK and Anuradha V. 2018. Fundamentals of seed science and technology. Brilliant

publications, New Delhi.

Basra AS. 2000. Hybrid seed production in vegetables. CRC press, Florida, USA.

Bench ALR and Sanchez RA. 2004. Handbook of seed physiology. Food products press, NY/

London.

Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. Testing of distinctiveness,

uniformity and stability for plant variety protection. IARI, New Delhi

Copland LO and McDonald MB. 2004. Seed science and technology, Kluwer academic press.

Fageria MS, Arya PS and Choudhry AK. 2000. Vegetable crops: breeding and seed production

Vol 1. Kalyani publishers, New Delhi.

George RAT. 1999. Vegetable seed production (2nd Edition). CAB International.

Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised

edition), Kalyani publishers, Ludhiana, 459p

Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. Seed: A global perspective. Associated

publishing company, New Delhi.

Singhal NC. 2003. Hybrid seed production. Kalyani publishers, New Delhi.

**PAPER – III: Biotechnological Approches in Vegetable Crops (VSC 607)**

**I. Course Title :** Biotechnological Approaches in Vegetable Crops

**II. Course Code :** VSC 607

**III. Credit Hours :** (2+1)

**IV. Why this course ?**

Biotechnology is a rapidly developing area of contemporary science. It can bring new ideas, improved tools and novel approaches to the solution of some persistent, seemingly intractable problems in vegetable production. Given the pressing need to enhance and stabilize the vegetable production in response to mounting population pressures and increasing awareness, there is an urgent need to explore novel technologies that will break traditional barriers.

**V. Aim of the course**

To impart latest knowledge in biotechnical advancement in vegetable crops

The course is organised as follows:-

**No. Blocks Units**

1 Biotechnological approaches in I Importance and scope of Biotechnology

vegetable crops II Somatic embryogenesis

III Blotting techniques, DNA finger printing,

IV Plant genetic engineering

V Concepts and methods of next generation

sequencing (NGS)

**VI. Theory**

**Unit I**

Importance and scope of biotechnology – in vegetable crop improvement. In-vitro culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture.

**Unit II**

Somatic embryogenesis – somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Somatic hybrids and cybrids and their application in vegetable improvement programme.

**Unit III**

Blotting techniques, DNA finger printing – Molecular markers/ DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allele mining by TILLING and EcoTILLING.

**Unit IV**

Plant genetic engineering – Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Biosafety issue, regulatory issues for commercial approval.

**Unit V**

Concepts and methods of next generation sequencing (NGS)- Genome sequencing, transcriptomics, proteomics, metabolomics. Genome editing (ZFN, TALENS and CRISPER) Crops. Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables

**VII. Practical**

• Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production (2);

• In-vitro mutation induction, in-vitro rooting – hardening at primary and secondary nurseries (3);

• DNA isolation from economic vegetable crop varieties – Quantification and amplification (2);

• DNA and Protein profiling – molecular markers, PCR Handling (2);

• Vectors for cloning and particle bombardment (3);

• DNA fingerprinting of flower crop varieties (3);

• Project preparation for establishment of low, medium and high cost tissue culture laboratories (1).

**VIII. Teaching Methods/ Activities**

• Class room lectures

• Laboratory/ field practicals

• Student seminars/ presentations

• Field tours/ demonstrations

• Assignments

**IX. Learning outcome**

The student would be expected to learn

• Different biotechnological tools

• NGS, genetic engineering

**X. Suggested Reading**

Bajaj YPS. (Ed.). 1987. Biotechnology in agriculture and forestry. Vol. XIX. Hitech and Micropropagation. Springer.

Chadha KL, Ravindran PN and Sahijram L. (Eds.). 2000. Biotechnology of horticulture and

plantation crops. Malhotra Publ. House.

Debnath M. 2005. Tools and techniques of biotechnology. Pointer publication, New Delhi.

Glover MD. 1984. Gene cloning: the mechanics of DNA manipulation. Chapman and Hall.

Gorden H and Rubsell S. 1960. Hormones and cell culture. AB Book Publ.

Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New India

Publ. Agency.

Keshavachandran R and Peter KV. 2008. Plant biotechnology; tissue culture and gene transfer.

Orient and Longman, USA.

Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New-India

Publication Agency, New Delhi.

Panopoulas NJ. (Ed.). 1981. Genetic engineering in plant sciences. Praeger Publ.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology

of horticultural crops. Vols. I-III. Naya Prokash.

Pierik RLM. 1987. In-vitro culture of higher plants. Martinus Nijhoff Publ.

Prasad S. 1999. Impact of plant biotechnology on horticulture. 2nd Ed. Agro Botanica.

Rout GR and Peter KV. 2018. Genetic engineering of horticultural crops. Academic Press Elsveer,

USA.

Sharma R. 2000. Plant tissue culture. Campus Books.

Singh BD. 2010. Biotechnology- expanding horizons. Kalyani Publishers, New Delhi.

Skoog Y and Miller CO. 1957. Chemical regulation of growth and formation in plant tissue

cultured in-vitro. Attidel. II Symp. On biotechnology action of growth substance.

Vasil TK, Vasi M, While DNR and Bery HR. 1979. Somatic hybridization and genetic

manipulation in plants, plant regulation and world agriculture. Planum Press.

**Ph.D Agriculture (Entomology)**

**PAPER – III: Immature Stages of Insects (ENT 602)**

**ENT 602 IMMATURE STAGES OF INSECTS 1+1**

**Objective**

To impart knowledge on morphology of immature stages of different groups of insects. Train the students in identification of common pest species during their immature stages.

**Theory**

**UNIT I**

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

**UNIT II**

Comparative study of life history strategies in hemi metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

**Practical**

Collection and preservation of immature forms of insects, Rearing of Immature stages of insects,

Study of different types of keys and practicing them, Comparative morphology and identification

of immature forms of order Lepidoptera, Comparative morphology and identification of immature

forms of order Coleoptera, Comparative morphology and identification of immature forms of

order Hymenoptera, Comparative morphology and identification of immature forms of order

Diptera, Comparative morphology and identification of immature forms of order Neuroptera.

**Suggested Readings**

Chu HF. 1992. How to Know Immature Insects. William Brown Publ., Iowa.

Peterson A. 1962. Larvae of Insects. Ohio University Press, Ohio.

Stehr FW. 1998. Immature Insects. Vols. I, II. Kendall Hunt Publ., Iowa

**PAPER – III: Advanced Insect Physiology (ENT 603)**

**ENT 603 ADVANCED INSECT PHYSIOLOGY 2+0**

**Objective**

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

**Theory**

**UNIT I**

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

**UNIT II**

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

**UNIT III**

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

**UNIT IV**

Endocrine system and insect hormones, physiology of insect growth and developmentmetamorphosis, polyphenism and diapause. Energetics of muscle contractions.

**References :**

Kerkut GA & Gilbert LI. 1985. Insect Physiology, Biochemistry and Pharmacology. Vols. IXIII. Pergamon Press, Oxford, New York.

Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement

of Entomology, Trivandrum, Kerala.

Murray S. Blum 1985 Fundamentals of Insect physiology. John Wiley & Sons, USA

**PAPER – III: Advanced Insecticide Toxicologylogy (ENT 607)**

**ENT 607 ADVANCED INSECTICIDE TOXICOLOGY 2+1**

**Objective**

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides and pesticide resistance mechanisms in insects.

**Theory**

**UNIT I**

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

**UNIT II**

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their mode of action and structural – activity relationships; advances in metabolism of insecticides.

**UNIT III**

Joint action of insecticides; activation, synergism and potentiation.

**UNIT IV**

Problems associated with pesticide use in agriculture: pesticide resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

**UNIT V**

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

**Practical**

Pesticide residues-Definition, Objectives of analysis and tolerance limits, Preparation of standardpesticide solutions,Sampling techniques in insecticide residue estimation, Methods of insecticide extraction from different samples, Methods of cleanup in insecticide residue estimation, Analysis of insecticide residues by Spectrophotometry, Analysis of insecticide residues byChromatography, Analysis of insecticide residues by ELISA, Radioisotopes & Mass Spectrometry, Biochemical techniques for detection of insecticide resistance in insects,Biological techniques for detection of insecticide resistance in insects, Visit to toxicology laboratories.

**Suggested Readings**

Busvine JR. 1971. A Critical Review on the Techniques for Testing Insecticides. CABI, London.

Dhaliwal GS & Koul O. 2007. Biopesticides and Pest Management. Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. Handbook of Pesticide Toxicology. Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.

Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York.

O’ Brien RD. 1974. Insecticides Action and Metabolism. Academic Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. Insecticides in Agriculture and Environment.Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ.,

**PAPER – III: Advanced Acarology (ENT 609)**

**ENT 609 ADVANCED ACAROLOGY 1+1**

**Objective**

To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

**Theory**

**UNIT I**

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

**UNIT II**

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

**UNIT III**

Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites UNIT IV Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

**Practical**

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens etc.

**Suggested Readings**

Evans GO.1992. Principles of Acarology. CABI, London.

Gerson H & Smiley RL. 1990. Acarine Biocontrol Agents- An Illustrated Key and Manual.Chapman & Hall, New York.

Gupta SK. 1985. Handbook of Plant Mites of India. Zoological Survey of India, Calcutta.

Krantz GW. 1970. A Manual of Acarology. Oregon State University Book Stores, Corvallis,Oregon.

**Blue print for Paper-I**

**(For Theory Examinations)**

**Course: Pre- Ph.D. (Agriculture)**

**Duration: 2 Hours Max Marks: 50**

**Section-A**

Answer any FIVE questions. Each question carries ten marks (5 X 10= 50)

1. From I unit.
2. From I unit.
3. From I unit.
4. From I unit.
5. From I unit.
6. From II unit.
7. From II unit.
8. From II unit.
9. From II unit.
10. From II unit.

**MODEL FOR BOTH PAPER-II AND PAPER-III**

**Time : 3 hours Max. Marks: 100**

**[Two questions from each Unit]**

**[Each question carries 10 ]**

**[The candidate has to answer any five questions]**

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]

1. (a) [10 Marks]

(b) [10 Marks]