

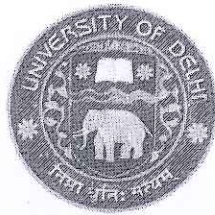
Ann-10.01(a)

Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

FACULTY OF SCIENCE

UNDERGRADUATE PROGRAMME (Courses effective from Academic Year 2015-16)



SYLLABUS OF COURSES TO BE OFFERED

Core Courses, Elective Courses & Ability Enhancement Courses

Disclaimer: The CBCS syllabus is uploaded as given by the Faculty concerned to the Academic Council. The same has been approved as it is by the Academic Council on 13.7.2015 and Executive Council on 14.7.2015. Any query may kindly be addressed to the concerned Faculty.

Undergraduate Programme Secretariat

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
 - 2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
 - 2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
 - 2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
 - 3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.
 - 3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Details of Courses Under Undergraduate Programme (B.Sc.)

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
<u>I. Core Course</u> (12 Papers) 04 Courses from each of the 03 disciplines of choice	12X4= 48	12X5=60
Core Course Practical / Tutorial* (12 Practical/ Tutorials*) 04 Courses from each of the 03 Disciplines of choice	12X2=24	12X1=12
<u>II. Elective Course</u> (6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.	6x4=24	6X5=30
Elective Course Practical / Tutorials* (6 Practical / Tutorials*) Two Papers from each discipline of choice including paper of interdisciplinary nature	6 X 2=12	6X1=6
<ul style="list-style-type: none"> • Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester 		
<u>III. Ability Enhancement Courses</u>		
1. Ability Enhancement Compulsory (2 Papers of 2 credits each) Environmental Science English/MIL Communication	2 X 2=4	2X2=4
2. Ability Enhancement Elective (Skill Based) (4 Papers of 2 credits each)	4 X 2=8	4 X 2=8
	Total credit= 120	Total credit= 120
Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.		

*wherever there is practical there will be no tutorials and vice -versa

Details of Courses

Core Courses –Botany

1. Biology of life forms: Plants
2. Agricultural Botany and Weed science
3. Fundamentals of Plant Systematics and Ecology
4. Developmental Biology: Plants

Core Courses: Zoology

1. Animal: Form, Structure and Function
2. Cell and cellular Processes
3. Biochemistry and Immunology
4. Molecular biology and Development biology

Core Courses-Chemistry

1. Inorganic chemistry
2. Organic Chemistry -1
3. Organic Chemistry-2
4. Physical chemistry

Discipline Specific Electives-Botany (Any two)

1. Genetics and Plant Biotechnology
2. Plants regulators and Economic Botany
3. Dissertation

Discipline Specific Electives: Zoology (Any two)

1. General Entomology
2. Applied Entomology
3. Integrated Pest Management
4. Dissertation

Discipline Specific Electives-Chemistry (Any two)

1. Soils And Fertilizers
2. Herbicides
3. Fungicides
4. Dissertation

Ability Enhancement Compulsory Courses

1. English Communication
2. Environmental Science

Skill Enhancement Courses (Any four)

Botany

1. Medicinal Plants and IPR (Intellectual Property Rights)
2. Plants Quarantine
3. Plant health diagnostics and Management
4. Plants regulators and Economic Botany

Zoology

1. Biotechnological control of Pest
2. Biological Control
3. Insect Toxicology
4. Quality control in IPM
5. Use of nuclear technology for agro-pest management

Chemistry

1. Conventional Insecticides
2. Biological Insecticides
3. Pesticide Formulations
4. Analytical Techniques involved in Pesticide Analysis

Scheme of B.Sc. Programme (Applied Life Sciences with Agro-chemicals and Pest Management)

Semester	Course Opted	Course Name	Credits
I	Ability Enhancement Compulsory Courses-I	Environmental Science/ English Communication	2
	Core course Botany -I		4
	Core Course Botany I Practical		2
	Core course Zoology- I		4
	Core Course Zoology- I Practical		2
	Core course Chemistry- I		4
	Core Course Chemistry- I Practical		2
II	Ability Enhancement Compulsory Courses-II	Environmental Science/ English Communication	2
	Core course Botany -II		4
	Core Course Botany II Practical		2
	Core course Zoology-II		4
	Core Course Zoology- II Practical		2
	Core course Chemistry- II		4
	Core Course Chemistry- II Practical		2
III	Core course Botany -III		4
	Core Course Botany III Practical		2
	Core course Zoology-III		4
	Core Course Zoology- III Practical		2
	Core course Chemistry- III		4
	Core Course Chemistry- III Practical		2
	Skill Enhancement Course I		2
IV	Core course Botany -IV		4
	Core Course Botany IV Practical		2
	Core course Zoology-IV		4
	Core Course Zoology- IV Practical		2
	Core course Chemistry- IV		4
	Core Course Chemistry- IV Practical		2
	Skill Enhancement Course II		2
V	Discipline Specific Elective Botany -I		4
	Discipline Specific Elective Botany-I Practical		2
	Discipline Specific Elective Zoology -I		4
	Discipline Specific Elective Zoology -I Practical		2
	Discipline Specific Elective Chemistry -I		4
	Discipline Specific Elective Chemistry -I Practical		2
	Skill Enhancement Course III		2
VI	Discipline Specific Elective Botany -II		4
	Discipline Specific Elective Botany-II Practical		2

	Discipline Specific Elective Zoology -II		4
	Discipline Specific Elective Zoology -II Practical		2
	Discipline Specific Elective Chemistry -II		4
	Discipline Specific Elective Chemistry -II Practical		2
	Skill Enhancement Course_IV		2
	Total		120

CORE COURSES –BOTANY 1

Biology of life forms: Plants
(Credits: Theory-4, Practicals-2)

Theory (Lectures: 60)

Unit 1: Classifying the diversity of life: Kingdoms of Life –Eubacteria, Archaea and Eukaryotes
(4 Lectures)

Unit 2: Viruses: Discovery; Physiochemical and biological characteristics; Classification; Replication, Lytic and Lysogenic cycle; Structure of DNA virus (bacteriophage T4), RNA virus (TMV), economic importance. (6 Lectures)

Unit 3: Bacteria: Discovery of bacteria; Ecology and distribution; General structure; Comparison of Archaea and Eubacteria; Wall-less forms (L-forms, Mycoplasma, Protoplasts and Sphaeroplasts) Nutrition; Reproduction–vegetative, asexual and recombination; Economic importance. (8Lectures)

Unit 4: Algae: Diagnostic features of identification; morphology, reproduction and classification with special reference to *Nostoc*, *Volvox*, and *Spirogyra*. Economic importance of Algae. (10 Lectures)

Unit 5: Fungi: Diagnostic features of identification; morphology, reproduction and classification with special reference to *Rhizopus*, *Penicillium*, *Agaricus* and *Alternaria*; Lichens (a general account), and economic importance of lichens and fungi. (10 Lectures)

Unit 6: Archegoniate: Characteristic features of identification, classification and reproduction of Bryophytes and Pteridophytes with special reference to *Marchantia*, *Funaria*, and *Pteris*; economic importance of bryophytes and pteridophytes. (12 Lectures)

Unit 7: Gymnosperms: Characteristic features, classification, study of vegetative structures and reproduction of gymnosperms, economic importance of gymnosperms. *Pinus*: detailed account. (5 Lectures)

Unit 8: Angiosperms: Diagnostic features, Structure of flower, inflorescence, and fruits. (5 Lectures)

Practicals

1. **Viruses:** EM of TMV and Bacteriophage, study specimens of virus infected plants (any two)
2. **Bacteria:** Types through permanent slides/photographs, specimens of infected plants (any two).
3. **Algae:** Study of vegetative and reproductive structures of (a) *Nostoc* (b) *Volvox*, (c) *Spirogyra* through temporary preparations and permanent slides.
4. **Fungi:** Study of vegetative and reproductive structures of (a) *Rhizopus*, (b) *Penicillium*, (c) *Alternaria* and (d) *Agaricus* through temporary preparations and permanent slides/specimen/photographs.
5. Study of growth forms of Lichens (crustose, foliose and fruticose)
6. **Bryophytes:** Study of (a) *Marchantia* morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides), (b) *Funaria*: detailed study and classification from W.M. rhizoids, leaf, operculum, peristome, spores and permanent slides of archegonia, antheridia and capsule.
7. **Pteridophytes:** Study of (through temporary/permanent slides) and classification of *Pteris*: detailed study of T. S. of rachis, V.S. of sporophyll and W.M. of sporangium.
8. **Gymnosperms:** Study of *Pinus* from specimens and permanent slides only.
9. **Angiosperms:** Study of flower morphology, types of inflorescence (any 5 types) and fruit type (any 5 types) through specimen or photographs.

Suggested Readings:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad

CORE COURSES –BOTANY II
Agricultural Botany and Weed Science
(Credits: Theory-4, Practicals-2)

Theory (Lectures: 60)

SECTION A: Agricultural Botany

Unit 1 Seed Physiology - Seed dormancy, types, factors causing dormancy, mechanism and methods for breaking seed dormancy, seed viability, seed vigour, hormonal regulation of seed dormancy and germination (Lectures: 8)

Unit 2: Physiology of Growth and Yield - Principal of growth analysis, source-sink relationship, factors affecting growth, dry matter partitioning and yield, crop simulations and modeling, use of controlled environment for plant growth and development studies, concept of phytotronics. (Lectures: 8)

Unit 3: Chemical Regulation of Growth and Development - Role of hormones in plant growth and development, commercial applications of growth regulators, growth retardant and its usefulness. (Lectures: 8)

Unit 4: Reproductive Physiology and Senescence - Photoperiodism, flowering response, photo perception, critical photoperiod, photo-induction, phytochrome and its role in flowering, hormonal regulation, vernalization, physiology of fruit ripening, senescence, regulation of senescence. (Lectures: 10)

SECTION B: Weed Science

Unit 5: Biology of Weeds - Ecology of weeds, competition, reproduction of weeds. Seed biology. (Lectures: 6)

Unit 6: Weed Management Practices - Mechanical Practices, Cultural Practices, Biological control. (Lectures: 8)

Unit 7: Chemical Weed Control - Herbicide classification, Selectivity of herbicides, absorption and translocation of herbicides, Mode of action of herbicides, Detoxification mechanisms of herbicides. Weed resistance to herbicides. (Lectures: 8)

Unit 8: Weed Control Methods: Weed control in wheat, rice and vegetable crops. Control of five abnoxious weeds. (Lectures: 4)

Practicals

1. To study opening and closing of stomata.
2. To determine stomatal index of the given leaf.
3. To study the effect of ethylene on shelf life of cut flowers.
4. To study the effect of cytokinin on leaf senescence.
5. To study effect of heavy metals on growth and development.
6. To test the viability of weed seeds.
7. To evaluate the allelopathic effects of weeds on germination of crop seeds.
8. To evaluate effect of herbicides on seed germination and seedling growth of weeds.

Suggested Readings:

1. Taiz, L. & Zeiger, E. 2006 Plant Physiology (5th edition) Sinauer Associates, Inc. Sunderland,
2. M.A.W.G. Hopkins, Introduction to plant physiology, John Wiley and Sons Inc USA.
3. Mandal, R.C., Weeds, weedicides and weed control: Principle and Practice Agro Botanical Publishers, Delhi
4. Subramanian,S. All about weed control, Kalayani publishers.
5. F. M. Ashton and T. J. Monaco, *Weed Science: Principles and Practices*. John Wiley and Sons. Inc.
6. V. S. Rao, *Principles of Weed Science*. Oxford and IBH Publishers, New Delhi

CORE COURSES –BOTANY III

Fundamentals of Plant Systematics and Ecology

(Credits: Theory-4, Practicals-2)

Theory

(Lectures: 60)

SECTION A: Systematics

Unit 1: Aims, fundamental components of systematics description, identification, nomenclature, phylogeny, classification: artificial, natural and phylogenetic, biosystematics. **(5 Lectures)**

Unit 2: Systematics in Practices: Herbarium- Methods and their roles, role of computers and internet resources in identification; Keys, floras, monographs, manuals and journals. **(8 Lectures)**

Unit 3: Taxonomic Hierarchy- Concept of taxa, categories and hierarchy. **(4 Lectures)**

Unit 4: Botanical Nomenclature- principles and rules; ranks and names, type method; author citation; valid publication; rejection of names, principle of priority and its limitations; names of hybrids and cultivars. **(9 Lectures)**

Unit 5: System of classification: An outline of Bentham and Hooker's and Engler and Prantl's systems of classification and their merits and Demerits. APG-III (brief introduction only) **(6 Lectures)**

SECTION B: Ecology

Unit 6: Introduction to ecology, level of organization **(2 Lecture)**

Unit 7: Ecological factors **(10 Lectures)**
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 8: Biotic interactions **(2 Lectures)**

Unit 9: Plant communities **(6 Lectures)**
Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 10: Ecosystem **(8 Lectures)**
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; biogeochemical cycling; carbon, nitrogen and Phosphorous cycle.

Practicals

1. Study of herbarium technique (Mounting of a properly dried and pressed specimen of any wild plant on sheet with complete herbarium label).
2. Taxonomic study of characters of 2 plants from each of the following families:
(a) *Malvaceae*
(b) *Solanaceae*,
(c) *Asteraceae*
(d) *Fabaceae*
Classification according to the system of Bentham and Hooker.
3. Use of internet in identification of plants.
4. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
5. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
6. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Symbiotic interaction: Root nodules, Epiphytes, Predation (Insectivorous plants)
7. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (Species to be listed)
8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law

Suggested readings:

1. Gurcharan Singh (2004) Plant Systematics — *Theory and Practice* (2nd Ed.) Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Simpson, M.C. (2006). Plant Systematics. Elsevier, Amsterdam.
3. Bhattacharyya, Bharati (2008) Systematic botany, narosa Publishing House
4. Sabamurty, A.V.V.S. (2005) Taxonomy of Angiosperms, I.K. International Pvt. Ltd New Delhi.
5. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
6. Sharma, P.D. (2010) 12th edition Ecology and Environment. Rastogi Publications, Meerut, India.

CORE COURSES –BOTANY IV

Developmental Biology: Plants

(Credits: Theory-4, Practicals-2)

Theory	(Lectures: 60)
Unit 1: Meristematic and permanent tissue:	(10 Lectures)
Meristems and derivatives- structural organization of shoot and root apices; permanent tissue: simple and complex tissues.	
Unit 2: Dermal system	(4 Lectures)
Epidermis, cuticle, stomata, trichomes and glands	
Unit 3: Organs	(6 Lectures)
Structure of dicot and monocot root, stem and leaf.	
Unit 4: Secondary Growth	(10Lectures)
Vascular cambium – structure and function, Secondary growth in root and stem, periderm.	
Unit5: Structural organization of flower	(1Lecture)
Unit 6: Anther:	(8Lectures)
structure and development, microsporogenesis, pollen development; structure of pollen wall.	
Unit 7: Ovule:	(8Lectures)
structure and types, megasporogenesis and megagametogenesis, mature embryo sac	
Unit 8: Pollination and fertilization:	(6 Lectures)
Pollination mechanisms and adaptations; double fertilization; sexual incompatibility- basic concepts	
Unit 9: Endosperm and embryo:	(5Lectures)
Types and function of endosperm, embryogenesis, Dicot and monocot embryo	
Unit 10: Seed development basic concepts	(2 Lectures)

Core Course Zoology –I

Animal: Form Structure and Function

(Credits: Theory-4, Practicals-2)

Theory (60Lectures)

Unit 1. General characteristics and outline classification of different animal groups (upto classes for non-chordates and upto orders for chordates) (5Lectures)

Unit 2. Acoelomates (5Lectures)
Locomotion and reproduction in Protista; Canal system in Porifera; Metagenesis and polymorphism in Cnidarians; Parasitic adaptations in Platyhelminthes.

Unit 3. Schizocoelomates (4 lectures)
Metamerism in Annelida; Vision in Arthropods; Shell and Pearl formation in molluscs.

Unit 4. Enterocoelomates (6 lectures)
Water Vascular system in Echinodermata; Osmoregulation in Fishes; Respiration in Amphibians; Adaptation in Reptiles; Flight adaptations in Birds; Integument in Mammals.

Unit 5. Tissues and Glands (6 lectures)
Different types of tissues in man-Epithelial, Connective, Muscular and Nervous; Types of Glands.

Unit 6. Muscular Physiology (6 lectures)
Mechanism of Muscular Contraction.

Unit 7. Physiology of Digestion (6 lectures)
Mechanical and Chemical digestion of food, & absorption of food

Unit 8. Respiration & Renal physiology (8 lectures)
Transport of oxygen & carbon dioxide in blood. Functional anatomy of kidney, counter-current mechanism and urea cycle.

Unit 9 Circulatory System (6 lectures)
Structure and function of heart, Blood and lymph, Conduction of Heart beat.

Unit 10. Endocrine system (8 lectures)
Endocrine glands and their hormones

Practicals

Non-Chordata

1. Study of following specimens:

Euglena, *Noctiluca*, *Paramecium*, *Sycon*, *Euplectella*, *Obelia*, *Aurelia*, *Physalia*, *Tubipora*, *Metridium*, *Fasciola*, *Taenia*, *Ascaris*, *Nereis*, *Aphrodite*, *Leech*, *Peripatus*, *Limulus*, Hermit crab, *Daphnia*, Millipede, Centipede, Scorpion, *Chiton*, *Dentalium*, *Octopus*, *Asterias*, and *Antedon*

2. Study of Permanent Slides:

T S of *Sycon*, L S of *Sycon*, Medusa of *Obelia*, T. S. of arm of Starfish.

4. Temporary mounts

Gemmules, spicules and spongin fibres of porifera.

Chordata

5. Study of following specimens

Balanoglossus, *Amphioxus*, *Petromyzon*, *Pristis*, *Hippocampus*, *Labeo*, *Ichthyophis/Uraeotyphlus*, *Salamander*, *Rhacophorus Draco*, *Uromastix*, *Naja*, *Viper*, model of *Archaeopteryx*, any three common birds-(*Crow*, *duck*, *Owl*), Squirrel and Bat.

6. Temporary mounts: Unstained mounts of Placoid scales.

7. Preparation of haemin and hemochromogen crystals.

8. Estimation of Haemoglobin using Haemoglobinometer.

9. Histological slides- Examination of sections of mammalian skin, oesophagus, ileum, rectum, liver, pancreas, trachea, lung, kidney, pituitary, adrenal, thyroid, ovary, testis

Suggested books:

1. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.
4. Widmaier E.P., Raff, H., Strang, K.T. (2004) 9th edn. Vander's Human Physiology, Mc Graw- hill
5. Tortora, G.J. and Grabowski, S.92001) Principles of anatomy and physiology. Harper and Collins.
6. P.S. Verma, A Manual of Practical Zoology: Invertebrates. S. Chand & Company.
7. 8. S.S. Lal, Practical Zoology, Volume 1, 2 & 3. Rastogi-Publications.

Core Course Zoology –II

Cell and cellular processes (Credits: Theory-4, Practicals-2)

Theory (60 Lectures)

Unit 1. Techniques in Biology (8 Lectures)

Principles of microscopy; Light Microscopy; compound microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM)

Unit 2. Cell as a unit of Life (7 Lectures)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

Unit 3. Cell Organelles (25 Lectures)

- **Mitochondria:** Structure, marker enzymes, composition; mitochondrial biogenesis; Semiautonomous nature; Symbiont hypothesis; mitochondrial DNA

- **Chloroplast:** Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA

- **ER, Golgi Body & Lysosomes:** Structures and roles. Signal peptide hypothesis, N-linked glycosylation, Role of golgi in O linked glycosylation. Cell secretion, Lysosome formation.

- **Peroxisomes and Glyoxisomes:** Structures, composition, functions in animals and plants and biogenesis

- **Nucleus:** Nuclear Envelope- structure of nuclear pore complex; chromatin; DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure.

Unit 4. Cell Membrane and Cell Wall (10 Lectures)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Selective permeability of the membranes; Cell wall.

Unit 5. Cell Cycle (10 Lectures)

Interphase, Mitosis and Meiosis Role of Cell division; Overview of Cell cycle; Molecular controls; Meiosis

Practicals

1. To learn use of microscope and principles of fixation and staining.
2. Study of the photomicrographs of cell organelles; nuclear pore complex (photograph)
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-Buccal epithelial cell and nerve cell.
5. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus Green B.
7. To prepare temporary stained squash from root tips of *Allium cepa* and to study the various stages of mitosis.
8. Demonstration of dialysis of starch and simple sugar.
9. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.

Suggested books:

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi.
3. Sheeler, P and Bianchi, D.E. (2006) Cell and Molecular Biology, 3rd edition, John Wiley & Sons NY.
4. Cooper, G.M., Hausman, R.E. The Cell: A molecular approach. (2009) ASM Press and Sinauer Associates (Fifth Edition).
5. De Roberties, (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins
6. S.S. Lal, Practical Zoology, Volume 3. Rastogi-Publications
7. 8. Gerald Karp, Cell Biology, John Wiley & Sons Inc. Feb. 2007
8. De Roberties, The Cell and Molecular Biology, Lippincott Williams & Wilkins
9. Moore TC (1981) Research Experiences in Plant Physiology. Springer-Verlag,
10. Karp, B. (2002). Cell and Molecular Biology. 3rd Edition. John Wiley and Sons, Inc., New York.

Core Course Zoology –III

Biochemistry and immunology (Credits: Theory-4, Practicals-2)

Theory

(60 Lectures)

Unit-1. Biomolecules

(12 Lectures)

Carbohydrates: Structure and functional significance of mono-di-and polysaccharides; Lipids: structure and functional significance of fatty acids, triglycerides, phospholipids, glycolipids and steroids, Amino acids and Protein: structural properties and functions. Nucleic acids-DNA and RNA types and structure.

Unit- 2. Metabolism

(12 Lectures)

Carbohydrate metabolism: glycolysis, citric acid cycle, pentose phosphate pathway, gluconeogenesis; Lipids metabolism: beta oxidation of fatty acids, Protein metabolism: Overview of Protein degradation, catabolism of amino acids, transamination, oxidative deamination.

Unit- 3. Enzymes

(6 Lectures)

Classification, kinetics, mechanism of action, and inhibition.

Unit- 4. Introduction to Immune system and humoral Immune response

(14 Lectures)

Historical background, cells and organs of Immune system, Immunity: innate and acquired immunity, immunogens and haptens, factors influencing immunogenicity, Complement system, Mucosal immune system, B-Cell Biology – B-cell development, Antibody structure and types, Monoclonal and polyclonal Antibodies, Hybridoma technology

Unit- 5. Cell mediated immune response

(10 Lectures)

T-Cell Biology - T cell development , Structure of TCR, Thymic education, Antigen Processing and Presentation-MHC; Techniques based on antigen- antibody interactions,

Unit- 6. Perspectives of Immunology

(6 Lectures)

AIDS, Vaccines, Transplantation Immunology,

Practicals

Immunology

1. Isolation, staining and counting of mononuclear cells from peripheral blood.
2. Demonstration of Primary (Bone marrow & Thymus) and secondary immune organs (spleen, Lymph nodes) in rat.
3. Determination of ABO blood groups and Rh-factor
4. Ouchterlony (double diffusion) assay for Antigen -antibody specificity and titre.

Biochemistry

5. Study of effect of temperature, pH on salivary amylase
5. Separation and identification of amino acids by paper chromatography.
6. Protein and Carbohydrate qualitative estimation

Suggested Readings:

1. Stryer, L. (1995). Biochemistry. 4th ed. W.H. Freeman.
2. Lehninger, A.L. Nelson, D.K. and Cox, M.M. (1993). Principles of Biochemistry, CBS Publishers and Distributors.
3. T. J. Kindt, R. A. Goldsby, and B.A. Osborne. 2007. Kuby Immunology, W.H. Freeman and Co, New York.
4. S. S.Lal, Practical Zoology, Volume 3, Rastogi-Publications
5. De Robertis, (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins
6. Roitt, I.M. (2001). Essential Immunology. Blackwell Scientific Publications.

Core Course Zoology –IV

Molecular biology and development biology (Credits: Theory-4, Practicals-2)

Theory (60 Lectures)

Unit-1. Genetic material (6 Lectures)

DNA structure -Watson and Crick model, types of DNA, genetic code and Its features

Unit -2. DNA replication (8 Lectures)

DNA polymerases and Replication enzymes, DNA replication in Prokaryotes and eukaryotes, Semi-conservative mode of replication

Unit -3. Transcription and Translation (16 Lectures)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Mechanism of transcription and translation (Prokaryotes and eukaryotes): Charging of tRNA, aminoacyl tRNA synthetases.

Unit -4. Regulation of gene expression (10 Lectures)

Lac operon and Tryptophan operon in Prokaryotes and Eukaryotes

Unit -5. Animal development (10 Lectures)

Gametogenesis: Spermatogenesis, Oogenesis, type of eggs, Fertilization, cleavage, Fate maps

Unit -6. Embryonic Development (10 Lectures)

Blastulation and Gastrulation in Amphibia and Chick. Fate of germ layers, Placenta–types and function

Practicals

1. Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
2. Preparation of polytene chromosomes from dipteran larva.
3. Preparation of barr body (sex chromatin)
4. Study DNA packaging by micrographs.
5. Preparation of the karyotype and ideogram from given photograph of somatic metaphase Chromosome.
6. Study of developmental stages in frogs-whole mounts and sections (permanent slides): cleavage stages, blastula, gastrula, neurula, tadpole larva and sections of tadpole larva through eye and ear.
7. Study of whole mounts and sections of chick embryo at different stages, primitive streak , 28, 33, 48, 72 and 96 hours.

Suggested Readings:

1. Cooper, G.M., Hausman, R.E. *The Cell: A molecular approach.* (2009) ASM Press and Sinauer Associates (Fifth Edition).
2. De Robertis, E.D.P. *Cell and Molecular Biology.*(2008) Lippincott Williams and Williams (Sixth Edition).
- 3 Russell, P. J. (2009). *iGenetics- A Molecular Approach.* III Edition. Benjamin Cummings
4. Gilbert, S.F. (2006) 8th edn. *Developmental Biology,* Sinauer Associates, Inc
5. Campbell N.A. & Reece, J.B. (2005) 8th edn. *Biology.* Pearson Education, Inc. and Dorling Kindersely Publishing, Inc.

Core Course Chemistry –I

Inorganic chemistry (Credits: Theory-4, Practicals-2)

Theory

(60 Lectures)

Unit-1. Atomic Structure

(12 Lectures)

Recapitulation of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Significance of quantum numbers, orbital angular momentum. Shapes of s, p and d atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbital. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit- 2. Chemical Bonding and Molecular Structure

(15 Lectures)

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.

Covalent bonding : VB Approach :Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches.

Unit- 3. General Principles of Metallurgy

(13 Lectures)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

Unit- 4 s- and p- Block Elements

(10 Lectures)

Periodicity in s- and p- block elements, w.r.t. electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity. inert pair effect, diagonal relationship and anomalous behaviour of first member of each group. Concept of multicentre bonding (diborane). Structure, Applications in industrial, organic and environmental chemistry. Hydrides of nitrogen (NH₃, N₂H₄, N₃H, NH₂OH)

Unit- 5. Transition Elements (3rd series)

(10 Lectures)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, Lanthanides and actinides: Electronic configurations, Oxidation states, colour, magnetic properties, lanthanide contraction

Practicals

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO_4 .
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
4. Estimation of Fe(II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu(II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.
6. Semi-micro qualitative analysis using H_2S of mixtures not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:
Cations : NH_4^+ , Pb^{2+} , Ag^+ , Bi^{3+} , Cu^{2+} , Cd^{2+} , Sn^{2+} , Fe^{3+} , Al^{3+} , Co^{2+} , Cr^{3+} , Ni^{2+} , Mn^{2+} , Zn^{2+} ,
 Ba^{2+} , Sr^{2+} , Ca^{2+} , K^+ ,
Anions : CO_3^{2-} , S^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, NO_3^- , CH_3COO^- , Cl^- , Br^- , I^- , NO_2^- , SO_4^{2-} , PO_4^{3-} , BO_3^{3-} ,
 $\text{C}_2\text{O}_4^{2-}$, F^- . (Spot tests should be carried out wherever feasible.)

Suggested readings:

1. J. D. Lee (2008) A new Concise Inorganic Chemistry, 5th edition E L. B. S.
2. James E. Huheey, Ellen Keiter and Richard Keiter(2009) Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.

Core Course Chemistry –II

Organic Chemistry -1 (Credits: Theory-4, Practicals-2)

Theory

(60 Lectures)

Unit-1. Basics concepts

(15 Lectures)

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive intermediates: Carbocations, Carbanions free radicals.

Unit- 2. Reaction mechanism

(10 Lectures)

Aldol Condensation, Cannizzaro Reaction, Friedel-Crafts reaction, Rosenmund Reduction, Sandmeyer Reaction, Shapiro Reaction, Williamson Synthesis

Unit- 3. Aliphatic Hydrocarbons

(15 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: Preparation: Catalytic hydrogenation, Kolbe's synthesis, Grignard reagent and its Reactions: Free radical, Substitution, Halogenation.

Alkenes: Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule) and its Reactions: Hydration, Ozonolysis, hydroboration-oxidation.

Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and its Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO_4 ,

Unit-4. Stereochemistry

(10 Lectures)

Conformations w.r.t. ethane, butane and cyclohexane. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds) . Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two $\text{C}=\text{C}$ systems).

Unit-5. Carbonyl Compounds (Aldehydes and ketones)

(10 Lectures)

Preparation of Acetaldehyde and Acetone

Reactions –Reaction with HCN, ROH, NaHSO_3 , $\text{NH}_2\text{-G}$ derivatives. Iodoform test. Wittig reaction, Clemensen reduction and Wolff Kishner reduction..

Practicals

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
 - (a) Bromination of Phenol/Aniline
 - (b) Benzoylation of amines/phenols
 - (c) Oxime and 2, 4- dinitrophenylhydrazone of aldehyde/ketone
4. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).

Suggested Readings:

1. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
2. Mann F. G. & Saunders B. C, (1960) Practical Organic Chemistry. Orient Longman,
- 3 I. L. Finar (1971) Organic Chemistry (Vol. I & II), E. L. B. S.
4. R.T. Morrison, RN Boyd, (1966), Organic Chemistry. II ed., Allyn and Bacon, Boston, MA, 560
5. Arun Bahl and B. S. Bahl(1987) Advanced Organic Chemistry, S. Chand and Co.
6. Peter Sykes (1986) A Guide Book to Mechanism in Organic Chemistry, Orient Longman

Core Course Chemistry –III

Physical chemistry

(Credits: Theory-4, Practicals-2)

Theory (60 Lectures)

Unit- 1. Chemical Thermodynamics (15 Lectures)

Definition, State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties. First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal conditions for both reversible processes. Various statements of Second Law of thermodynamics, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy. Criteria of spontaneity. Gibbs – Helmholtz equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit- 2. Chemical Equilibrium (8 Lectures)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^\ominus , Le Chatelier's principle.

Unit- 3. Ionic Equilibria (9 Lectures)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, Buffer solutions.

Unit- 4. Conductance (10 Lectures)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Ionic mobility. Applications of conductance measurements: solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit- 5. Electrochemistry (8 Lectures)

Types of electrodes. Standard electrode potential. Electrochemical series. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations - qualitative treatment (acid-base and oxidation-reduction only).

Unit-6. Solutions (10 Lectures)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapor pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Nernst distribution law and its applications, solvent extraction.

Practicals

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of integral enthalpy of solution of salts (KNO_3 , NH_4Cl)
3. Determination of enthalpy of hydration of copper sulphate.
4. pH measurements:
 - a. Measurement of pH of different solutions, like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
 - b. Preparation of buffer solutions:
 - (i) Sodium acetate-acetic acid
 - (ii) Ammonium chloride-ammonium hydroxide
5. Surface tension measurement (use of organic solvents excluded)
 - a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
 - b) Study of the variation of surface tension of a detergent solution with concentration.
6. Viscosity measurement (use of organic solvents excluded)
 - a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
 - b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
7. Phase equilibria
 - a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
 - b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
 - c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Suggested readings:

- 1 Barrow, G. M. (2007). *Physical Chemistry* Tata McGraw Hill
2. Castellan, G. W. (2004). *Physical Chemistry* 4th Ed. Narosa Publishing House.
3. Mahan, B. H. (1998). *University Chemistry* 3rd Ed. Narosa Publishing House.

Core Course Chemistry –IV
Organic Chemistry-2
(Credits: Theory-4, Practicals-2)

Theory

(60 Lectures)

Unit-1. Aromatic hydrocarbons

(8 Lectures)

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions : (Case benzene) : Electrophilic substitution: nitration, halogenation and sulphonation. (Upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (Upto 4 carbons on benzene).

Unit-2. Alkyl and Aryl Halides

(8 Lectures)

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1 and SN2) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & iso-nitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene)*: Aromatic nucleophilic substitution (replacement by -OH group) and effect of nitro substituent.

Unit-3. Alcohols, Phenols and Ethers (Upto 5 Carbons)

(10 Lectures)

Alcohols: *Preparation*: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification,

Phenols: (Phenol case) *Preparation*: Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer - Tiemann Reaction, Gattermann-Koch Reaction.

Unit-4. Carboxylic acids and their derivatives

(10 Lectures)

Carboxylic acids (aliphatic and aromatic) *Preparation*: Acidic and Alkaline hydrolysis of Esters.

Reactions: Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter-conversion.

Reactions: Reformatsky Reaction, Perkin condensation.

Unit -5. Amines and Diazonium Salts

(8 Lectures)

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann Vs Saytzeff elimination, Carbylamine test.

Diazonium salts: *Preparation:* from aromatic amines. *Reactions:* conversion to benzene, phenol, dyes.

Unit-6. Amino Acids, Peptides and Proteins:

(8 Lectures)

Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis. Zwitter ion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of $-\text{COOH}$ group, acetylation of $-\text{NH}_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

Unit -7. Application of Spectroscopy to Simple Organic Molecules

(8 Lectures)

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max} & ϵ_{max} , chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α, β - unsaturated compounds.

Infrared radiations and types of molecular vibrations, functional group and Finger print region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular Hydrogen bonding), aldehydes, ketones, carboxylic acids and derivatives (effect of substitution on $>\text{C}=\text{O}$ stretching absorptions).

Practicals

1. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1° amines) and preparation of one derivative
2. Preparations: Mechanism of various reactions involved to be discussed.
Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
 - (a) Nitration of Nitrobenzene
 - (b) Preparation of carboxylic acid by alkaline hydrolysis of ester/amide.
 - (c) Oxidation of alcohol/aldehydes/hydrocarbons to carboxylic acid
 - (d) Osazone from glucose/fructose
 - (e) Amides and anilides from carboxylic acid.
 - (f) Preparation of methyl orange.

Suggested Readings:

1. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
2. Mann F. G. & Saunders B. C, (1960) Practical Organic Chemistry. Orient Longman,
- 3 I. L. Finar (1971) Organic Chemistry (Vol. I & II), E. L. B. S.
4. R.T. Morrison, RN Boyd, (1966), Organic Chemistry. II ed., Allyn and Bacon, Boston, MA, 560
5. Arun Bahl and B. S. Bahl(1987) Advanced Organic Chemistry, S. Chand and Co.
6. Peter Sykes (1986) A Guide Book to Mechanism in Organic Chemistry, Orient Longman

Discipline Specific Electives-Botany (Any two)

1. Genetics and Plant Biotechnology

(Credits: Theory-4, Practical-2)

Theory

(Lectures: 60)

Unit- 1. Transmission Genetics: Mendel's laws of inheritance, allelic and non-allelic interactions, modified dihybrid ratios, polygenic inheritance, multiple alleles, extra nuclear inheritance.

(10 Lectures)

Unit -2. Physical and Molecular Organization of Genetic Material — chromosomes, chromosome morphology, karyotype, idiogram, polytene and lampbrush chromosomes, nucleosome, DNA/RNA as genetic material, Watson and Crick's model, RNA types.

(10 Lectures)

Unit -3. Mutations — spontaneous and induced mutations, mechanism of mutation, genomic mutations (aneuploidy, euploidy), chromosomal aberrations.

(10 Lectures)

Unit -4. Linkage and Crossing Over — complete and incomplete linkage, two-point and three-point test cross, cytological basis of crossing over, Molecular basis of recombination; sex-linked inheritance.

(6 Lectures)

Unit -5. Recombinant DNA Technology: Basics; *Agrobacterium* mediated gene transfer

(4 Lectures)

Unit -6. GM plants: resistance to pathogens & pests, stress tolerance, golden rice, BT-cotton, flavor savor tomato.

(8 Lectures)

Unit -7. Microbial and Industrial Biotechnology: production of antibiotics, alcohol, single cell proteins, enzymes,

(4 Lectures)

Unit -8. Gene therapy, DNA Fingerprinting.

(3 Lectures)

Unit -9. Ethics and Biosafety: public perception of biotechnology, ethical and biosafety issues.

(5 Lectures)

Practicals

1. Study of gene interaction/deviations from the Mendelian ratios using seed Samples in ratio of 9:7, 9:4:3, 9:6:1 and 12:3:1.
2. To study of the karyotype of person with Down's, Turner's and Klinefelter's Syndrome.
3. Study of the organization of T-DNA and eukaryotic chromosome (through illustration).
4. Study of salivary gland and lampbrush chromosomes.
5. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.
6. Study of GM plants (Golden rice, Bt-cotton and flavor savor tomato)

Suggested readings:

1. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition

DSE 2 Plants regulators and Economic Botany

(Credits: Theory-4, Practical-2)

Theory

(Lectures: 60)

Unit-1. Chemical Regulation of Growth and Development

(5 lectures)

Role of hormones in plant growth and development, commercial applications of growth regulators, growth retardant and its usefulness.

Unit-2. Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. (20 lectures)

Unit 3: Origin of Cultivated Plants

(4 Lectures)

Concept of centres of origin, their importance with reference to Vavilov's work

Unit 4: Cereals

(4 Lectures)

Wheat -Origin, morphology, uses

Unit 5: Legumes

(4Lectures)

General account with special reference to Gram and soybean

Unit 6: Spices

(6 Lectures)

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 7: Beverages

(4Lectures)

Tea (morphology, processing, uses)

Unit 8: Oils and Fats

(5 Lectures)

General description with special reference to groundnut

Unit 9: Fibre Yielding Plants

(8 Lectures)

General description with special reference to Cotton and Jute (Botanical name, family, part used, morphology and uses)

Practicals

1. To study the role of ABA in leaf senescence
2. To study the role of ethylene in fruit ripening.
3. To study the effect of gibberellins in bolting of floral axis.(through photograph)
4. To study and comments (Botanical name, family, part used, morphology and uses) of economically important plants through specimens, sections and micro chemical tests:
 - a. Wheat
 - b. Gram,
 - c. Soybean,
 - d. Black pepper & Clove
 - e. Tea,
 - f. Cotton & Jute
 - g. Groundnut

Suggested readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.

DSE 3. DISSERTATION
(Credits: Theory-4, Practical-2)

Discipline Specific Electives: Zoology (Any two)

DSE-1 General Entomology

(Credits: Theory-4, Practical-2)

Theory

(60 Lectures)

Unit -1 Taxonomy

(18 Lectures)

Salient features of Insects, basis of insect classification; classification of insects up to orders (economical important groups), origin and evolution of insects, Elementary knowledge of collection, preservation and culture techniques of insect

Unit -2 Morphology of Insect

(Lectures13)

Segmentation in Insect, Structure of Head, antennae, thorax, legs, wings and various types of mouth parts

Unit -3 Physiology of Insect

(Lectures 13)

Physiology of digestion, excretion, respiration, circulation and Insect sense organs (mechano-, photo- and chemoreceptors).

Unit -4 Reproduction and Development

(Lectures 16)

Embryonic and post-embryonic development; Types of metamorphosis, Role of Neuroendocrine system in development, Parthenogenesis

Practicals

1. Collection, dry mounting, labeling and preservation of insects
2. Identification of stored grain pest insect *Sitophilus oryzae*, *Corcyra cephalonica*, *Trogoderma granarium*, *Callosobruchus chinensis*,
3. Identification of Crop pest insect
Helicoverpa armigera, *Spodoptera litura*, *Earias vitella*, *Pectinophora gossypiella*, locust,
4. Culture of two insects of economic importance including one crop pest and submission of culture report.
5. Study of the life history of 2 different insect pests (drawn from culture to be submitted)
6. Study of mouth parts (sponging type, piercing type, siphoning type, lapping type), wings, legs and antennae

Suggested Readings:

1. Atwal, A.S. Agricultural pest of India and south East Asia. Kalyani Pub., N.Delhi. 1993
2. Dennis, S. Hill. Agricultural Insect pests of the tropics and their management, Cambridge university press.2005
3. Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M ,Introduction to the study of insects, Saunders College Publication, USA
4. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
5. David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata-McGraw Hill, New Delhi.
6. Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
7. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th E Chapman & Hall, London.
8. Wigglesworth VB.1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York.

DSE-2 Applied Entomology

(Credits: Theory-4, Practical-2)

Theory

(60 Lectures)

Unit-1 Pest

(10 Lectures)

Introduction, classification of pests, factors responsible for emergence of pest, Damage economic threshold level

Unit -2 Bionomics and control of the following crop pests:

(15 Lectures)

Rice pests (*Leptocorisa acuta*); Wheat pest (*Sesamia interens*); Pulse pest (*Helicoverpa armigera*); Sugarcane pests (*Scirpophaga nivella*, *Pyrilla perpusilla*); Cotton pests (*Earias vitella*, *Pectinophora gossypiella*); Vegetable pest (*Raphidopalpa faveicollis*); Fruit pest (*Papilio demoleus*)

Unit -3 Bionomics and management of the following stored grain pests:

(10 Lectures)

Sitophilus oryzae, *Corcyra cephalonica*, *Trogoderma granarium*, *Callosobruchus chinensis*.

Unit -4 Bionomics and management of the following important pests:

(10 Lectures)

Fleas, mosquitoes, houseflies, sandflies, cockroaches, lice, termites

Unit -5 Control Methods

(15 Lectures)

Classification: Natural & applied control [Physical, mechanical, cultural, biological, genetic, chemical controls], Integrated pest management (IPM): Definition; principle, theory and advantages.

Practicals

1. Study of Biocontrol agents for insect pest: **Biological Agents;** (Pathogens – NPV); **Parasites** (*Trichogramma*, *Cotesia*); **Predators** (Gambusia fish, lady bird beetle)
2. Damage caused by the commonly occurring insect pests – Infested plant/plant parts
3. Determination of LD₅₀ or LC₅₀ of insecticides based on the data provided
4. Instruments used in IPM
5. Bioefficacy of EPN
6. Dry Lab exercise for SIT efficacy
7. Field trips to entomological institutes, museums, laboratories – IARI fields, CWC, FCI, Stored grain institutes (any two)

Suggested readings:

1. Atwal, A.S. (1993) Agricultural pest of India and South East Asia. Kalyani Pub., New Delhi.
2. Dennis, S. Hill. (2005) Agricultural Insect pests of the tropics and their management, Cambridge University press.
3. Pedigo, L.P. 1996). Entomology and pest management, prentice hall, N. Delhi.
4. Edward B Radcliffe, William D Hutchison, and Rafael E Cancelado. (2009) Integrated Pest Management, Cambridge University Press.
5. S.Pradhan, Insect pest of crops - National Book trust

DSE-3 Integrated Pest Management

(Credits: Theory-4, Practical-2)

Theory	(60 Lectures)
Unit-1 Pest History and origin, definition and its ecology, pest status, Economic injury level (EIL), economic threshold, carrying capacity, secondary pest outbreak, pest surveillance	(12 Lectures)
Unit -2 Various strategies for Integrated Pest Management Mechanical, Physical, Cultural, Biological, Chemical, Physiological, Regulatory etc.	(10 Lectures)
Unit -3 Biological control Principle; bio-control agents- Parasitoids, predators and pathogens, advantages and drawbacks.	(10 Lectures)
Unit -4 Chemical control Insecticidal Classification of insecticide, Conventional insecticides; insecticide adjuvants and formulations, control with reference to chlorinated hydrocarbons; organophosphates; carbamates; botanical; synthetic pyrethroids; fumigants; IGR compounds & pheromones.	(15 Lectures)
Unit -5 Genetic control Sterile insect techniques (SIT); radio-sterilization and chemo-sterilization, hybrid sterility.	(8 Lectures)
Unit -6 Regulatory Quarantine laws	(5 Lectures)

Practicals

1. Computation of EIL, ETL and SIT Efficacy through data provided
2. Bioefficacy of EPN through data provided
3. Equipments used in IPM
4. Determination of Probit Analysis based on the data provided
5. Damage caused by the commonly occurring insect pests – Infested grains/plant parts
6. Identification of common natural enemies of crop pests (parasitoids, predators, microbes) .
7. Visits to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids/ common predators, microbes and their laboratory hosts (Any Two)
8. Submit a Project report on quality control and registration standards for bio-control agents.

Suggested readings:

1. Pedigo, L.P. (1996) Entomology and pest management, Prentice Hall, n. Delhi.
2. Raymond A. Cloyd, Philip L. Nixon and Nancy R. Pataky. 2004. IPM for Gardeners: A Guide to Integrated Pest Management, Timber Press
3. Horowitz, A. Rami and Ishaaya, Isaac. (2009) Insect Pest Management - Field and Protected Crops by
4. Mary Lou Flint and Robert van den Bosch, (1981). Introduction to Integrated Pest Management, New York: Plenum Press,
5. Robert F Norris, Edward P Caswell Chen, Marcos Kogan. (2003) Concepts in Integrated Pest Management Prentice Hall.
7. Rajinder Peshin, & A. K. Dhawan (2009) Vol. I Integrated Pest Management: innovation-Development process, Springer.
8. Edward B Radcliffe, William D Hutchison, and Rafael E Cancelado. (2009) Integrated Pest Management, Cambridge University Press.
9. Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. 1st Ed., Springer, New York.

DSE 4 Dissertation

Suggested topics

1. To determine whether insect larvae are equally attracted to different colored lights.
2. Effect of UV light on insects/Effect of photoperiod on the emergence of adult butterfly/moth
3. Effect of visible light on development of insect (*Spodoptera*)
4. To study the faunal composition (insects and mites) of soil samples. (Berley's funnel)
5. Strengthening of eco-friendly strategies of integrated insect and mite pest management including: Biological control, Bio-rational pesticides, Host plant resistance, Judicious use of pesticides, Molecular biosystematics
6. Investigations on ecological factors including: Survey and surveillance of insect pests, Forecasting of insect pest population life-tables, Insect biology, Population dynamics as influenced by abiotic and biotic factors
7. Climate change and pests
8. Management of silkworm pests and diseases
9. Plants as sources of insecticides

Discipline Specific Electives: Chemistry (Any two)
(Credits: Theory-4, Practical-2)

DSE 1 Soils And Fertilizers

Theory

(60Lectures)

Unit-1 Soils

(15Lectures)

Formation, nature, origin, composition, classification. Characteristics, acidity, salinity, and alkanity of soils. Chemistry of weathering of materials soils and clay minerals.

Unit -2 Nutrients

(5Lectures)

Macro and Micro-nutrients of Soils

Unit -3 Types of fertilizers

(30Lectures)

Various nitrogen fertilizers and there soil reaction. Fate of NO_3 and NH_4 ions in soils, denitrification, nitrogen fixation by legumes.

Phosphate fertilizers: Phosphate in soil, pH, microbes and available phosphorous and its control.

Potassium avalibility in soil, nutrient availability in soil, soil fertility evaluation.

Soil fertility and nutrients, recycling of nutrients, chelation and soil management

Unit-4 Biofertilizers

(10Lectures)

Practicals

1. Preparation and preservation of soil sample in laboratory.
2. To measure the pH of some given soil samples.
3. To determine organic carbon from soil sample.
4. To estimate the carbonate content in the given soil samples.
5. Determination of water holding capacity of soil.
6. Estimation of nitrogen in an organic compound (pesticides) by Kjeldahl method.
7. To measure the conductance of some given soil samples.
8. To perform the qualitative test for nitrogen fertilizers (NH_4^+ , NO_3^- , Urea), phosphorus fertilizers (PO_4^{3-}) and potash fertilizers (K^+)

Suggested readings:

1. Dr. Sarvesh Kumar Dubey and Dr. Asha Arora.(2011) A Practical Book on Soil, Plant, Water and Fertilizer Analysis .
2. Dr. HLS Tandon (2008) Fertilizers and Their Composition, Characteristics, Quality, Transformations and Applications.
3. Langdon R. Elsworth and Walter O. Paley. (2008) Fertilizers: Properties, Applications and Effects , Nova Science Pub.
4. Chopra, SL, and Kanwar, JS, (1976), Analytical Agricultural Chemistry, Kalyani Publishers, Ludhiana, New Delhi.
5. Jackson, M.L. 1969. Soil chemical analysis - advanced course (2nd edition).
6. Handbook of agriculture by I. C. A. R. Publication.
7. Jain. (1988). Textbook of agricultural biochemistry.
8. Yawalker,K.S.,Agrawal,J.P.and Bokde, S. (1992). Manures and Fertilizers, Agri- Horticultural Publishing House, Nagpur (Maharashtra).

DSE 2- Herbicides

(Credits: Theory-4, Practical-2)

Theory	(60Lectures)
Unit-1 Classification, selectivity and uptake of herbicides, discovery	(15Lectures)
Unit-2 Synthesis herbicides, structure-activity relationship (SAR)	(10Lectures)
Unit-3 Mode of action herbicides	(10Lectures)
Unit-4 Uses of the following classes with special reference to the individual compounds mentioned:	(25Lectures)
(a) Aryl Alkanoic Acids: 2, 4 D, MCPA, dicamba, dichlorobenzil, and dalapon.	
(b) Aromatic carbamates: barban and asulam.	
(c) Triazines: Simazine.	
(d) Bipyridiniums, paraquat and glyphosate	
(e) Sulfonylurea: Chlorosulfuron	
(f) Uracils: Bromacil	
(g) Ureas: Monuron and Isoproturon	

Practicals

1. To carryout market survey of potent herbicides with details as follows:
 - a) Name of Herbicide
 - b) Chemical name and structure of herbicide
 - c) Chemical class of herbicides
 - d) Type of formulation available
 - e) Manufacturer's name
 - f) Useful information on label of packaging regarding
 - i. Toxicity
 - ii. LD 50 ("Lethal Dose, 50%")
 - iii. Side effects
 - iv. Antidotes
2. Methods and modes of application of herbicides.
3. Preparation of 2,4D (2,4-Dichlorophenoxyacetic acid) and MCPA (2-methyl-4-chlorophenoxyacetic acid).
4. Analysis of 2,4D (2,4-Dichlorophenoxyacetic acid) and MCPA (2-methyl-4-chlorophenoxyacetic acid).

Suggested Readings:

1. Agrochemicals preparation and mode of action by R. J. W. Cremlyn.
2. Herbicides and Environment by Andreas Kortekamp.
3. Herbicides, Theory and Applications by Sonia Soloneski and Marcelo L. Larramendy.
4. Solving Weed Problems: How to Identify and Eradicate Weeds Effectively from Your Lawn and Garden by Peter Loewer
5. A. S. Crafts. *Chemistry and mode of action of herbicides*, John Wiley.

DSE 3- Fungicides
(Credits: Theory-4, Practical-2)

Theory	(60Lectures)
Unit-1. Types of fungicides and Mode of action	(6Lectures)
Unit-2. Chemistry of the following compounds:	(30Lectures)
Copper and mercury derivatives	
Dithiocarbamates: Thiram, Ziram, Nabam,	
Dinitro phenols: 2, 4-Dinitro o-Cresol (DNOC) Karathane	
Quinines: Dichlone	
Benzimidazoles: Benomyl.	
Organo phosphorus fungicides: Kitazine	
Phenyl amides: Metalaxyl	
Triazoles: Propiconazole	
Thiophanates: Thiophanates.	
Unit-3. Role of Fumigants and fumigation techniques.	(12Lectures)
Unit-4. Nematicides, Molluscicides and Rodenticides.	(12Lectures)

Practicals

1. To carryout market survey of potent fungicides with details as follows:
 - a) Name of fungicides
 - b) Chemical name and structure of fungicides
 - c) Chemical class of fungicides
 - d) Type of formulation available
 - e) Manufacturer's name
 - f) Useful information on label of packaging regarding
 - i. Toxicity
 - ii. LD 50,
 - iii. Side effects
 - iv. Antidotes
2. Methods and modes of application of fungicides.
3. Preparation and use of Thiram, Ziram, Nabam etc.
4. Efficacy of some fungicides on plant growth.
5. To determine the active ingredient contents of some fungicide formulations.
6. To demonstrate the fumigation technique.

Suggested readings:

1. Agrochemicals preparation and mode of action by R. J. W. Cremllyn
2. Fungicides by Odile Carisse. Fungi and fungicides; a practical manual, concerning the fungous diseases of cultivated plants and the means of preventing their ravages by Clarence Moore.
3. Agrochemicals preparation and mode of action by R. J. W. Cremllyn 1991.
4. Pesticides: Preparation and Mode of Action by R. J. W. (Richard James William) Cremllyn (Oct 10, 1979)

DSE 4- Dissertation
(Credits: Theory-4, Practical-2)

Skill Enhancement Courses: Botany

(Credits 2)

SEC1. Medicinal Plants and IPR (Intellectual Property Rights)

Lectures: 30

- Unit 1:** History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences (2 lectures)
- Unit 2:** Ethnobotany and Folk medicines. Applications of Ethnobotany (2 lectures)
- Unit 3: Medicinal plants:** Botanical names, vernacular names, Morphology of the plant part of medicinal importance and uses with reference to *Cinchona*, *Digitalis*, *Papaver*, *Withania*, *Rauwolfia*, *Artemisia*, and *Cannabis*. (6 lectures)
- Unit 4: Introduction to intellectual property right (IPR)** Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO). (2 lectures)
- Unit 5: Patents:** Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement; Copyrights: Works protected under copyright law, Rights, Transfer of Copyright, Infringement; Trademarks ,introduction, Types, Rights, Protection of goodwill, Infringement (6 Lectures)
- Unit 6:** Concept of Traditional Knowledge, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level. (3 Lectures)
- Unit 7:** Industrial Designs, Geographical Indications (only brief introduction) (2 Lectures)
- Unit 8: Protection of Plant Varieties** Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001. (3 Lectures)
- Unit 9: Biotechnology and Intellectual Property Rights.** Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues (4 Lectures)

SEC 2 Plants Quarantine

(Credits 2)

Lectures: 30

Unit 1: Plant quarantine: Introduction to Plant Quarantine Information System (PQIS) and objective (3 lectures)

Unit 2: Imports: Plant Quarantine Order and Amendments, Issuance of the Import Permit, Import inspection and clearance, Procedures of PEQ inspection, Time schedules for clearance, Permits required for import of Germplasm, Transgenic or Genetically Modified Organisms, live insects and microbial cultures, plants and plant products, Requirement of Import of Wood and Timber: Special conditions of Import Special conditions for import of plant species. (8 lectures)

Unit 3: Exports: Export inspection and certification procedure: Time schedules for clearance, Fees and Charges, Circular issued to Export Certification Authorities. (5 lectures)

Unit 4: Post-entry Quarantine: Appeal and Revision, Power of Relaxation, issuance of import permit, import inspection, inspection authorities Fees and charges, commodities not requiring Plant Quarantine clearance (4 lectures)

Unit 5: Phytosanitary: Phytosanitary Agreement, national standards for phytosanitary measures, accredit treatment facilities, Quarantine Disinfestation Treatment (5 lectures)

Unit 6: Laws

The Destructive Insects and Pests Act, 1914 and amendments

The Plant Quarantine Order 2003 - Amendments

International Plant Protection Convention

WTO-SPS Agreement

International Standards on Phytosanitary Measures (ISPMs) (5 lectures)

Suggested reading:

M.C. Muthaiyan (2009) Principles and Practices of Plant Quarantine, Allied publishers private limited.

SEC 3 Plant health diagnostics and Management
(Credits 2)
Lectures: 30

Unit 1: Plant Pathology (10 lectures)

Importance, concepts and types of plant disease symptoms, causes and classification of diseases. assessment, Diagnosis, Identification of casual organism by Koch postulates, principles of plant disease control, Histochemical and Serological methods of studying plant pathogens, Modern techniques in analysis of plant diseases. Plant disease Epidemiology, dissemination factors affecting the development of epidemics, Disease forecasting. Plant disease epidemic assessment. Transmission and Control of Plant Diseases

Unit 3: Fungal Diseases: (12 lectures)

Causal organism, symptomatology, disease cycle, prevention and control of the following fungal diseases:-

- White rust of crucifers
- Late blight of potato
- Downy mildews
- Powdry mildews
- Rusts of wheat
- Smut of wheat and barley

Unit 4: Bacterial Diseases (4 lectures)

- Causal organism, symptomatology, prevention and control of the following Bacterial diseases
- Citrus canker
- Angular leaf spots of cotton

Unit 5: Viral Diseases – (4 lectures)

- Causal organism symptomatology, prevention and control of the following viral diseases
- Tobacco mosaic
- Yellow mosaic of soybean

Suggested reading:

1. G. N. Agrios. Plant Pathology, Academic Press, USA.
2. R. S. Singh, Plant Diseases, Oxford and IBH.
3. R. S. Mehrotra, Plant Pathology, Tata McGraw Hill, New Delhi.
4. O. P. Sharma, Textbook of Fungi, Tata McGraw Hill, New Delhi.

SEC 4 Plants regulators and Economic Botany
(Credits 2)
Lectures: 30

- Unit 1: Chemical Regulation of Growth and Development** (3 lectures)
Role of hormones in plant growth and development, commercial applications of growth regulators, growth retardant and its usefulness.
- Unit 2: Discovery, chemical nature (basic structure), bioassay and physiological roles of**
Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.
(10 lectures)
- Unit 3: Origin of Cultivated Plants** (2 Lectures)
Concept of centres of origin, their importance with reference to Vavilov's work
- Unit 4: Cereals** (3 Lectures)
Wheat -Origin, morphology, uses
- Unit 5: Legumes** (3 Lectures)
General account with special reference to Gram and soybean
- Unit 6: Spices** (2 Lectures)
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)
- Unit 7: Beverages** (2 Lectures)
Tea (morphology, processing, uses)
- Unit 8: Oils and Fats** (2 Lectures)
General description with special reference to groundnut
- Unit 9: Fibre Yielding Plants** (3 Lectures)
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Skill Enhancement Courses: Zoology
(Credits 2)
SEC 1: Biotechnological Control of Pest

Lectures: 30

Unit-1 Introduction (4 Lectures)

Plant resistance to insects: types of resistance, mechanism of resistance-antibiosis, antixenosis, tolerance, factors mediating resistance, JH Mimics & MH-agonist. demonstration of antibiosis, tolerance and antixenosis.

Unit-2 Techniques (8 Lectures)

Recombinant DNA technology, GIT, Transgenesis, nucleic acid hybridization, Cloning, Germ Cell Transplantation, Embryonic Stem Cells, bioremediation.

Unit-3 GMOs (12 Lectures)

Transgenic plants: history, *Bacillus thuringiensis* and its mode of action on insect, different sub species of *Bt*, *Bt plants* resistance management of *Bt* crop, prospective and controversies of *Bt* crop, successful examples of resistant crop varieties in India and world

Transgenic animals: A genetically modified animal. Transgenic mosquito, spider silk, transgenic livestock, Applications of Transgenic Animals in Agriculture

Unit-4 Applications (6 Lectures)

- Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE,
- Use of tissue culture techniques in plant protection. Computer application for predicting/forecasting pest attack and identification

Suggestive Reading:

1. Dhaliwal GS & Singh R. (Eds). 2004. *Host Plant Resistance to Insects - Concepts and Applications*. Panima Publ., New Delhi.
2. Maxwell FG & Jennings PR. (Eds). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons, New York.
3. Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, London.
4. Panda N & Khush GS. 1995. *Plant Resistance to Insects*. CABI, London.
5. Smith CM. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches*. Springer, Berlin.
6. Wheeler, M. B. (2013) Transgenic Animals in Agriculture. *Nature Education Knowledge* 4(11):1

SEC 2: Biological Control of Crop Pests
(Credits 2)
Lectures: 30

Unit-1 Introduction

(6 Lectures)

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

Unit-2 Agents of biological control

(10 Lectures)

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action.

Unit-3 Methods of Biocontrol

(8 Lectures)

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

Unit-4 Perspectives

(6 Lectures)

Successful biological control projects, analysis, trends and future possibilities of biological control.

Importation of natural enemies- Quarantine regulations, biotechnology in biological control.

Semiochemicals, Kairomones in biological control.

Suggested Readings:

1. Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.
2. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
3. Dhaliwal GS & Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
4. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
5. Ignacimuthu SS & Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi.
6. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.
7. Van Driesche & Bellows TS. Jr. 1996. Biological Control. Chapman & Hall, New York.

SEC 3: Insect Toxicology
(Credits 2)
Lectures: 30

Unit-1 (6 Lectures)

Definition and scope of insecticide toxicology, history of chemical control, pesticides registration, pesticide industries and markets.

Unit-2 (8 Lectures)

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility,

Unit-3 (10 Lectures)

IGRs, Insecticides and its metabolism-phase I and phase II reactions; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. Insecticide Act registration and quality control of insecticides; safe use of insecticides ; diagnosis and treatment of insecticide poisoning, health hazards: carcinogenic, mutagenic and teratogenic effects

Unit-4 (6 Lectures)

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and post construction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.

Suggestive Reading:

1. Toxicology and Risk Assessment: A Comprehensive Introduction, Greim H., and Snyder, R. (ed), John Wiley and Sons, UK
2. The Complete Book of pesticide management, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
- 3 Chattopadhyay SB. 1985. *Principles and Procedures of Plant Protection*. Oxford & IBH, New Delhi.
- 4 Gupta HCL.1999. *Insecticides: Toxicology and Uses*. Agrotech Publ., Udaipur.
- 5 Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action*. Narosa Publ. House, New Delhi.
- 6 Matsumura F. 1985. *Toxicology of Insecticides*. Plenum Press, New York.
- 7 Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment*. Narosa Publ. House, New Delhi.
- 8 Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture*. Lewis Publ., New York.

SEC 4: Quality Control In IPM
(Credits 2)
Lectures: 30

Unit-1 Concepts of Quality control (6 Lectures)

Definition, Attributes, Biological control agent, their mass rearing and maintenance, Implementation of QC (Production control and Process control)

Unit-2 General quality-control criteria for mass-reared natural enemies (10 Lectures)

- Quantification: number of live natural-enemy organisms in container
- Sex ratio: minimum % females (male-biased ratio may indicate poor quality)
- Emergence: emergence rate to be specified for all organisms
- Fecundity: number of offspring produced during a certain period
- Longevity: minimum longevity in days
- Parasitism: number of hosts parasitized during a certain period
- Pupal size
- Adult size: hind tibia length of adults

Unit-3 Mechanism of Quality control (10 Lectures)

With reference to Quality control in *Trichogramma* Production

a) Locomotor behaviour

- Crucial host seeking behaviour during pre-parasitization phase to gain momentum for reach out host eggs
- Types of behaviour includes: Walks, hops, flight

b) Bioefficacy

- **Parasitization efficacy** (number of host eggs parasitized)
- **Development** (developmental period of parasitoid within host egg)
- **Emergence** (% emergence of adult wasps from host)
- **Longevity** (adult life span of parasitoid)
- **Sex-ratio** (ratio of male : female)

Unit-4 Quality issues (4 Lectures)

Genetic and environmental components, International Standard for quality control of commercially produced natural enemies

Suggested Readings:

- 1.E. Wajnberg and S. A. Hassan. Biological Control with Egg Parasitoids. CAB International and IOBC (International Organization for Biological Control of Noxious Animals and Plants).
- 2.J C van Lenteren, A Hale. Guidelines for quality control of commercially produced natural enemies, *Nature's Alternative International, Canada, J N Klapwijk, Berkel and Rodenrijs, The Netherlands, et al*

SEC 5: Use of Nuclear Technology for Agro-Pest Management
(Credits 2)
Lectures: 30

Unit-1 Radiation (10 Lectures)

Definition, Types: Ionizing radiation and Non-ionizing, Sources, Production of Ionizing radiation: Gamma irradiators, Electron irradiators, X-rays irradiators and Dosimetry (radiation doses and dose rate), Safety and security

Unit-2 Radiation technology in agriculture (15 Lectures)

Colonization and production of insect host and their natural enemies, Combating pests and diseases, The principle of SIT and its uses in different order of insects, Modified Sterile Insect Technique (F₁ sterility), Phytosanitary Treatments (post harvested), Quarantine control.

Unit-3 Future trends (5 Lectures)

Integration of Radio-Genetic tactic with Biological Control and Synergistic impact on pest control

Suggested Readings:

1. JORGE HENDRICHS, *Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Austria*
2. Lide, D.R. (ed.), (1990), CRC Handbook of Physics and Chemistry, Boca Raton, FL: CRC Press.
3. McLaughlin, W.L., Boyd, A.W., Chadwick, K.H., McDonald, J.C., and Miller, A. (1989), *Dosimetry for Radiation Processing*, New York: Taylor & Francis, p. 251.
4. International Atomic Energy Agency (IAEA) (1996c), *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, Safety Series No. 115, Vienna Austria: Jointly published by FAO, IAEA, ILO, OECD/NEA, PAHA and WHO.

Skill Enhancement Courses: Chemistry
(Credits 2)
SEC 1: Conventional Insecticides
Lectures: 30

Unit-1 Carbamate insecticides

(8 Lectures)

Preparations and pesticidal properties of following carbamate insecticides: Carbaryl, Methomyl. Mode of action of carbamate insecticides.

Unit-2 Organophosphorus insecticides

(10 Lectures)

Nomenclature and structural diversities of organophosphorus compounds; Mode of action of organophosphorus insecticides.

Unit-3 Organochlorine Insecticides

(12 Lectures)

Preparation and properties of organophosphorus insecticides

The chlorinated cyclodienes and their stereochemistry:

Chloridane, heptachlor, aldrin, dieldrin endosulfan.

Mode of action of organochlorine insecticides.

Suggested Readings:

1. Perry, A.S., Yamamoto, I., I. Shaaya and R. Perry, *Insecticides in Agriculture and Environment*, Narora Publishing House.
2. R.J. Kuhr, H.W. Derough, *Carbamate Insecticides, Chemistry, Biochemistry and Toxicology*, CRC Press.
3. O'Brien, R.D., *Insecticide, Action and Metabolism*, Academic Press, New York and London.
4. *Chemical Pesticides: Mode of Action and Toxicology* by Jorgen Stenersen (CRC, 2004)
5. *The Chemistry of Organophosphorus Pesticides: Reactivity, Synthesis, Mode of Action, Toxicology* by C. Fest, K.-J Schmidt. 1973. Springer- Verlag, New York.

SEC 2: Biological Insecticides
(Credits 2)
Lectures: 30

- Unit-1 Alkaloids:** Nicotine and its analogs (6 Lectures)
- Unit-2 Pyrethrum:** Properties of Natural pyrethroids, Synthetic analogs of Pyrethroids: Allethrin, Fenvalerate, decamethrin. Mode of action of pyrethroids. (10 Lectures)
- Unit-3 Novel insect-control chemicals-Azadirachtin** (8 Lectures)
- Unit-4 Repellants, Chemosterilants, Antifeedants, Sex attractants** (6 Lectures)

Note: No structure elucidation or synthesis is required for above compounds

Suggested Readings:

1. Natural Products in Plant Pest Management by edited by N K Dubey.(2011)
2. Vickery, ML and Vickery, B. (1981). Secondary plant metabolism. Macmillan, London.
3. I. L Finar, Organic Chemistry Vol:2 The English language book society and Longman group Ltd, London. (Latest edition).
4. Koul, O. and Dhaliwal, GS (eds) Phytochemical Biopesticides. Harwood Academic Publishers, Amsterdam R.L. Metcalf *Organic Insecticides, their Chemistry and mode of action.*
5. O'Brien, R.D., *Insecticide, Action and Metabolism*, Academic Press, New York and London.

SEC 3: Pesticide Formulations
(Credits 2)
Lectures: 30

Unit 1: Introduction (6 Lectures)

Definition, purpose of formulations, different types of formulations

Unit 2: characteristics and specifications of formulation (16 Lectures)

Physio-chemical characteristics of formulation, important BSI specification.

Unit 3: Forms of common pesticides (8 Lectures)

Wettable powders, solutions, emulsifiable concentrates, aerosols, dusts and granules.

Suggested Readings

1. Franklin R. Hall, Paul D. Berger and Herbert M. Collins, (1995) *Pesticide Formulations and Application Systems* (v. 14)
2. R. Wade, M. Dekker, (1973) *Pesticide Formulation*, Inc. New York,
3. Chester L. Foy, David W. Pritchard, (1996) *Pesticide Formulation and Adjuvant Technology*, CRC Press
4. D. Alan Knowles, (1998) *Chemistry and technology of agrochemical formulations*, Springer

SEC 4: Analytical Techniques involved in Pesticide Analysis
(Credits 2)
Lectures: 30

Unit 1: Principle underlying the following analytical techniques: (10 Lectures)

- a. Ultraviolet (UV) visible absorption spectroscopy
- b. Infra Red (IR) spectroscopy

Unit 2: Principle of Nuclear Magnetic Resonance spectroscopy (nonmathematical treatment):
aspinning proton in magnetic field, precession frequency, ¹H NMR spectroscopy, Chemical shift,
shielding and deshielding effects, spin-spin coupling. (12 Lectures)

Unit 3: Mass spectroscopy (MS) introduction, basic principles, ionization methods, applications in
characterization of simple organic molecules. (8 Lectures)

Suggested Readings

1. Robert. M. Silverstein, Basseler, & Morrill (1991) *Spectrometric identification of Organic Compounds*, John Wiley and Sons. N.Y.
2. Kalsi, P. S. (2005). *Spectroscopy of Organic Compounds*, New Age international publishers, New Delhi.
3. F. D. Snell and C. T. Snell (1959) *Colorimetric Methods of analysis*, D. Van Nostrand Co., New York.