SEMESTER III

ZOM 303B: ENTOMOLOGY

Course I: Insect Physiology I and Industrial Entomology (Credit 3)
Section A: Insect Physiology - I (Credit 2)

Hours of Teaching

1. Digestive system **3**
- 1.1 Digestion of various biomolecules
- 1.2 Absorption of food

2. Fat body: Physiology and biochemistry **3**

3. Excretory system **4**
- 3.1 Organs of excretion
- 3.2 Nitrogenous excretion
- 3.3 Production of urine and its hormonal regulation
  - 3.3.1 Terrestrial and salt water insects
  - 3.3.2 Control of diuresis

4. Circulatory system **12**
- 4.1 Haemocytes
  - 4.1.1 Type
  - 4.1.2 Origin and longevity
  - 4.1.3 Changes in haemocyte population
- 4.2 Immunity
  - 4.2.1 Cell mediated immunity
  - 4.2.2 Humoral immunity
  - 4.2.3 Haemolymph proteins
  - 4.2.4 Storage proteins: synthesis, uptake and their role
  - 4.2.5 Vitellogenin and uptake by ovary
  - 4.2.6 Antibacterial proteins
  - 4.2.7 Lectins
  - 4.2.8 Protease inhibitors
  - 4.2.9 Enzyme in haemolymph
  - 4.2.10 Peptides: neuropeptides and humoral factors
  - 4.2.11 Chromoproteins
  - 4.2.12 Specific proteins
- 4.3 Trehalose
  - 4.3.1 Chemistry
  - 4.3.2 Metabolism and hormonal regulation
  - 4.3.3 Physiological roles

5. Reproduction **4**
- 5.1 Anatomy of reproductive organs
- 5.2 Spermatogenesis
- 5.3 Oogenesis

Section B: Industrial Entomology (Credit 1)

Hours of Teaching

1. Sericulture **6**
- 1.1 Mulberry sericulture
  - 1.1.1 Cultivation of food plants

1.1.2 Rearing of silkworms
1.1.3 Harvesting and processing of cocoons
1.1.4 Diseases of *Bombyx mori*
1.1.5 Predators and parasitoids of silkworm and their management
1.2 Non-mulberry sericulture: Tasar, Muga, Eri
1.2.1 Food plants
1.2.2 Rearing of silkworms

2. Apiculture **5**
2.1 Organization of bee colony
2.2 Dance language of honeybees
2.3 Diseases of honeybees
2.4 Beekeeping methods
2.4.1 Equipment and tools
2.4.2 Apiary management

3. Lac culture **2**
3.1 Lac insect and its life history
3.2 Propagation of lac insects

Books Recommended

1. Advances in Insect Physiology (vols. 1-28), Academic Press, 1986-2001
2. Chapman: The Insects: Structure and Function (4th ed.), ELBS, 1998
3. Kerkut and Gilbert: Comprehensive Insect Physiology, biochemistry and pharmacology (vols 1-13), Pergamon, 1985
4. Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001

Books Suggested

1. Gilbert et al.: Comprehensive Molecular Insect Science (Volume 1- 7), Elsevier, 2005
2. Gullan & Cranston: The Insects: An Outline of Entomology (4^{th} ed.) Blackwell, 2010
3. Gupta: Insect Hemocytes, Cambridge University Press, 1979
4. Imms: A General Text Book of Entomology (2 vols.), Asia Publishing House, 1997
5. Rockstein: Biochemistry of Insects, Academic Press, 1978
6. Wigglesworth: Principles of Insect Physiology, ELBS, 1972

ZOM 304B: ENTOMOLOGY

Course II: Insect pests and their management (Credit 3)

Hours of teaching

1. Origin of insect pests **1**
2. Natural control **1**
3. Cultural techniques: agronomic practices (crop rotation, tillage, sowing/planting density, intercropping, trap cropping) **2**
4. Chemical methods **17**
4.1 Botanical insecticides (pyrethrins and azadirachtin)
4.2 Organochlorines, organophosphates, carbamates, pyrethroids & Neonicotinoids
4.3 Insect growth regulators (juvenoids, moulting-accelerating compounds & anti-hormones)
4.4. Pymetrozine, avermectins & spinosyns
4.5 Mode of action of insecticides affecting: acetylcholine receptors, GABA receptors & voltage-gated ion channels

5. Biological methods **5**
- 5.1 Predators & parasitoids
- 5.2 Importation biological control
- 5.3 Conservation biological control
- 5.4 Augmentation

6. Microbial methods (virus, bacteria & fungi) **5**

7. Behavioural methods: Use of semiochemicals in: Stimulo-deterrent diversionary strategy, mass trapping & mating disruption methods **3**

8. Genetic and biotechnological methods **3**
- 8.1 SIRM
- 8.2 Transgenic plants with insecticidal genes

9. Integrated pest management **2**

Books Recommended

1. Dent : Integrated Pest Management, CABI, 2000
2. Gullan and Cranston: The Insects: An Outline of Entomology (5th ed.) Wiley Blackwell, 2014
3. Ishaaya and Degheele: Insecticides with novel modes of action: Mechanism and Application Springer-verlag, 1998.
4. Ishaaya : Biochemical sites of insecticide action and resistance Springer-Verlag, 2001
5. Thacker: An introduction to arthropod pest control. Cambridge University Press, 2002

Books Suggested

1. David and Ramamurthy: Elements of Economic Entomology (6th ed.), Namrutha, 2011
2. Pedigo: Entomology and Pest Management (4th ed.), Prentice Hall, 2002
3. Srivastava & Dhaliwal: A Text Book of Applied Entomology (Vol. I & II.) Kalyani Publ., 2010

LABORATORY EXERCISES

ZOM 306B: ENTOMOLOGY (Credit 2)

Section A: Insect physiology-I and Industrial Entomology (Credit 1)

1. Preparation of stained histological slides of
   - 1.1 Alimentary canal of cockroach (foregut, midgut and hindgut)
   - 1.2 Salivary apparatus of cockroach and *Dysdercus*
   - 1.3 Malpighian tubules of cockroach
   - 1.4 Blood cells of cockroach
   - 1.5 Reproductive organs of hemi and holometabolous insects
   - 1.6 L.S. telotrophic and polytrophic ovarioles
   - 1.7 Testis of cockroach and *Dysdercus*
2. Demonstration of amylase and proteinase activities of salivary gland of cockroach
3. Study of morphology of eggs of *Drosophila,* cockroach and *Dysdercus*
4. Study of food utilization by silkworm *Bombyx mori*
5. Visit to a silkworm rearing/training centre
6. Study of pre- and post-cocooning characteristics of *B. mori*
7. Study of silkworm diseases using permanent slides/specimen
8. Study of external morphology of different castes of honey bee and preparation of a permanent mount of sting apparatus

Section B: Insect Pests and their Management (Credit 1)

1. Collection and preservation of insects by
   1.1 Dry preservation methods (direct pinning, carding and pointing)
   1.2 Liquid preservation and processesed mounting methods
2. Study of key features of insects belonging to economically important insect orders (Orthoptera, Hemiptera, Lepidoptera, Hymenoptera, Diptera)
3. Measurement of oxygen consumption in pyrethroid - treated cockroach
4. Study of pheromone trap, insect probe trap and repellometer
5. Study of the antifeedant effect of an azadirachtin - based insecticide on grasshoppers
6. Determination of LC_{50} of an insecticide using *Drosophila melanogaster* larvae or *Tribolium castaneum*
7. Culture of *Dysdercus koenigii/ Bactrocera cucurbitae*
8. Monitoring insect pest population of *Bactrocera dorsalis* by using sex pheromone analogues
9. Study of insecticide appliances

SEMESTER IV

ZOM 402B: ENTOMOLOGY

Course III: Insect Physiology II (Credit 3)

Hours of teaching

1. Endocrine organs and hormones **12**
- 1.1 Historical perspective
- 1.2 Endocrine glands and concept of neurosecretion
- 1.3 Juvenile Hormone
  - 1.3.1 Introduction, chemistry and agonists
  - 1.3.2 Function and catabolism
  - 1.3.3 Mode of action
- 1.4 Ecdysteroids
  - 1.4.1 Cholesterol trafficking in steroidogenic cells
  - 1.4.2 Ecdysteroid receptor (history, structure and evolution)
  - 1.4.3 Function and mode of action
- 1.5 Vertebrate hormones in insects

2. Neurotransmitters and neuromodulator system **8**
- 2.1 Cholinergic system
- 2.2 Biogenic amines
  - 2.2.1 Synthesis and metabolism
  - 2.2.2 Catecholamines
  - 2.2.3 Indolamines
- 2.3 Amino acids
  - 2.3.1 Glutaminergic system
  - 2.3.2 GABAergic system
- 2.4 Neuropeptides
  - 2.4.1 FMRFamide-related peptides
  - 2.4.2 Cholesystokinin-related peptides
  - 2.4.3 Proctolin

3. Mechanisms for cuticular sclerotization **6**
- 3.1 Components of sclerotized cuticle (structural proteins, chitin, catechols, enzymes)
- 3.2 Dityrosin cross links
- 3.3 Quinone tanning
- 3.4 B-sclerotization

4. Insect sterol **2**
- 4.1 Structure and dietary sources (algal, fungal & plant sterols)
- 4.2 Sterol use and metabolism
- 4.3 Sterol intake, absorption, transport and distribution
- 4.4 Sterol ecology and implication

5. Visual system **4**
- 5.1 Compound eye
- 5.2 Image formation
- 5.3 Light and dark adaptation

6. Mechanism and significance of sound production **3**

7. Bioluminescence **4**
- 7.1 Light producing organ
- 7.2 Mechanism of light production
- 7.3 Control and significance of light production

Books Recommended

1. Advances in Insect Physiology (vols. 1-28), Academic Press, 1986-2001
2. Chapman: The Insects: Structure and Function (4th ed.), ELBS, 1998
3. Kerkut and Gilbert: Comprehensive Insect Physiology, biochemistry and pharmacology (vols 1-13), Pergamon, 1985
4. Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001

Books Suggested

1. Gullan and Cranston: The Insects: An outline of Entomology (5th ed. 2014 Wiley Blackwell)
2. Gilbert et al.: Comprehensive Molecular Insect Science (Volume 1- 7), Elsevier, 2005
3. Gullan & Cranston: The Insects: An Outline of Entomology (4th ed.) Blackwell, 2010
4. Gupta: Insect Hemocytes, Cambridge University Press, 1979
5. Imms: A General Text Book of Entomology (2 vols.), Asia Publishing House, 1997
6. Rockstein: Biochemistry of Insects, Academic Press, 1978
7. Wigglesworth: Principles of Insect Physiology, ELBS, 1972

ZOM 403B: ENTOMOLOGY

Course IV: Agricultural and Medical Entomology (Credit 3)

Section A: Agricultural Entomology (Credit 2)

Hours of teaching

1. **Insect – plant interactions** — **10**
   - 1.1 Types of damage by insects
   - 1.2 Insect feeding preferences and host - plant selection
     - 1.2.1. Role of plant chemicals in stimulation of feeding and oviposition
     - 1.2.2 Role of plant chemicals as feeding deterrents
   - 1.3 Plant toxins and their effect on insects
2. **Ecology of interactions in agroecosystems** — **2**
   - 2.1 Insect pollinators and flowering plants
   - 2.2 Trophic dynamics
   - 2.3 Habitat modifications (altered resource concentration, apparency and microenvironent)
3. **Environmental monitoring using aquatic insects** — **1**
4. **Insect pest invasions and prevention** — **1**
5. **Insect pests of crops** — **9**
   - 5.1 Major pests of the following crops, nature of damage caused and pest management: paddy, wheat, sugarcane, pulses, cotton, vegetables, fruits and stored grain
   - 5.2 Polyphagous insect pest: locusts, aphids
6. **Environmental impact of insecticides** — **3**
   - 6.1 Insect resistance to insecticides
   - 6.2 Concept of insecticide treadmill and pest resurgence

Section: B Medical Entomology (Credit 1)

1. **Medical Entomology** — **9**
   - 1.1 Pests of public importance and their control: mosquitoes, house flies, lice, bedbugs, fleas
   - 1.2 Insect borne diseases of man: typhus, yellow fever, dengue fever, encephalitis, plague, leishmaniasis, sleeping sickness, malaria, filaria,
   - 1.3 Insect venoms and allergens
2. **Forensic entomology:** — **2**
   - 2.1 Insects succession on corpse

2.2 Determination of time of death

3. Insect cell culture and insects as bioreactor **2**

Books Recommended

1. Byrd and Castner: Forensic Entomology, CRC Press, 2001
2. Gullan & Cranston: The Insects: An Outline of Entomology (4th ed.) Blackwell, 2010
3. Harborne: Introduction to Ecological Biochemistry (4th ed.), 1993
4. Mullen and Durden: Medical and Veterinary Entomology, Academic Press, 2002
5. Service: Medical Entomology for Students (5th ed.), Cambridge University Press, 2012

Books Suggested

1. Marquardt et al.: Biology of Disease Vectors (2nd ed.), Elsevier Academic Press, 2005
2. Pedigo: Entomology and Pest Management (4th ed.), Prentice Hall, 2002
3. Schoonhoven et al.: Insect-plant Biology- from physiology to evolution (1st ed.), Chapman & Hall, 1998
4. Srivastava & Dhaliwal: A Text Book of Applied Entomology (Vol. I & II.) Kalyani Publ., 2010
5. Thacker: An introduction to arthropod pest control. Cambridge University Press, 2002

LABORATORY EXERCISES

ZOM 405B: ENTOMOLOGY PRACTICAL (Credit 2)

Section A: Insect Physiology II (Credit 1)

1. Dissection of CNS if cockroach and *Dysdercus*
2. Whole mount stained preparation of
   2.1 Brain
   2.2 Corpora cardiac
   2.3 Corpora allata
   2.4 Prothoracic gland
3. Preparation of histological slides of brain, CC,CA and CNS ganglia
4. Preparation of permanent AF stained slide to demonstrate presence of MNSCs in brain of cockroach/*Dysdercus*
5. Demonstration of presence of chitin in the cuticle of cockroach
6. Dissection of lamina medulla lobula complex in live cockroach/cricket
7. Ligation experiment to demonstrate effect of brain hormones on development
8. Effect of insect hormones (JH, 20-HE)/Thyroxin on the growth and development of *Dysdercus*/silkworm

Section B: Agricultural and Medical Entomology (Credit 1)

1. Identification of insects belonging to economically important insect orders (Orthoptera, Hemiptera, Lepidoptera, Hymenoptera, and Diptera) till family level, by using *dichotomous keys*
2. Dissection and permanent whole mount preparation of
   2.1 Mouthparts of cockroach and *Dysdercus koenigii*
   2.2 Mouth parts and legs of honey bee
3. Study of insect pests of stored grains
4. Study of food preferences of grasshoppers and *Tribolium castaneum* / *Callosobruches* sp.
5. Study of repellents on stored grain pests using an olfactometer
6. A field study of aquatic insects
7. Study of some public health important insect pests with the help of specimens or slides
8. Study of life cycle of mosquitoes and their habitats.
9. Study of life cycle of house flies and their habitats.
10. Preparation of a permanent slide of sting apparatus of honey bee.