

MODEL ANSWER AND MARKING SCHEME
MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END THEORY EXAMINATION

B. Sc. (Hons.) Agriculture

Semester : II (New)	Term: II	Academic Year : 2021-2022
Course No : ENTO 121	Title : Fundamentals of Entomology	
Credits : 2 (1 + 1)		
Day & Date :	Time :	Total Marks: 40

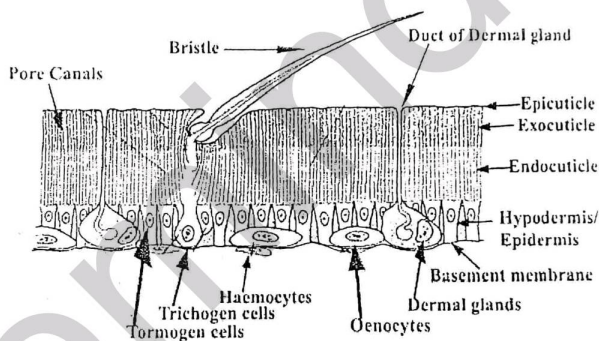
Note: 1. Solve ANY EIGHT questions from SECTION "A"
2. All questions from SECTION "B" are compulsory
3. All questions carry equal marks
4. Draw neat diagrams wherever necessary

SECTION "A"

Q. 1 Describe structure of insect integument with labeled figure.

Ans. : Labeled figure of insect integument.

(1 mark)



Description of structure of insect integument

(3 marks)

It consists of three parts i.e. 1. cuticle 2. epidermis or hypodermis and 3. basement membrane.

I. Cuticle: It is a complex, non-cellular layer which forms the outermost investment of the body and its appendages. The cuticle has two sub divisions viz., 1. epicuticle (Non-chitinous) and 2. procuticle with chitin-protein complex. **1. Epicuticle:** It is a very thin layer as compared to procuticle. Its thickness varies from $1/100^{\text{th}}$ to 4 micron. This layer consists of three layers. A. protein epicuticle consisting of protein and polyphenol B. lipid epicuticle (wax layer) C. tectocuticle (Cement layer). The wax layer imparts water conserving property.

2. Procuticle: It is much thicker than epicuticle. It is composed of chitin protein and other substances. Chitin is the chief constituent forming 20-50% dry weight of the cuticle. It is highly resistant to alkalis. It is divisible into outer exocuticle and inner endocuticle. The exocuticle is hard and dark in colour due to tanning. The endocuticle is not involved in tanning.

II Epidermis: It is one cell thick and underlies the cuticular part. Some of the cells are modified to form sense organs. It is the cellular layer of the integument that underlies and secretes the cuticle. It also produces moulting fluid, absorb digested products of the old cuticle and repairs the wound. Certain hypodermal cells produce hair like organ called setae.

III Basement membrane: The inner ends of the hypodermal cells are bound by a more or less distinct membrane called basement membrane. It is 0.5 micron thick.

Q. 2 Explain modifications in insect antenna with suitable examples. (Any eight 4 marks)

- Ans:
- 1. Filiform:** Antennal segments are equal in thickness, without prominent constrictions at the joints; giving an appearance of thread. e.g. Grasshopper.
 - 2. Moniliform or necklace or Bead like:** Antennal segments are somewhat globular with prominent constrictions at the joints giving an appearance of beads. e. g. Thrips, Termites.
 - 3. Setaceous or Whip like or Bristle like:** Antennal segments go on reducing in thickness towards the tip and then ending in a point. e.g. Cockroach.
 - 4. Serrate or Saw tooth like:** Antennal segments are produced into triangular projections like a teeth of saw. e.g. Metallic beetle, Click beetle.
 - 5. Pectinate or Comb like:** Antennal segments bear a comb like structure either on one side or on both the sides. **5 (a): Unipectinate:** The comb like structure is present on one side only. e.g. Male silk moth. **5 (b) Bipectinate:** The comb like structure is present on both the sides of antennal segments. e.g. Female silk moth.
 - 6. Capitite or Knob like:** Terminal antennal segments are abruptly enlarged to form knob. e.g. Weevil, Khapra beetle.
 - 7. Clavate or Club like:** The succeeding antennal segments of flagellum go on gradually increasing in thickness, thereby giving an appearance of club. e.g. Lemon butterfly, Cabbage butterfly.
 - 8. Geniculate or Elbowed type:** The flagellum is bent into an arm like structure, while the pedicel forms the resting point or pivot. e.g. Honey bee, Wasp.
 - 9. Lamellate or Leaf like:** Terminal segments at tip are enlarged towards one side of antennae forming plate or lamina. e.g. Rhinoceros beetle, Dung roller.
 - 10. Aristate or Bristle like:** Third antennal segment or flagellum bears a bristle like structure dorsally, thus forming arista. e.g. Housefly.
 - 11. Stylete or Style like:** Bristle like structure arises at the terminal end of third antennal segment. e.g. Jassid.
 - 12. Plumose or Whorl like:** Whorl of hairs arises from the entire antennal segments. e.g.

Male mosquito.

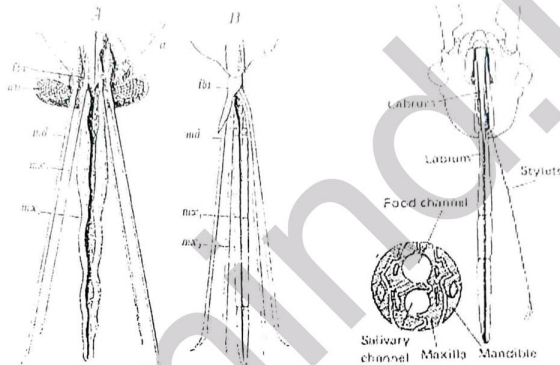
13. **Pilose:** Whorl of hairs arises on the joints of antennal segments only, e.g. Female Mosquito.

14. **Flabulate:** A fan like structure is present at the base of flagellum, e.g. Strepsipterous insects.

Q. 3 Describe piercing and sucking mouth parts of insect with labeled diagram.

Ans. : Labeled diagram of piercing and sucking mouth parts

(1 mark)



Description of piercing and sucking mouth parts

(3 marks)

Labium projects downwards from the anterior part of the head like a beak. Beak is four segmented and grooved throughout its entire length. At the base of the labium there is a triangular flap like structure called labrum. Labium is neither involved in piercing nor sucking. It functions as a protective covering for the four stylets (fascicle) found within the groove. Both mandibles and maxillae are modified into long slender sclerotized hair like structure called stylets. They are lying close together and suited for piercing and sucking. The tips of the stylets may have minute teeth for piercing the plant tissue. The inner maxillary stylets are doubly grooved on their inner faces. When these are closely opposed they form two canals viz., food canal and salivary canal through sap and saliva are conducted respectively. Saliva contains enzymes or toxins that can distort plant cell wall to permit the stylets to penetrate down and reach phloem for sucking the sap. Both palps are absent. e.g. Plant bugs.

Q. 4 Describe wing modifications in insects quoting examples.

(4 marks)

Ans. : 1. **Tegmina:** The first pair of wing is thickened to form a leathery structure. e.g.

Cockroach, Mantid, Grasshopper.

2. **Elytra:** The first pair of wing is hardened to form horny sheath called elytra. e.g. Beetles and Weevils.
3. **Hemelytra:** The first pair of wing is thickened at the base and membranous towards the apex. e.g. Plant bugs.
4. **Halters:** Only front pair of wing is present. The second pair is modified into dumbbell shaped fleshy structure known as balancer or halters. e.g. Housefly.
5. **Scaly:** Wings are covered with scales. e.g. Moths and Butterflies.
6. **Fringed:** The wings are membranous and narrow. But bear long bristles. e.g. Thrips.
7. **Fissured:** Forewings are longitudinally divided twice forming a fork like structure whereas hind wings are divided twice in to three arms. All the forks possess small marginal hairs. They are useful for flight. e.g. Plum moth
8. **Membranous:** The wings are entirely membranous. e.g. Bees and Wasps.

Q. 5 Define metamorphosis and describe its types quoting examples.

Ans. : **Definition of metamorphosis:** The change in the body form during post embryonic development in insects is called metamorphosis. (1 mark)

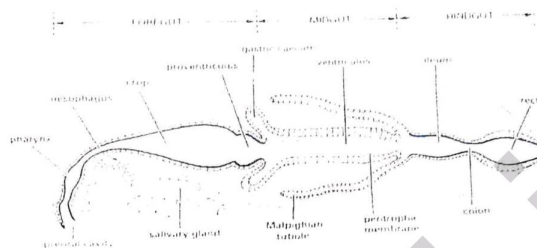
Types of metamorphosis with examples (3 marks)

1. **Ametabolous :** Insects undergo no metamorphosis. Development takes place through three different life-stages i.e. egg, juvenile and adult. Immatures are called Juveniles. Feeding habit and habitat of immatures and adults are same. e.g. Silverfish.
2. **Hemimetabolous:** It is also called incomplete or gradual metamorphosis. Life-cycle is completed in three stages viz., egg, nymph and adult. Immature forms are called nymphs. Feeding habits and habitats of immature and mature forms are same. Wings develop externally. e.g. Grasshopper, Red cotton bug
3. **Holometabolous:** It is also called complete or complex metamorphosis. The life-cycle is completed in four stages viz., egg, larva, pupa and adult. Feeding habits, habitats and structure of immature and mature stages are completely different. Wings develop internally. e.g. butterfly, beetles, housefly.
4. **Anamorphosis:** In insects like Protura, first instar larva has only 8 abdominal segments with terminal telson. The remaining three segments are added in subsequent moults. Telson remains at terminal end.
5. **Hypermetamorphosis:** In insects like blister beetle the larva passes through totally different instars, hence known as hypermetamorphosis .
6. **Epimorphosis:** In which segments and legs are not added at molts e.g. Myriopods

Q. 6 Describe digestive system of insect with labeled diagram.

Ans. : Labeled diagram of digestive system of insect

(1 mark)



Description of digestive system of insect

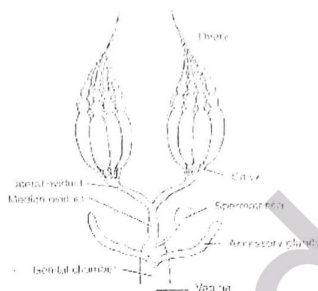
(3 marks)

The digestive system of insect consists of an alimentary canal and the associated glands which pore their secretions into it. It includes organs of ingestion, digestion, absorption, egestion and excretion. The alimentary canal is a tubular structure extending from mouth to anus and divisible into three parts viz., 1. Stomodaeum or foregut 2. Mesenteron or mid gut and 3. Proctodaeum or hind gut. Stomodaeum begins with buccal cavity and leads to pharynx. Pharynx leads to thin walled tube, oesophagus. Its hind portion is dilated to form crop. Crop serves as food reservoir. Some digestion may occur in crop as the contents are mixed with saliva and some lipids may be absorbed. At the posterior end of crop is the gizzard or proventriculus which forms the last portion of foregut. The cuticular lining of gizzard is developed into prominent denticles and thus serves for grinding and straining food material. The posterior part of proventriculus projects into narrow tube that extends in mid gut as stomodaeal cardiac valve which prevents backward movement of food. However, digestive juices flow freely from midgut to crop. Mesenteron is also termed as stomach or ventriculus. This region begins at the base of outer fold of stomodaeal valve and ends posteriorly before the bases of Malpighian tubules. It is a long uniform tube. It carries eight bunt small tubes known as gastric or hepatic or enteric caeca. They are secretory and absorptive in function. Proctodaeum or hind gut is the posterior part of alimentary canal and extends from stomach to anus. The Malpighian tubules arise at the beginning of hind gut which are excretory in function. The entrance to the hind gut is more or less constricted and guarded by a valve known as proctodaeal or pyloric valve. It is generally differentiated into anterior small intestine or ileum followed by large intestine or colon and finally rectum, opening to the exterior through anus. The rectum contains 4-6 rectal papillae which reabsorb salt and water as the waste matter passes allowing only solid waste to pass. A salivary glands lie in thoracic region on either side of foregut. Each gland is composed of a number of lobes and a thin walled sac or reservoir. The ducts of two reservoirs join to form a common salivary duct which opens into mouth cavity at the base of hypopharynx. The salivary glands secrete the saliva which contains enzymes to carryout digestion of complex food material.

Q. 7 Explain female reproductive system of insect with labeled diagram.

(1 mark)

Ans. : Labeled diagram of female reproductive system of insect



Description of female reproductive system of insect

(3 marks)

Ovaries: Compact bodies lying in body cavity of abdomen on either side of alimentary canal. Each ovary is composed of a variable number of separate egg tubes or ovarioles which opens in to the lateral oviduct. Each ovariole / egg tube is differentiated internally into four zones viz., i) Terminal filaments, ii) Germarium/iii) Vitellarium/ zone of growth and iv) Pedicel.

Lateral oviduct: Proximal ends of ovarioles from each ovary unite to form lateral oviduct on each side. It is mesodermal in origin.

Female genital duct / common oviduct: Oviducts are paired canals leading from ovaries and two ducts unite forming a common oviduct. In Glossina (Tsetse fly), the vagina is enlarged and form a chamber Uterus.

Accessory glands / collateral glands/ cement glands: These are one or two pairs of glands often produce substance for attaching the eggs to the substratum during oviposition. e.g. egg case production in mantid, ootheca formation in cockroach, venom production in bees.

Spermatheca: Pouch or sac like structure, ectodermal in origin. Function of spermatheca is to receive and store spermatozoa. The spermatheca opens on dorsal wall of genital duct.

Bursa copulatrix: Pouch / chamber like development of vaginal region opens through 9th abdominal segment by genital aperture. This chamber serves as a copulatory pouch during mating and thus it is known as bursa copulatrix. Its external opening is called as vulva. In many insects, the vulva is narrow and the bursa copulatrix becomes an enclosed pouch or tube referred to as vagina.

Q. 8 Explain circulatory system of insect.

Ans. : Organs of circulation :The diaphragms & sinuses

(4 marks)

Haemocoel is divided into 3 sinuses by 2 fibromuscular septa known as diaphragms

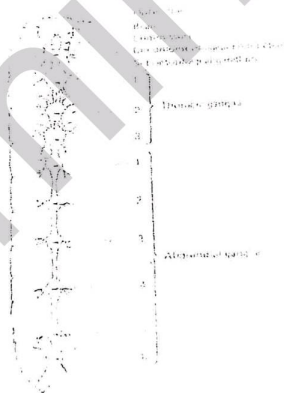
1. Dorsal diaphragm: It extends across the abdominal cavity above the alimentary canal

The blood space enclosed by this is known as the dorsal or pericardial sinus which contains heart. 2. Ventral diaphragm: It stretches across the abdominal cavity just above ventral nerve cord. The blood space enclosed by this is known as ventral or perineural sinus. The visceral sinus is present between dorsal and ventral sinuses, containing principal internal organs. Pairs of alary muscles are composed of striated fibres arise from terga and spread out fanwise over the surface of dorsal diaphragm. Dorsal vessel extends from the posterior end of abdomen into head. It is situated along the mid dorsal line just below the integument, between it and dorsal diaphragm. It is continuous tube, closed posteriorly and is open at anterior end at cephalic region. It is divided into heart and aorta. Heart acts as pumping organ and aorta acts as conducting vessel. Heart is characteristically chambered. Each chamber has slit like opening in the lateral walls (incurrent ostia or lateral inlets). Aorta is the anterior prolongation of dorsal vessel. It extends forward through thorax and ends in head over brain. It is the principal artery of blood. Accessory pulsatory organ is a sac like structure which is situated in various regions of body. It ensures adequate blood supply to the appendages.

Q. 9 Explain central nervous system of insect with labeled diagram.

Ans. : Labeled diagram of central nervous system of insect

(1 mark)



Description of central nervous system of insect

(3 marks)

It is the major portion of nervous system. Basically it constitutes a pair of ganglia in each body segment. These are united by a transverse strand of nerve fibres known as commissures. A pair of longitudinal strand of nerve fibres is called connectives. These join the fused ganglia of each segment with the preceding and following ganglia of the other segment. It is distinguished into three regions viz., 1. The brain or cerebral supraoesophageal ganglion 2. Sub-oesophageal ganglion and 3. The ventral nerve cord. The brain is the ganglionic centre of the head lying dorsally above oesophagus. It forms

major part of CNS which receives stimuli from the sense organs of the head and posterior part of the body. It is divided into 1. Protocerebrum 2. Deutocerebrum and 3. Tritocerebrum. The protocerebrum is formed due to fusion of the preantennary or first head segment. It is bilobed and continuous laterally with optic lobes. It supplies nerves to the compound eyes and ocelli. The deutocerebrum lies on ventral side of the protocerebrum. It is also known as mid-brain. It is formed by fusion of the antennary head segment and it supplies nerves to antennae. The tritocerebrum is also known as hind-brain which lies below and behind deutocerebrum. It is formed due to fusion of intercalary head segment. It is divided into two separate lobes which are attached to deutocerebrum. 2. Suboesophageal ganglion is second ganglionic centre of head. It is formed by the fusion of ganglion of mandibular, maxillary and labial segments. It lies below the oesophagus and posterior to the brain. It supplies nerves to mandibles, maxillae, hypopharynx, labium and neck. 3. Ventral nerve cord consists of various ganglion lying in thoracic and abdominal region with their connectives. Generally 3 ganglia in each of the thoracic segments and 5 abdominal ganglia are lying in the abdominal region. Thoracic ganglion are prothoracic, mesothoracic and metathoracic.

Q. 10 Write short note (Any two).

1. Order Coleoptera

(2 marks)

Ans: Coleoptera (*Coleos* = Sheath; *Ptera* = Wing) e.g. Beetles and Weevils

The coleoptera is the **largest** order in the animal kingdom, with about **350000** described species of holometabolous.

General characters of Coleoptera

- a) Minute to large insects with hard exoskeleton.
- b) Forewings are modified into horny shell like elytra (vein less sheath).
- c) Elytra covering the folded hind wing at rest.
- d) Mouthparts biting and chewing type.
- e) Prothorax large.
- f) Antenna lamellate, serrate or clubbed type.
- g) In weevil, antennae carried forward; the frons and vertex prolonged anteriorly to form rostrum or snout.
- h) Ocelli are usually absent.
- i) Metamorphosis complete.
- j) Larvae types are apodous, campodeiform, euriciform or scarabaeiform.
- k) Pupation in a specially constructed cell or chamber.
- l) Most of the beetles are ground-dwellers, some are aquatic.

Sub-orders: Adephaga and Polyphaga

Important families: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae,

2. Structure of typical insect leg

Ans. : Labeled figure of typical insect leg

(1 mark)



Structure of typical insect leg:

Description of structure of insect leg

(1 mark)

- a) **Coxa:** It is a basal segment which articulates to pleurite by coxal process of pleuron and trochantin (articular sclerite)
- b) **Trochanter:** It is small, single quadrangular segment which is present between coxa and femur. It is loosely articulated with coxa and rigidly fixed to the femur.
- c) **Femur:** It is strong segment which possesses powerful muscles. Its lower end is articulated with tibia and forms a knee joint.
- d) **Tibia:** It is 4th segment. It equals or exceeds the length of femur
- e) **Tarsus and pretarsus:** It is foot. Its upper part is called tarsus and lower one is called pretarsus. Tarsus may be 1 to 5 segmented. Each segment is called tarsomere. Pretarsus bears two sharp curved hooks or claws. A median lobe between claws is called arolium. In Diptera there are two lobes between two claws called pulvilli. A prolonged median bristle like structure lying between two lobes is called empodium.

3. Malpighian tubules

(2 marks)

Ans. : It is discovered by Italian anatomist, Malpighi. These are present in all insects except in Collembola, some Thysanura and aphid. These are long, slender and blind tubules lying in the haemocoel and freely bathed by the blood. They open at their proximal extremities into the intestine near the junction of hind gut and mid gut. Distally these are usually free but in some insects the distal ends of tubules are closely applied to the hind gut. This type of condition is known as cryptonephridial condition. This condition occurs in the larvae and adults of many Coleoptera, in some Hymenoptera larvae. Cryptonephridial system enables the insects to conserve water by withdrawing moisture from faeces. Number, size and type of Malpighian tubules vary from insect to insect. The primitive number is believed to be six but fewer or more may be present. When few tubules are present these are generally long, some times longer than the body. When great many, these are often short.

4. Sense organs

(2 marks)

- Ans. : 1. **Photoreceptors**: These are simple eyes and compound eyes. Simple eyes (Ocelli) are three, one dorsal and two lateral in position. The compound eyes are main organs of vision, one on each side of head. It is composed of a number of vision units called ommatidia.
2. **Auditory organs**: These organs perceive sound waves. Johnston's organ is present on pedicel part of antennae in male mosquito. A tympanum on first abdominal segment in short-horned grasshopper and fore-tibia of cricket is also auditory organ.
3. **Chemoreceptors**: It is sense of smell which are located on antennae or palps. In moths it is used to attract opposite sex and locate site for oviposition.
4. **Gustatory organs**: These are sense of taste which are situated on antennae in honey bee and on tarsi of housefly and on the surface of mouth parts.
5. **Mechanoreceptors**: These form the sense of touch and balance. e.g. sensilla and sensory hairs

SECTION "B"

Q. 11 Define the following terms.

1. Entomology 2. Morphology 3. Ecdysis 4. Taxonomy

Ans. : 1. Entomology: It is the branch of zoology which deals with study of insects (1 mark)

Ans. : 2. Morphology: It is the study of external organs or features of organism. (1 mark)

Ans. : 3. Ecdysis: It is the process of shedding exoskeleton. (1 mark)

Ans. : 4. Taxonomy: It is the theory and practices of classification of organism. (1 mark)

Q. 12 Do as directed.

1. State the head position in red cotton bug.

Answer: Opisthognathous (1 mark)

2. Hamulate/frenate type of wing coupling apparatus is observed in honey bees (Choose the correct word).

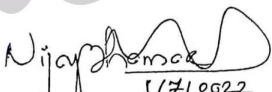
Answer: Hamulate (1 mark)


3. Apodus larvae possess abdominal legs (State True or False).

Answer: False (1 mark)

4. Name the order of mustard sawfly.

Answer: Hymenoptera (1 mark)


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