

BRITISH BEEKEEPERS' ASSOCIATION
MODULE 5 HONEY BEE BIOLOGY
Sample Paper Marking Scheme

- Marks should only be awarded for points which answer the question.
- The allocation of points to be included are a guide to what should be included and are not necessarily definitive.
- Where more points are provided than the number requested eg 8 points when only 6 are asked for, then first 6 answers should be taken.
- 0 marks if answer doesn't work
- Do not penalise poor spelling so long as the meaning is clear other than technical terms.
- **How the answer is phrased is not important but that aspect must be understood from the answer rather than just mentioning the words.**

SECTION A (10 marks, 1 for each question)

- Q1 Name the valve at the anterior end of the ventriculus.
A Proventriculus
- Q2 Precisely where on a bee is the labellum (flabellum) located?
A The far end of the glossa
- Q3 How many pairs of spiracles does an adult bee have?
A 10
- Q4 Juvenile hormone is secreted by what organ?
A Corpora allata
- Q5 Name one type of flight muscle.
A Direct / indirect also accept dorsoventral /longitudinal
- Q6 Name the fat body cells which are only found in the larva and pupa.
A Urate
- Q7 How many malpighian tubules does a larva have?
A Four
- Q8 What is the purpose of the hamuli?
A To connect the hind wing to a fold on the forewing
- Q9 Name an organ which is normally smaller in summer bees than in winter bees.
A Rectum
- Q10 A ramus is part of which structure.
A Sting

Section B

- Q11 (a) Name the different types of eyes found in a bee and state the number of each type of eye and their location on the bee's head. 6
- (b) Describe the structure of a single ommatidium. 7
- (c) What is on the surface of the ommatidium and what function does that feature serve? 2

Q11 (a) Name the different types of eyes found in a bee and state the number of each type of eye and their location on the bee's head. 6 Marks

1. Simple eye
2. ocelli-
3. 3 - on top of head (workers)
4. on front of ace (drones)
5. Compound
6. 2 - on either side of the head

1 Mark for each

(b) Describe the structure of a single ommatidium. 7 Marks

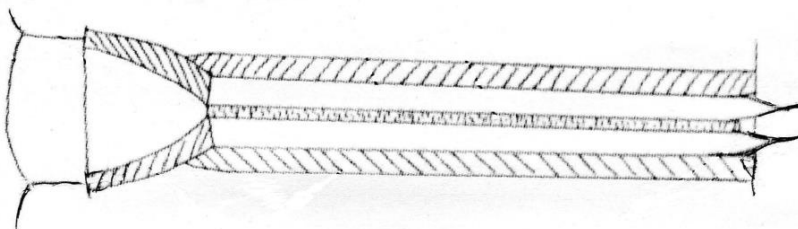
The light gathering parts:

1. Transparent corneal lens hexagon shaped
2. Crystalline cone made from 4 cone (accept semper) cells which are hard and transparent & tapering at the end
3. Outside the crystalline cone are 2 primary pigment cells (cornegen cells) the purpose of which is to prevent light from other ommatidia entering the come

The sensory parts:

4. Retinula cells which are elongated nerve cells 8 full length and 1 short all twisted around each other
5. Rhabdom at the centre of retinula cells is a space filled by microvilli which are finger like projections from the edges of the retinula cells
6. Secondary pigment cells surround the retinula cells
7. Nerve fibres pass from the end of the retinula cells

1 mark for each line maximum 7 marks



(c) What is on the surface of the ommatidium and what function does that feature serve? 2

Marks

1. Hairs on the edge
2. detect wind speed
3. helping bees assess flying distance
4. protection from damage

1 March each line Maximum 2 Marks

- Q12 (a) List the differences between winter bees and summer bees. 6
 (b) List the factors determining caste determination. 9

Q12 (a) List the differences between winter bees and summer bees. 6 Marks

Summer	Winter
1. Live 5-6 weeks	Live up to 6 months
2. Low levels of glycogen protein and fat in fat bodies	Bodies can contain large amounts of glycogen
3. High metabolic rate	Lower metabolic rate
4. Hardworking- work selves to death	Little work
5. Care for brood	Little brood rearing
6. Atrophied hypopharyngeal gland in food older bees	Hypopharyngeal gland plump & full of brood
7. Rectum voided frequently	Rectum collects waste until it can be voided, enlarged

1 mark for each line maximum 6 marks

(b) List the factors determining caste determination. 9 Marks

1. Eggs laid in worker/queen cell
2. white secretion = mandibular gland, clear= hypopharyngeal gland, yellow=crop content (sugar and pollen)
3. Workers are fed brood food in the ratio 2:9:3 white/clear/yellow (derived from pollen) for 3 days
4. After day 3 the worker receives less white, more clear and more yellow
5. Queen fed royal jelly for 3 days
6. Royal jelly contains about 34% sugar and mainly mandibular gland secretions (white food)
7. Queen then fed food which is a ratio of 1:1white to clear for 2 days
8. Queen larva receive x10 as much food as worker brood, the higher feeding rate stimulates stretch receptors of the ventriculus
9. Queen larva have a higher rate (x10 of worker brood) of Juvenile Hormone by day 3
10. this promotes queen characteristics by stimulating the corpora allata.

1 mark each line maximum 9 marks

Q13	(a)	List 4 functions of haemolymph.	4
	(b)	Name the 2 parts of haemolymph.	2
	(c)	Describe how haemolymph circulates around the bee's body.	9

Q13 (a) List 4 functions of haemolymph. 4 Marks

1. Transport of food/waste and hormones
2. Mechanical support
3. Regulates/controls water contents of cells
4. Metabolism – chemical reactions take place in it and chemicals are broken down
5. Phagocytosis surround and destroy bacteria and parasites
6. Wound healing
7. Eversion of endophallus in drone

1 mark each line maximum 4 marks (only mark first four items given, ignore others)

(b) Name the 2 parts of haemolymph. 2 Marks

1. Plasma
2. Haemocytes

1 mark for each

(c) Describe how haemolymph circulates around the bee's body. 9 Marks

1. Fluid underneath the ventral diaphragm is moved front to back
2. Fluid above the dorsal diaphragm is moved back to front
3. The heart muscles in the abdomen contract and squeeze haemolymph forward into the aorta in thorax the muscles relax
4. ostia (5 valves) in the heart open and haemolymph flows in to fill the cavity
5. The aorta ends just behind the brain ensuring the brain is supplied
6. Antennal vesicle relaxes and haemolymph flows into it through an opening at the back
7. The antennal vesicle then squeezes fluid through the 2 vessels going into the antennae
8. Antennal vesicle relaxes & haemolymph flows into it through an opening at the back
9. The antennal vesicle then squeezes fluid through the 2 vessels going into the antennae

1 mark for each line maximum 9 Marks

- Q14 (a) Give an account of the development of the egg from the time it is laid to the point at which the larva emerges. 9
- (b) Name the features A-F on the diagram. 6

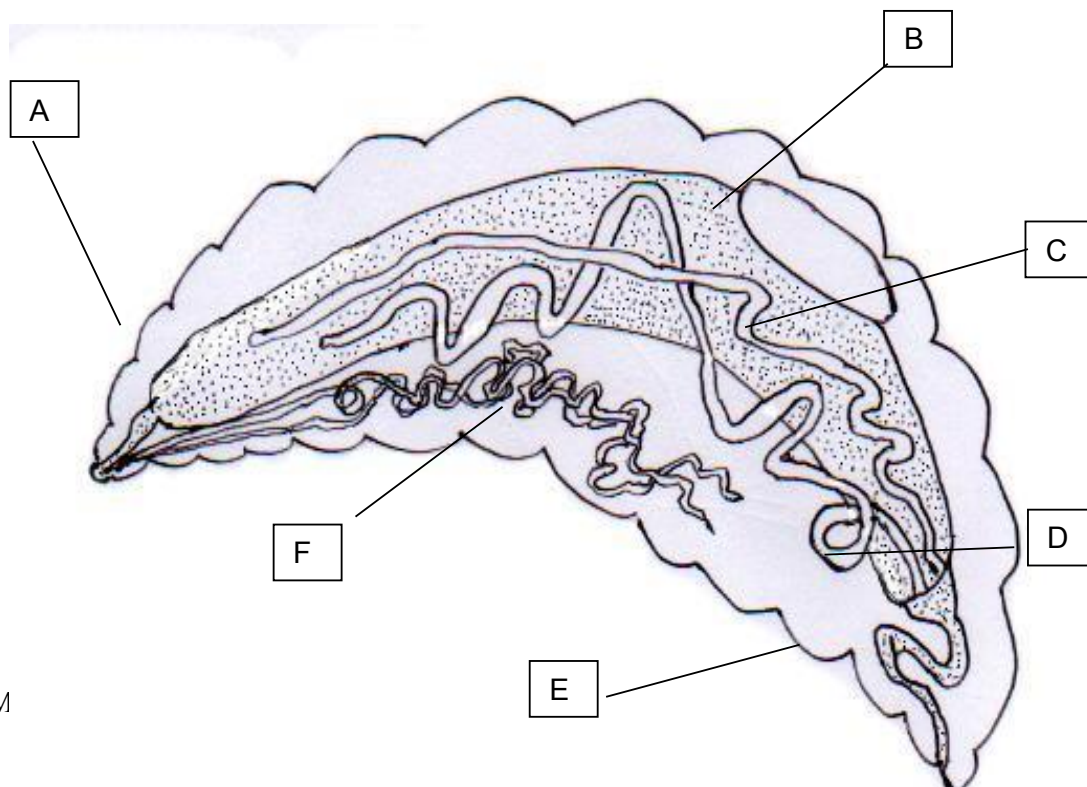
Q14 (a) Give an account of the development of the egg from the time it is laid to the point at which the larva emerges from it. 9 Marks

1. Cleavage the nucleus divides forming cells which spread throughout the yolk
 2. Blastoderm formation cleavage cells move to form the blastoderm which is immediately inside the vitelline membrane
 3. Germ band forms- blastoderm thickens on ventral side and forms germ band which spreads over sides and end of egg
 4. Germ band divides by longitudinal fissures and divides into 2 lateral plates at side and 1 median plate in the middle of ventral side
 5. Median plate moves inwards towards yolk and becomes mesoderm
 6. Lateral plates grow ventrally and join together to form ectoderm which surrounds mesoderm
 7. Endoderm forms as 2 ingrowths from front & back of blastoderm. They become separate structures moving inwards then enclose the yolk – this will become the ventriculus
 8. Ingrowths from ectoderm appear which will become the front and hind gut
 9. Day 3 larva moves and bursts the membrane surrounding it - the amnion
- 1 mark each line maximum 9 marks*

(b). Name the features A-F on the diagram.

6

- A Foregut
 - B Testis
 - C Malpighian tubule
 - D Hindgut
 - E Anus
 - F Silk glands
- 1 mark for each feature*



M

- Q15 (a) List 3 differences between the endocrine and exocrine glands. 3
- (b) Name three of the glands making up the endocrine system in a larva, describe where they are located and what they do. 9
- (c) What endocrine gland is present in the larva but not in the adult bee and what does it produce? 2

Q15 (a) List 2 differences between the endocrine and exocrine glands. 3 Marks

Endocrine	Exocrine
Ductless	Ducted
Release hormones directly into Haemolymph	Release pheromones to outside of body
Affect the individual bee	Affects other honey bees

1 mark each point, total 3 marks

(b). Name three of the glands making up the endocrine system in a larva, describe where they are located and what they do. 9 Marks

1. Neurosecretory cells
2. In groups in brain and ganglia
3. Secrete chemicals to other glands or down nerve fibres to other organs

4. Corpora cardiaca
5. 2 glands behind brain either side of aorta
6. Store chemicals produced by neurosecretory cells and also make chemicals of their own

7. Corpora allata
8. Either side of oesophagus
9. Produce juvenile hormone

10. Prothoracic glands
11. 2 glands in thorax near first spiracle
12. Produce and secrete ecdysone

Maximum 3 Marks for each of 3 Glands making 9 Marks in total

(c) What endocrine gland is present in the larva but not in the adult bee and what does it produce? 2 Marks

1. Prothoracic
2. Ecdysone

Section C

- Q16 (a) Describe where the sting is located in an adult bee, the features forming the structure of the sting and how these operate to inject venom into a victim. 20
- (b) Name 4 of the main components which are found in venom. 4
- (c) List the source, purpose and main components of the alarm pheromones produced by the worker 6

Q16 (a) Describe where the sting is located in an adult bee, the features forming the structure of the sting and how these operate to inject venom into a victim. 20 Marks

1. The sting is housed in the sting chamber at the rear of the abdomen A7.
2. To activate the sting, the tip of the abdomen is swung down into an almost vertical position.
3. The shaft which normally encloses the sting mechanism is swung upwards.
4. On each side the sting comprises of 3 main plates.
5. The lower plate, the oblong plate is fixed and does not move.
6. This plate is continuous with the 2nd ramus which arches backwards
7. to run continuously with the central rod of the bulb
8. and merge to form one common stylet.
9. The upper plate, the quadrate plate is mobile and is moved backwards and forwards by the protractor and retractor muscles.
10. The triangular plate is continuous with the 1st ramus,
11. it is a long curved rod which arches backwards to run continuously with the lancet.
12. When the quadrate plate is pulled backwards the triangular plate rocks on the oblong plate,
13. the movement transferred to the arching ramii causing retraction of the lancets.
14. Equally when the quadrate plate is pulled forwards by the protractor muscles the triangular plate rocks forwards and the lancet is protracted.
15. The 1st ramus is grooved and runs on a track like ridge formed by the 2nd ramus.
16. The ramii enter the bulb and exit to form the two lancets and one stylet.
17. The track and groove of the stylet and lancets allow the two lancets to glide smoothly back and forth.
18. The bulb is a sac like structure lying between the oblong plates and holds the venom produced by the venom gland.
19. The venom is propelled down through the bulb by a structure attached to each lancet, called the umbrella valve,
20. into a central canal formed by the two lancets and the stylet.
21. When a honey bee stings a soft bodied animal the backward facing barbs on the lancets are stuck,
22. giving purchase for the other lancet to penetrate deeper into the wound.

1 mark each line Maximum 20 marks

(b) Name 4 of the main components which are found in venom. 4 Marks

1. Hyaluronidase
2. Phospholipase A
3. Phosphatase
4. Histamine
5. Melittin

1 Mark for each Maximum 5 Marks

(c) List the source, purpose and the main component of the alarm pheromones produce by the worker. 6 Marks

1. Mandibular gland
2. Subdue intruder
3. 2-Heptanone
4. Koschevnikov gland
5. attract other bees to the location and causes the other bees to behave defensively,
6. Iso-pentyl acetate

1 mark per line max 6

- Q17 (a) Discuss the structural and physiological differences between laying workers and normal workers and the role of pheromones in bringing about these differences. 15
- (b) Explain how feeding brings about caste determination in the honeybee. 15

Q17(a) Discuss the structural and physiological differences between laying workers and normal workers and the role of pheromones in bringing about the differences. 15 Marks

Structural and physiological differences:

No structural external differences except -

1. in some cases workers **develop into a 'pseudo queen' with a slightly enlarged abdomen**
 2. **'Pseudo queens' mandibular gland enlarges; and produce a pheromone similar to queen substance**
 3. Internally the **ovarioles, about 2 – 12 have enlarged** and are producing eggs
 4. There may be some workers with developed ovaries in a normal colony
 5. Can only lay a **few eggs compared with the queen**
 6. **Spermatheca is vestigial** and does not contain sperm
 7. Workers are unable to mate as genitalia not developed
 8. **Workers will lay unfertilised eggs** which develop into drones
 9. In very few cases worker eggs may be female eggs
 10. (due to incomplete mitosis)
- Triggers in the development:
11. **Inhibited by presence of queen cell, virgin queen or mated queen**
 12. Queen mandibular pheromone **9ODA inhibits worker ovary development**
 13. possibly pheromones from the **abdominal tergite glands of a mated queen**
 14. **Brood pheromone inhibits** worker ovary development
 15. When all brood has emerged, including drones ie approx 24 days brood pheromone is absent
 16. **Once workers start to lay, worker brood pheromone inhibits** further w ovary development

One mark per line, max 15

(b) Explain how the feeding brings about caste determination in the honeybee. 15 Marks

1. **The type of cell has an influence on feeding,**
2. **Larvae that emerge in worker cells are fed with worker jelly,**
3. **Larvae that emerge in queen cells are fed royal jelly,**
4. **Up to 3 day old larvae are able to develop into queens if transferred to queen cells,**
5. (man made or emergency), after 3 days will develop as intercastes,
Brood food contains mixtures of secretions from:
6. **Hypopharyngeal gland protein, mineral, vitamins, etc, - clear fluid,**
7. **mandibular gland fatty acids – white fluid,**
8. which also act as preservative,
9. **and crop content (mainly sugars and some pollen) – yellow,**
Worker Larvae
10. **Worker larvae are mass fed for the first 3 days, then progressively fed,**
11. **Worker larvae are fed more protein in the first 3 days,**
12. Less sugar 12% - then **progressively more sugars 47% and some pollen,**
Queen Larvae
13. **Queen larvae are mass fed throughout their larval life,**
14. **Mainly white secretion Ratio of 1:1 white to clear,**

15. In the queen larva the higher proportion of sugar fed in the first 3 days – **,34% compared to 12%,**

16. Higher sugar content of these 3 days also encourages more feeding - phagostimulant,

17. Stimulates stretch receptors of midgut ,stimulates **increased production of JH (juvenile hormone)** from the **corpora allata**,
18. **synthesis of queen characteristics, and faster development,**
19. Contains more **pantothenic acid, bioppterin and neopterin** from mandibular gland than worker jelly,
20. The proportion of sugar is reduced and protein increased in the following days.

*If quoting the proportion, it needs to be accurate for a mark
1 mark each highlighted point plus others to max of 15*