BRITISH BEEKEEPERS' ASSOCIATION
MODULE 7 HONEYBEE BREEDING
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 What year is indicated by the colour WHITE when marking a queen?
A Year ending 1 or 6.

Q2 Which part of an egg is penetrated by sperm?
A Micropyle

Q3 What is the name of the pheromone that attracts drones to the queen?
A 9-ODA (or 9-oxodec-2-enoic acid)

Q4 What proportion of the queen's wing should be removed when clipping?
A one third

Q5 What is the optimum age of a larva for grafting?
A Less than 24 hours

Q6 What is the name for the type of cell division that produces normal cells during the growth of an organism?
A Mitosis

Q7 What type of bee results from parthenogenesis?
A Drone/male bee

Q8 Name a virus associated with Nosema which might affect a queen rearing programme.
A Black Queen cell virus

Q9 At what age after emergence are drones sexually mature?
10 to 14 days.

Q10 What is a gamete?
A A reproductive cell, an egg or a sperm.

SECTION B

Q11	(a)	Describe briefly the genetic basis of sex determination.	7
	(b)	How does parthenogenesis affect the resulting progeny?	5
	(c)	What are the advantages of parthenogenesis to the colony?	1
	(d)	What are the disadvantages of a drone laying queen to a colony?	2

11 (a) Describe briefly the genetic basis of sex determination. 7 Marks

1. Sex alleles at least 12 at same locus
2. 1 allele = drone,
3. he will be homozygous
4. 2 alleles same = diploid drone,
5. homozygous
6. 2 different alleles – fertilised egg female
7. heterozygous

1 mark per line to a maximum of 7

(b) How does parthenogenesis affect the resulting progeny? 5 Marks

1. All male sperm is identical therefore all workers derived from one drone carry 75% identical genes.
2. Multiple matings by the queen result in groups of super-sisters.
3. Gender of brood is determined by choice of the queen to fertilise an egg or not.
4. Quality of a breeder queen is determined by the outcome of her daughter queens' progeny.
5. Not such a great diversity in characteristics from successive generations.
6. Drone gametes can reflect recessive genes
7. They can produce bees of known geno/phenotype

1 mark each line to a maximum of 5

(c) What are the advantages of parthenogenesis to the colony? 1 Mark

1. A group of super sister groups more closely related to each other. Leads to a cohesive workforce which benefit from sacrificing their lives for the good of the colony.

1 mark

(d) What are the disadvantages of a drone laying queen to a colony? 2 Marks

1. DLQ will only produce drones will eventually lead to demise of colony
2. Drones are produced in worker cells so are stunted and would be unable to compete with normal drones.

1 mark each line

Q12	(a)	How can queenlessness be confirmed in a colony?	2
	(b)	List the factors that can result in a colony becoming queenless and identify, with reasons, whether the colony can normally recover from this without intervention.	7
	(c)	Explain what happens within a colony if it is queenless for more than 3 weeks?	6

12 (a) How can queenlessness be confirmed in a colony? 2 Marks

1. Insert a test frame with eggs **and young larvae** in the queenless colony.
2. queen cells on frame indicate no queen present.

Sieve the bees – not reliable. No eggs – not reliable.so no marks

1mark for each point. To maximum of 2

(b) List the factors that can result in a colony becoming queenless and identify, with reasons whether the colony can normally recover from these factors without intervention. 7 Marks

1. Queen killed by poor beekeeping manipulation –
2. recoverable because young brood available.
3. Attack by wasps or other predator such as Asian Hornet –
4. not recoverable colony depleted and brood eaten.
5. Swarmed colony losing virgin –
6. not recoverable as no brood.
7. Queen dies in winter –
8. not recoverable and queen reared would not mate.

1 mark each line to a maximum of 7

(c) Explain what happens within a colony if it is queenless for more than 3 weeks? 6 Marks

1. No queen pheromone to supress ovary development in workers.
2. No brood pheromone to supress ovary development in workers
3. Laying workers develop in the colony and multiple eggs laid on sides of cells.
4. Laying workers lay in random worker cells producing stunted drones
5. Laying workers produce pheromone, becoming pseudo queens, that suppress other workers developing ovaries and produce conditions where colony will reject introduced queen.
6. Colony doomed

1 mark each line

13 (a) Using 2 British Standard colonies how should a mating nucleus be made up? 13

(b) Indicate in your answer on which day in the queen rearing plan this should be done and why? 2

13 (a) Using 2 British Standard colonies how should a mating nucleus be made up? 13

1. First find and cage the queens from each donor colony
2. A simple mating nucleus (nuc) should consist of a minimum of 3 frames covered with bees
3. a frame of stores containing fresh pollen and liquid honey
4. a frame of emerging brood
5. a frame of sealed brood
6. If nuc remains in the apiary 3 other frames covered in bees should be lightly shaken over the donor colony to dislodge older bees before being shaken into the nuc
7. If nuc is to be moved away at least 3 miles another frame covered in bees should be shaken into the nuc, firmly closed with foam and transported away immediately
8. To stop fighting - spray each frame and bees lightly with very weak sugar syrup
9. Leave the frames well apart in the nuc box and exposed to the light
10. Smoke well when bringing the frames together
11. The entrance should be reduced and lightly closed with grass
12. Return the queens to **correc**t colonies and add frames of drawn comb and/or foundation to replace those donated
13. Destroy incipient queen cells
14. Introduce ripe queen cell so exit tip is over brood
15. The introduced cell will not be ready to hatch for two more days, on day 16

1 mark each item to a maximum 13 marks

(b) Indicate in your answer on which day in the queen rearing plan this should be done and why? 2

1. Mating nucs should be made 8 days after grafting/egg selection i.e. on day 12,
2. so that the nuc is queen less for two days before the queen cells are put in

Q14	(a)	What is meant by 'in breeding' and 'out breeding'?	2
	(b)	Is it possible for the British Black bee and the African bee to mate and produce viable offspring? Briefly explain your answer.	2
	(c)	How can the quality of a breeder queen be assessed?	3
	(d)	What are the potential advantages and problems when cross breeding subspecies of honeybees?	8

Q 14. (a) What is meant by 'in breeding' and 'out breeding'? 2 Marks

1. In breeding – mating between closely related individuals
2. Out breeding – mating between unrelated individuals of the same species.

1 Mark for each

(b) Is it possible for the British Black bee and the African bee to mate and produce viable offspring? Explain your answer. 2 Marks

1. Yes.
2. Because they are both in the same species (Apis *mellifera)*

1 Mark for each

(c) How can the quality of a breeder queen be assessed? 3 Marks

1. Records of colony performance and health etc over at least 2 years
2. Compare performance of sister queens
3. Produce a number of queens from her and assess the quality of their colonies.
4. DNA testing for inheritance traits

1 Mark for each to a maximum of 3.

(d) What are the potential advantages and problems when cross breeding subspecies of honeybees? 8 Marks

Advantages

1. Cross breeding introduces new genes and results in new characteristics.
2. Reduces the possibility of diploid drones.
3. Resulting colonies can be more active (F1 hybrid vigour)
4. Resulting bees probably more disease resistant.

Disadvantages

5. Resulting colonies less adapted to local conditions.
6. The outcome is not predictable.
7. Introduces new characteristics into an area with adverse effect on local beekeepers
8. Have to continue cross breeding and second generation may exhibit unwanted characteristics

1 mark per line maximum 8

Q15 (a) List the three types of queen cells produced by a colony. 1

(b) UNDER SEPARATE HEADINGS outline how these different queen cells might be distinguished and what conditions lead to each type of cell. 14

Q15 (a) List the three types of queen cells produced by a colony. 1 Mark

1. Swarm, Emergency, supersedure

1 mark

(b) UNDER SEPARATE HEADINGS outline how these different queen cells might be distinguished and what conditions lead to each type of cell. 14 Marks

Swarm

1. Many cells usually on periphery of brood frame
2. Queen substance not getting around due to congestion
3. Specially built queen cells look bigger drawn from queen cups
4. Ageing queen or reduced pheromone (*not failing queen*)
5. Produced under swarming impulse

Emergency

6. Usually around centre of brood nest
7. 6 - 20 cells
8. Look smaller because extending into existing worker cells - hooknose
9. Produced if queen disappears or fails suddenly

Supersedure

10. Queen gradually declining but not failing
11. Can still lay eggs in queen cells
12. Few queen cells
13. Specially built queen cells look bigger
14. Often in dents of comb in centre of brood nest

1 mark per line up to 14

SECTION C

16. (a) Record keeping is vital for successful stock improvement. What information should be recorded and in what format should this information be recorded. 16

(b) From your record card select **ONE** feature for each of the following operations and explain its importance. **You must select a different feature in each case.** 4

(i) A beekeeper with 4 hives in a suburban backyard.

(ii) A commercial operation with over 100 hives.

(c) Queen breeders use two distinct units in their programmes to produce virgins: the cell starter/raiser and a cell finisher. Explain how each is used and the differences between them. In your answer stress the important components of each. 10

16. (a) Record keeping is vital for successful stock improvement. What information should be recorded and in what format should this information be recorded. 16

1. General layout with some indication of scoring.
2. Origin of queen
3. Extra mark if both drone & mother queen ref
4. Year produced/mated
5. Appearance/morphometry measurement(s)
6. Disease resistance/hygienic behaviour
7. split into Varroa; Chalk; DVW; Nosema; eq
8. Temper, following and quiet on comb
9. Low swarming
10. Supersedure
11. Brood pattern/popholes/brood viability
12. Comb building
13. Appearance of cappings
14. Propolis
15. Adapted to colder areas of country
16. Good wintering/thrifty-ness
17. qualitative scale eg good/bad/fair
18. quantitative scale eg 1 – 5, 5 being the best.

1 mark for each line above to a maximum of 16.

(b) From your record card select ONE important feature for each of the following operations and explain it importance. You must select a different feature in each case.

(i) A beekeeper with 4 hives in a suburban backyard.

(ii) A commercial operation with over 100 hives.

For each feature 1 mark for why the reason is important and 1 mark for the outcome.

Example (i) Temper /people around/get stung (cause annoyance)

(ii) Productivity/need crop/business/reduced swarmyness reduces management etc

(c) Queen breeders use two distinct units in their programmes to produce virgins: the cell starter or raiser and a cell finisher. Explain how each is used and the differences between them. In your answer stress the important components of each. 10

Starter:

1. Queen-less or has queen-less portion
2. Receives grafts/young larvae
3. Must be strong
4. Well supplied with pollen
5. Well fed so can collect more pollen
6. Lots of nurse bees
7. To raise/charge with royal jelly

Finisher:

1. Queen right
2. Complete cell construction
3. Nurture/incubates
4. Working colony
5. Very strong
6. Lots of nurse bees
7. To produce royal jelly

1 mark for each item with a maximum of 5 for starter and 5 for finisher.

Q17 (a) Describe the equipment and the method of instrumental insemination of a honeybee queen. 26

(b) Using instrumental insemination, what observable brood condition can arise from closely related drones and queens and what are the causes? 4

17 (a) Describe the equipment and the method of Instrumental Insemination of a honeybee queen. 26 Marks

1. Mature drones in a flight cage
2. Chilled before use
3. All apparatus and work areas must be sterile avoiding contamination with faecal matter from Drones
4. A stand for the micro-manipulator
5. dissecting microscope (x10 to x40)
6. queen holder and attachments for the two (ventral and dorsal) hooks to open the queen's sting chamber
7. Low voltage cool lamp
8. Source of CO2 connected to the queen holder to anaesthetise the queen (twice) to age her and encourage oviposition
9. A glass micro-syringe (0.3mm outer dia. and 0.15mm inner dia.) for depositing the drone semen
10. Long fine glass capillary tubes for storing drone semen
11. Five to six days after emergence the queen will be mature and ready to mate
12. One day before insemination a gentle stream of CO2 gas is directed over the queen for about 3 mins
13. The day after CO2 treatment a saline buffer solution is prepared by micro filtering the solution through a 2.um filter
14. Semen is collected from mature drones directly into a micro syringe avoiding adding mucus which coagulates on contact with the air
15. About 8ul is required from 8 drones
16. This will collect c.4.75million sperms
17. The semen is mixed in a special syringe with the filtered buffer solution to obtain a homogenous mass of semen (12:1, sperm: buffer solution)
18. This mixture is centrifuged at c.2 x gravity (2 x 32 ft/sec/sec) for a few minutes
19. The glass centrifuging tube contains the sperm at one end and the saline solution above it
20. The glass tube is cut off at the interface level and sperm loaded into the micro syringe
21. The queen is placed head first into the glass holder then eased backwards until the last abdominal segment is exposed
22. The holder is then attached to the apparatus and the queen is given a second stream of CO2 to anaesthetise her
23. The ventral hook is attached to the open sting chamber first
24. Then the specially shaped dorsal hook depresses the valve fold during the process of injecting the semen to ensure that it enters the oviducts
25. The tip of the micro syringe is placed at the entrance to the vagina past the valve fold and the semen slowly expelled
26. The hooks are released and the queen removed from the holder.
27. The treatment with CO2 ensures that the queen comes into lay about 2 days after insemination

1 mark each line Max 26 marks

(b) Using instrumental insemination, what observable brood condition and its causes, can arise from closely related drones and queens? 4 Marks

1. a spotty brood pattern often referred to as shot brood
2. arises as a result of inbreeding
3. sex alleles are the same at the given locus
4. diploid drones produced

1 mark each line maximum 4 marks