1a) Describe how sacbrood virus affects the larva, the typical visual signs and how the virus is spread through the colony (8)	• Virus normally enters young larva when they are fed • Larva about 2 days old are most susceptible to the disease • Larva normally undergo their 5th moult about 4 days after the cell is sealed, when the prepupa changes into the pupa • The virus causes the moult to fail, and the tough outer cuticle is not shed properly • The space inside fills with ecdysial, or moulting fluid • The pre-pupa, now in a fluid filled bag, or *sac,* dies - the fluid contains an enormous number of virus particles • The prepupa changes from yellow to brown and quickly dries into a dark brown flattened scale • The scale takes up the classic gondola or 'Chinese slipper' shape • Although the cell is capped before death, the workers will remove the capping to clean out the cell, in the process taking in virus particles • Virus particles accumulate in the worker hypopharyngeal glands and is fed to young larvae, repeating the cycle
1b) What effect does sacbrood virus have on the adult bee? (4)	• Hypopharyngeal glands are infected and they stop feeding larvae • They become foragers earlier than normal • Very few collect pollen • Their lives are shortened • Drones have their brain infected – put no outward signs. • Bees can carry the virus, especially over winter – but show no signs of the infection.
1c) Describe the signs of bald brood (3)	• exposed pupae and imago in open cells - if caused by wax moth the cells will be in rows • If caused by wax moth, a 'silken' trail where the cappings should be. (frass) • Rim of wax around the cell

2a) How would you recognise chalkbrood? (5)	• Perforated cappings (can look like AFB but not greasy) – bees remove cappings • white fluffy pellets, which had been the full-grown larvae (larvae stretch out in the cell) • turns black over time • Visible surface of the 'pellet' has a yellowish/pink protuberance (poached egg appearance) – this was the mouthparts of the pupae. • Hard mummies easily removed from cell • frequently found in floor debris or at entrance • Removal of dead brood (pellets) results in pepper-pot brood pattern.
2b) Briefly describe the lifecycle of the chalkbrood fungus. (5)	• Spores infect the brood from contaminated worker mouthparts • Spores can enter the larva via wounds in the surface eg Varroa feeding sites. • Spores germinate in the hindgut of the larva • Eventually, hyphae break out, overwhelming the larva • Once the larva dies the cell fills with white mycelium, drying out to the characteristic mummies • Spherical, sticky spores form within greyish-green fruiting bodies which can remain infective for 15 years
2c) What actions can a beekeeper take to prevent chalkbrood developing within a colony and spreading across an apiary? (5)	• Keep strong healthy colonies so brood nest temperature is maintained – Chalk Brood spores germinate better at temperature slightly lower than the normal brood nest temp. • Provide plenty space so the colony is able to maintain a well-ventilated environment – Chalk Brood spores germinate better in higher concentrations of CO_2 than is normally found in a strong/healthy colony. • Regular comb replacement to remove pathogens • Avoid transferring infected combs between colonies • Requeen different strain. (Young queen will also be stronger). • Make sure colonies are not too close together – minimise drifting. • Avoid excessively damp apiary sites – ensure good ventilation eg OMF, roof ventilation. Beware answers that concentrate only on hives being damp and cold, rather than the imbalance of bees to brood Reference: *Pam Gregory, HBHB, pp39-41*

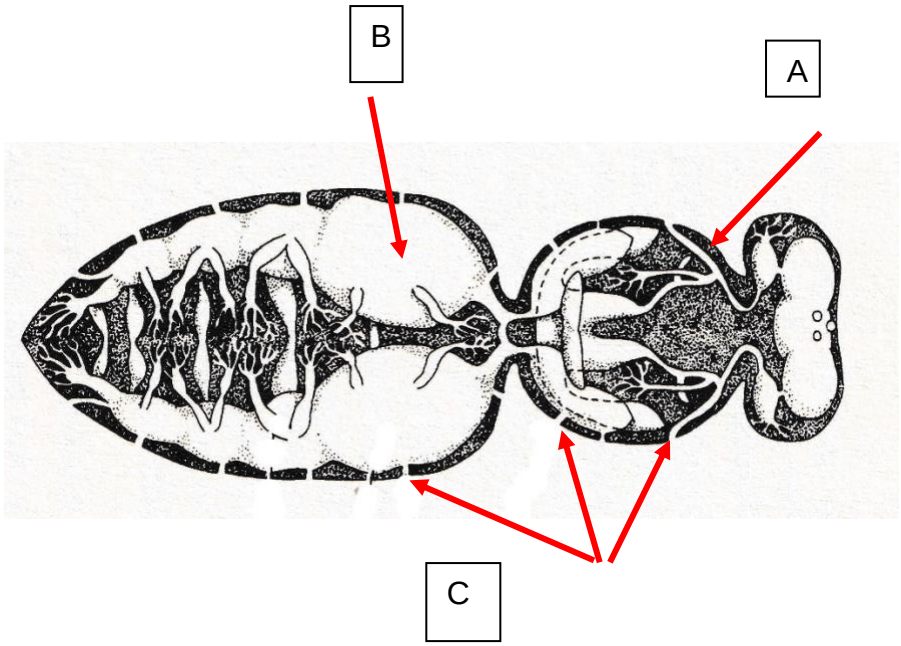
3a What is dysentery? Why does it usually occur? (2)	• Heavy soiling of hives or combs by faeces of adult bees due to excess water in bee gut • Usually occurs when bees feed on 'unsuitable' stores, such as honey or sugar with unusually high moisture contents.
3b What steps can be taken by the beekeeper to reduce the risk of dysentery occurring? (4)	• Complete Autumn feeding by first week of October using heavy syrup – to give the bees time to evaporate the water content and properly process this into winter stores before the cold weather arrives. • Avoid feeding bees with fermented honey • Feed only refined sucrose • Maintain vigorous, healthy stocks that are more able to withstand infection. • Feed only fondant/bag of sugar over the winter ie no liquid feeds.
3c Make brief notes on Malpighamoeba mellificae including the type of organism and lifecycle (6)	• Single-celled parasite • Affects the Malpighian tubules of adult bees • Cysts (dormant form of parasite) ingested from faeces of infected bees • Cysts germinate, invading the Malpighian tubules • Cysts multiply and at the expense of excretory cells. • Cysts pass into the rectum to be discharged with faeces.
3d What signs (if any) might arouse suspicions that a colony might be infected by Amoeba? (2)	• No specific signs • Associated with dysentery
3e How might Amoeba be transmitted from one colony to another? (1)	• Amoeba spread when soiled beekeeping equipment is transferred into a healthy colony
References: *NBU leaflet 'Common pests, diseases and disorders of the Adult Honey bee' p14* *NBU Leaflet – Feeding Sugar*	

4a What may lead the beekeeper to suspect a colony is infected with *Vairimorpha (Nosema) apis?* (1)	• Colony fails to build up in Spring *Note to tutors: Dysentery not accepted*
4b How does the *V. (Nosema)* apis differ from *V. (Nosema) ceranae*? (8)	• Spores are smaller and more slender, but not possible to distinguish these under the microscope • *Vairimorpha (Nosema) ceranae* does not produce as many spores as *V. (Nosema) apis* • *V. (Nosema) ceranae* attacks the basal cells of the gut wall as well as the epithelium and this damage provides an entry point for viruses and bacteria. (This may be the reason that *V. (Nosema) ceranae* may depress the immune system of the bee whereas • *V. (Nosema) apis* does not seem to do so. • No seasonal variation in *V. (Nosema) ceranae* • Dysentery does not occur in colonies with *V. (Nosema) ceranae* • *V. (Nosema) ceranae* seems to be spread in pollen when moistened by nectar during foraging. In this way it affects very young bees and this may account for its non-seasonal variation • *V. (Nosema) apis* spores damaged by heat but not by freezing • *V. (Nosema) ceranae* spores cannot withstand freezing, but are unaffected by heat. • Colonies affected by *V. (Nosema) ceranae* alone, or a combination of the two species are more likely to collapse than those affected by *V. (Nosema) apis* alone. Probably due to seasonal nature of *V. (Nosema) apis* which usually clears up in the summer.
4c Why is Vairimorpha (*Nosema) spp* more prevalent and have greater effect in winter and spring than in summer? (5)	• Bees that are infected with *V. (Nosema) apis* have shortened lives, so bees infected in the Autumn may not survive through the winter and early spring. This leads to spring dwindle and not enough bees to carry out all duties • In spring the colony is expanding rapidly and house bees cleaning up cells pick up the spores and spread them around the colony

Refs: *Celia Davis. Around & About, pp 68-69,* *Pam Gregory, HBHB, p58* *Randy Oliver, The Nosema Problem : Part 3 Seasonality and the effects of Nosema*	• Infected bees confined to the colony by bad weather in the spring can be forced to defecate in the hive, spreading spores • Spores left on flowers by visiting foragers can pass from colony to colony - pollen collection is particularly high during spring build up Several studies have shown a *V. (Nosema)* reproduction dependency on high pollen levels in the gut. Pollen substitutes fed in spring to boost colonies may exacerbate an existing problem • Warmer weather means bees can always defecate outside the hive, helping break the infection cycle during the summer period
4d What is the name of the structure within the spore that penetrates the epithelium and injects the genetic material. (1) *Ref: HBee Veterinary Medicine Vidal-Naquet* *Hbee Pests, Predators and Diseases Morse & Flottum*	• The polar filament

5a) What are the characteristic signs of chilled brood? (3)	• Larvae/pupae of all ages dead/dying • In 'sections' or 'slabs' usually on the edges of the brood nest • Larvae/pupae become darkened/black
5b) When is chilling most likely to occur naturally and why? (4)	• Spring (March/April) - Winter adults are dying; if the cluster contracts due to cold weather during colony build-up, the brood on the edge of the nest may chill. • After swarming, cold spell, - Not enough bees left to cover brood
5c) Give four situations caused by the beekeeper which could result in chilled brood (4)	• Splitting brood • Adding brood (augmentation) to a small colony • Artificial swarm without finding Q if adults can't cover brood quickly enough • Making up nucs with insufficient bees • Moving colony location at wrong time leaving bees behind
5d) Give 2 circumstances when drone brood may be neglected and two characteristic signs? (4)	• Reduction in number of adult bees • Drone laying queen/laying workers (both conditions lead to an aging and shrinking worker population which is insufficient to care for it) • A stressed colony due to prolonged bad weather or poor forage • Disease/parasitic mite syndrome • Drone larva decays to soft brown mass that sticks to cells • It can resemble AFB, but remains won't 'rope' • Irregular patches of neglected drone brood may appear in worker cells Reference: *Pam Gregory, HBHB, pp49 &177*

Part c



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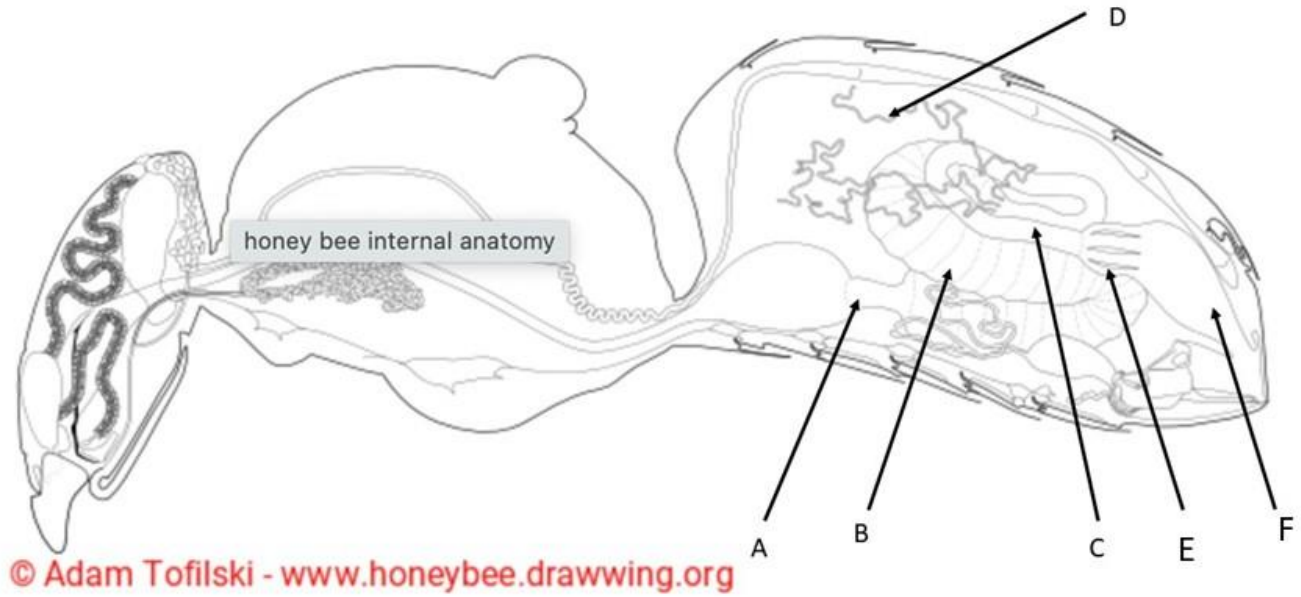
a) Label the attached diagram and give a brief description of the function of each of these parts. (3)	A - Large tracheae – main air tubes leading from spiracles - spiral thickenings (taenidia) prevent collapse B - Tracheal sac – serve as bellows C - Spiracles – act as valves to conserve moisture

b) Give the Scientific name, type of organism and life cycle of Acarine. (10) *Ref: Celia David, Honey bee Around & About, Pam Gregory Healthy Bees are Happy Bees.*	• *Acarapis woodii* • Parasitic mite • Mites invade bees large prothoracic tracheae. • Feeds by piercing the cuticle inside the tracheae and sucking the Haemolymph • Females lay between 5 & 7 eggs • Eggs hatch into nymphs between 3 and 6 days • emerge after about 14 days • Young mites then creep out from spiracles. • Clamber onto thoracic hairs of newly hatched young bees attracted by breathing movements • Bees more than 9 days old not usually affected.
c) What impact does Acarine have on the bee/colony (3)	• Shortens lifespan • Colony slow to build up in Spring • No visible signs on individual bees
d) What colony conditions will promote the spread of Acarine? (3) *Ref: Pam Gregory, HBHB, pp52-3, Celia Davis, Around & About, p76*	• Because of the way the mite transfers from bee to bee, crowded colonies with bees in close proximity make it easier for a newly emerged mite to transfer to a new host • Since the mites can only enter the spiracles of young bees (<9 days) periods with lots of young bees, such as when rapidly increasing in spring, provide ideal conditions for mite build up • Poor weather, leading to large numbers of confined bees can help spread
e) Why might we see an increase in cases of Acarine infestation in the future? (2)	The chemical treatments that kill Varroa generally also kill Acarine mites. • Moves by some of the beekeeping community to 'treatment free' husbandry,

Ref: Pam Gregory, HBHB, pp52-3, Celia Davis, Around & About, p76	• or the use of more mechanical means of IPM means that chemical treatment is reduced allowing Acarine to reappear
f) Describe the steps required to carry out a diagnosis of Acarine. Include the sample size, and rationale behind this number (9) *Ref: Bob Maurer Practical Microscopy, Celia Davis H bee Around & About*	Use freshly killed bees for this dissection • Collect a sample of 30 bees • Select older foragers • Kill in freezer, or using insect killing fluid (Ethyl acetate) • Pin each bee on a sloping surface (cork) using a double pin. • Remove the head and forelegs • Remove the prothoracic collar • Check the large trachea at x 30 magnification • Healthy trachea is creamy white. Diseased trache brown and black colouration. • A sample of 30 bees provides a 95% chance (confidence level) of finding a 10% infection


D
honey bee internal anatomy
A
B
C
E
F
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a) Name the parts A – F on the diagram, give a simple account of the function of each of these. (9) Note: ½ mark given per label. (as per exam marking) *Ref: Dade Anatomy & Dissection of the Hbee* *Celia Davis Hbee Inside out*	• A Proventriculus - a one-valve to filter and control the flow of materials from the crop to the rest of the gut • B Ventriculus - a long, wide tube lined by epithelium where digestion takes place. • C Small intestine - a narrow, pleated tube where absorption takes place. • D Malpighian tubules - ~ 100 tubes with single cell wall, filter and remove waste from haemolymph • E Rectal pads– 6 thickened areas on the rectum remove further water and dissolved substances • F Rectum - can expand to store faecal waste
b) Describe the lifecycle of *Vairimorpha (Nosema) apis* (8) *Ref: Pam Gregory, Healthy Bees are Happy Bees p 57*	• House bees pick up spores whilst cleaning contaminated combs. • Spores germinate in gut, developing a hollow filamentous tube from one end of the cell • Tube penetrates digestive (epithelial) cells of gut wall and injects spore contents. • In this growth (vegetative) state, parasite multiplies very quickly • Forms huge numbers of spores (over 5 days) • Host cell splits, spores spill into gut • Spores egested in faeces with other gut contents • Spores infect other gut cells, or contaminate comb. • Reduces protein absorption
c) What effect does *Vairimorpha (Nosema) apis* have on an individual worker bee? (5) *Ref: Pam Gregory, Healthy Bees are Happy Bees p 59*	• Reduces protein absorption • Hypopharyngeal glands underdeveloped – reduced ability to produce brood food. • Fat bodies fail to store protein • Becomes forager earlier. • Shortens life span

d) What effect does *Vairmorpha (Nosema) apis* have on affected Queens? (3) *Ref: Pam Gregory, Healthy Bees are Happy Bees p 59*	• Ovaries are affected. • Queens lay fewer eggs • Often causes supersedure. • New queens less likely to emerge (sometimes affected by Black Queen Cell virus)
e) Give a brief account of how an infection of either *Vairimorpha (Nosema) apis* or *Vairimorpha (Nosema) cerana* can be diagnosed in a laboratory. (5) *Ref: Bob Maurer Practical Microscopy, Celia Davis Honeybee Around and About*	• Collect a sample of 30 bees (older foragers) • Squash abdomens with small quantity of water • Place a drop of the resulting 'soup' onto a microscope slide • Can stain the slide with Nigrosin. • Place on cover slip. • Examine slide at x 400 magnification • *Vairimorpha (Nosema) sp* spores show as translucent rice-grain bodies with a smooth edge, often with a greenish tinge.