

Test Bank for Qualification Examination

Insect Physiology

Short Essay Question

1. Describe insect immunity, both cellular and humoral responses, in insects?
2. Describe the process of the insect embryogenesis.
3. Describe the structure and function of insect muscle; and explain what the differences are between “synchronous muscle” and “asynchronous muscle”.
4. Name three major insect hormones and describe their functions.
5. What is pheromone? Describe how insect pheromones are classified according to the behavior elicited from the receivers.

1. Discuss synaptic neurotransmitters relative to the insect nervous system (what kinds, what do they do, what is unique about insects versus vertebrates, etc.).
2. Discuss the overall structural organization of the insect respiratory system from the levels of the atmosphere to the cell.
3. Name two means for insect against cold.
4. Discuss nitrogen excretion in insects.
5. Definitions
 - a) peritrophic membrane
 - b) procuticle

一、昆蟲具有各式各樣用於提供外在與內在環境訊息的感覺受器(sensory receptors)。這些感覺細胞均擁有一個共通的特性，即傳導刺激能量，例如光、熱、化學能或機械能。請按此特性將昆蟲的感覺受器分類，並各舉一例詳述其功能。

二、何謂 Apolysis？請圖示說明 apolysis 的過程，並回答：脫皮前或剛脫皮後的昆蟲對觸殺性與系統性的殺蟲劑較敏感？為什麼？

三、費洛蒙可以用來監測害蟲的發生與密度消長，也可以作為殺蟲劑使用來防治害蟲。請問用費洛蒙來防治昆蟲的策略有哪些？立論基礎或操作機制為何？

1. Discuss hormones related to physiological events of molting and metamorphosis.
2. What are glial cells and what specific roles do they play in the insect nervous

system?

3. Compare and contrast the differences in the structural organization and visual functions of apposition and superposition ommatidia of insects.
4. Discuss nitrogen excretion in insects.

Embryogenesis -

1. Describe the main features of *Drosophila* embryo development.
2. Please use *Drosophila melanogaster* as an example to describe all the genes and their corresponding roles involved in the embryonic development.

Digestion -

3. Describe main structural divisions and their functions of the cockroach gut.
4. How does insect secrete digestive enzymes through midgut cells? What kinds of digestive enzymes are secreted by insect midgut cells and what are their corresponding functions?
5. The insect gut, particularly the midgut, has been recognized as a potential attack point for insect pest control. Please describe the structure and function of different midgut cells, and how the δ -endotoxin of *Bacillus thuringiensis* acts on the midgut of lepidopteran or dipteran larvae?
6. Name two means for regulating digestive enzyme activity in the insect midgut.

Nutrition -

7. How do insects obtain optimal nutrition for their growth?

Integument -

8. Describe the structure and chemical composition of insect cuticle and how new cuticle formation.
9. Describe hormonal control and biochemistry of sclerotization of cuticle.

Hormones and Development -

10. Discuss hormones related to physiological events of molting and development.
11. Please describe the roles and interaction of PTTH, juvenile hormones and ecdysteroids in the development and reproduction of insects.
12. Describe two different hormone families. For each family, describe the members of the family and the function of the hormone.
13. The physical functions of juvenile hormones (JH) are extremely easy to mimic, therefore compounds or insect growth regulators (IGRs) with JH activity have used commercially as insecticides. Please list three commercial IGRs and describe

how they are used to control insect pests.

14. How does the decapeptide hormone TMOF, trypsin modulating oostatic factor, regulate the successive maturation of eggs in *Aedes aegypti* female mosquitoes?

15. Hormonal regulation of insect hormones in insect ecdysis.

Diapause -

16. Hormonal control of diapause.

17. Diapause has evolved as a survival strategy of insects to avoid adverse environmental conditions. Please use *Bombyx mori* and *Hyalophora cecropia* as examples to describe how does insect enter embryonic and pupal diapause, respectively, through the effect of environmental cues and hormonal control?

Intermediary Metabolism -

18. Intracellular signal transduction of hormones involved in the regulation of insect energy metabolisms.

19. Describe any one of the intermediary metabolism happened in fat body.

Neuroanatomy -

20. Structure and function of insect nervous system.

Neurophysiology -

21. How neurons transmit messages electrically and chemically.

22. Discuss synaptic neurotransmitter relative to the insect nervous system (What kinds, what do they do, what is unique about insects versus vertebrates, etc.).

23. The nervous system, for example the cholinergic nervous system, is the primary target of insecticides. An understanding of difference between insect and vertebrate nervous system will help to develop more specific and safer insecticide. Please describe the cholinergic nervous system of insect and point out the difference from vertebrates.

Muscles -

24. Structure of insect skeletal and visceral muscle.

Insect Flight -

25. Discuss, comprehensively, the structure and function of flight muscles.

26. Energy metabolism and hormonal regulation in locust muscle for migratory flight.

27. A honeybee in continuous flight burns up to 2400 cal/g muscle/h which is much higher than the recorded metabolic rate of 215 cal/g muscle/h for hummingbirds. What kinds of energy sources do honeybee and other insects used for initial and continuous flight?

Sensory Systems -

28. Insect sensory organs and their functions.

Vision -

29. How insect process their vision.

30. Compare the differences in the structural organization and visual functions of apposition and superposition ommatidia.

Circulatory System -

31. Describe types of insect blood cells and function.

32. Discuss unique features of the insect circulatory system with regard to: a) hemolymph circulation, b) hemocytes, c) chemical composition of the hemolymph.

Immunity -

33. How insect defense invasion of microorganisms.

34. Discuss features of the insect circulatory system with regard to immune mechanisms.

35. How do Insects combat invading microorganisms by innate immune responses? Please describe the defense systems and mechanisms involved in the innate immune responses.

Respiration -

36. Physiology of insect gas exchange.

37. Describe how the tracheal system functions with respect to the transfers of oxygen and carbon dioxide in the insect.

38. Discuss the overall structural organization of the insect respiratory system from the levels of the atmosphere to the cell.

Excretion -

39. Nature and mode of action on insect hormones involved in the regulation of water balance.

40. How insects maintain electrolyte homeostasis.

41. Discuss nitrogen excretion in insects.

42. Describe the cryptonephridial system and filter chamber.

43. How does blood-feeding mosquito, e.g. *Aedes aegypti*, excrete a large salt (NaCl) load after blood meal in order to maintain electrolyte homeostasis?

Pheromones -

44. Classification of semiochemicals and their roles in insect communication.

45. How does hormone control the synthesis of sex pheromone in moths? Please give any example to describe the mode of action.

46. Pheromones have been used for monitoring and controlling insect populations. Could you tell what kinds of practical applications (or strategies) of pheromones were used in the control of insect populations. What are the mechanisms for these practice applications?
47. Please compare the differences between insect hormones and insect pheromones in terms of function and application on the insect pest control.

Reproduction -

48. Discuss comprehensively, the hormonal regulations of reproductive cycle in the mosquito, *Aedes aegypti*
49. Diagram and label a meroistic polytrophic follicle (identify anterior and posterior directions).
50. Please compare the structure of major types of insect ovaries and described the oogenesis in the polytrophic ovarioles.

Definitions -

- a) peritrophic membrane
 - b) pharate
 - c) uric acid
 - d) rhodopsin
 - e) glial cells in nervous system
 - f) critical weight
 - g) mushroom bodies
 - h) plastron
 - i) accessory pulsatile organs
 - j) trypsin
- Etc...

98/01 I

1. (1) What are the main hormones involved in insect metamorphosis? (2) Describe the roles of these hormones individually on the regulation of metamorphosis? (10%)
2. Describe the mechanism of how an insect nerve control muscle contraction, including how the muscle contracts? (10%)
3. Describe the physiology and hormonal control of vitellogenesis in insects. (10%)
4. Describe the roles of Malpighian tubule system in insects. (10%)
5. Give the definition of “pheromone”? Describe its physiological roles in insects.

(10%)

98/01 II

1. The insect gut, particularly the midgut, has been recognized as a potential attack point for insect pest control. Please describe the structure and function of different midgut cells, and interpret how the δ -endotoxin of *Bacillus thuringiensis* acts on the midgut of Lepidopteran or Dipteran larvae?
2. Diapause has evolved as a survival strategy of insects to avoid adverse environmental conditions. Please use *Bombyx mori* and *Hyalophora cecropia* as examples to describe how does insect enter embryonic and pupal diapause, respectively, through the effect of environmental cues and hormonal control?
3. A honeybee in continuous flight burns up to 2400 cal/g muscle/h which is much higher than the recorded metabolic rate of 215 cal/g muscle/h for hummingbirds. What kinds of energy sources do honeybee and other insects used for initial and continuous flight?
4. How do Insects combat invading microorganisms by innate immune responses? Please describe the defense systems and mechanisms involved in the innate immune responses.
5. Pheromones have been used for monitoring and controlling insect populations. Could you tell what kinds of strategies and how the practical applications of pheromones were used in the control of insect populations.

98/02 I

1. (1) Diagram the structure of insect skeletal muscle, and (2) describe the characteristics and processes of an insect neuron stimulating muscle contraction and (3) give an example to explain how insecticides affect on the process. (10%)
2. What the main roles of juvenile hormone in the regulation of insect (1) larval and (2) adult development. (10%)
3. Migratory flight is very energy-consuming event in insects. Using migratory locust or any other insect as an example to describe (1) how energy is provided to meet the demand during long distance flight, and (2) how hormone(s) is/are involved in the regulation of energy metabolism. (10%)
4. Describe how the Malpighian tubules maintain the ionic and osmotic homeostasis in insect body. (10%)
5. (1) What are insect “pheromones” and (2) describe its different role in control of insect physiology or behavior. (10%)

98/02 II

一、試說明昆蟲中腸細胞如何分泌消化酵素？分泌的消化酵素種類與功能各為何？

How does insect secrete digestive enzymes through midgut cells? What kinds of digestive enzymes are secreted by insect midgut cells and what are their corresponding functions?

二、青春激素的生理功能極易模仿，因此許多具有青春激素活性的化合物已經發展成為防治害蟲的生長調節殺蟲劑。請列出三種商品化的生長調節殺蟲劑，並說明他們如何用於害蟲防治。

The physical functions of juvenile hormones (JH) are extremely easy to mimic, therefore compounds or insect growth regulators (IGRs) with JH activity have used commercially as insecticides. Please list three commercial IGRs and describe how they are used to control insect pests.

三、試以簡圖說明昆蟲的肌肉組成單位，以及參與肌原纖維肌節收縮的主要蛋白排列。Please illustrate progressively smaller units that compose insect muscles and the arrangement of the major proteins involved with contraction of in each sarcomere of a myofibril.

四、試述昆蟲如何利用其免疫系統與防禦機制抵抗入侵的病原菌。

How does insect combat invading microorganisms by innate immune responses? Please describe the defense systems and mechanisms involved in the innate immune responses.

五、費洛蒙可以用來監測害蟲的發生與密度消長，也可以作為殺蟲劑使用來防治害蟲。請問用費洛蒙來防治昆蟲的策略有哪些？立論基礎或操作機制為何？

Pheromones have been used for monitoring and controlling insect populations. Could you tell what kinds of practical applications (or strategies) of pheromones were used in the control of insect populations. What are the mechanisms for these practice applications?

99/01 I

6. What is the significance for each of the following to cuticle tanning? (10 points)

- a) hemocytes
- b) N-acetyldopamine
- c) Tyrosine
- d) Polyphenol oxidase
- e) quinone

7. Discuss neurohormones related to physiological events of molting and metamorphosis. (10 points)

8. Name two means for regulating digestive enzyme activity in the insect midgut. (10 points)

9. Describe any one of the intermediary metabolism happened in flight muscle. (10

- points)
10. Discuss the events happened in an ovariole from the germarium to the vitellarium.
(10 points)

99/01 II

You have plenty of time to answer these essay questions, please discuss every question as clearly as possible, and DO NOT make me guess your answer.

1. Discuss the processes of insect embryogenesis and its major features. (10%)
2. Acetylcholine esterase (AcE) is a neurotransmitter which is the target of some pesticides such as organophosphates. Use AcE as an example to discuss: (1) the processes of message transmission between insect nerves (in detail), and (2) how organophosphorus pesticides affect the transmission processes. (10%)
3. Use a cockroach as an example to discuss the structure of insect compound eyes and the vision process. (10%)
4. Discuss how an insect innate immune system defends the invasion of microorganisms. Note: give at least three different types of actions. (10%)
5. What is the definition of “pheromone”? Discuss the characteristics and functions of different types of insect pheromones.

99/02 I

- 1.(1) Draw a model structure of insect cuticle and describe the major components of each part; (2) Discuss how insect molt. (10%)
2. Discuss how insect Malpighian tubules function? (10%)
3. Using a moth as an example, describe the involvement of juvenile hormone and ecdysteroids on the regulation of insect metamorphosis. (10%)
4. Describe insect flight muscle function and energy metabolism. (10%)
5. Based on a model insect- cockroach, discuss how hormonal regulation on the female reproduction, *i.e.*, egg development. (10%)

99/02 II

1. Discuss neurohormones related to physiological events of molting and metamorphosis. (12 points)
2. Discuss the role of the T tubules play for muscle contraction. (8 points)
3. Name two examples for the hormonal control of diapause. (10 points)
4. Compare the olfactory and gustatory chemoreceptors. (8 points)
5. Discuss unique features of the insect circulatory system with regard to a) temperature regulation and b) immune mechanisms. (12 points)

101/01 I

- 四、昆蟲具有各式各樣用於提供外在與內在環境訊息的感覺受器 (sensory receptors)。這些感覺細胞均擁有一個共通的特性，即傳導刺激能量，例如光、熱、化學能或機械能。請按此特性將昆蟲的感覺受器分類，並各舉一例詳述其功能。(20 分)
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- 六、費洛蒙可以用來監測害蟲的發生與密度消長，也可以作為殺蟲劑使用來防治害蟲。請問用費洛蒙來防治昆蟲的策略有哪些？立論基礎或操作機制為何？(15 分)

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5. Definitions (10 points)
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