國立中山大學生物科學系100 學年下學期

博士班資格考試(筆試)

科目：細胞分子生物學

◎任選五題作答，每題 20 分。答題超過五題者，依考題題號順序批改五題計分。

1.
It is clear that helices and sheets comprise the core of most globular proteins, and the largest contribution to the stability of folded proteins is the entropy change for the water molecules associated with its nonpolar residues (20 pts). Explain.

2.
One way to regulate protein activity in cell is degradation of proteins. Describe the cytoplasmic protein degradation by proteasomes in the following aspects (20 pts):
(a) the structure and function of proteasome
(b) the proteins targeted for degradation in proteasome
(c) how the proteins are recognized by the proteasome

3.
(a) Please describe the means through which the parietal cells in the gastric mucosa create acidic luminal environment. You may draw a cell to assist your explanation. (15 pts)
(b) Based on your answer in (a), can you propose a mechanism by which the pancreatic ductal cell produce alkaline secretion? (5 pts)

4.
Please describe the detailed molecular events involved with the contraction of a skeletal muscle. Your description should include the “regulatory” portion of such events. You may begin your description at the depolarization of postsynaptic membrane of the neuromuscular junction. (20 pts)

〈續背面〉

5.

(a) Please draw a standard morphology of the neuron and labeled the basic structure of the neuron. (10 pts)

(b) Please describe the detailed ionic mechanism underlying the generation of action potential. (10 pts)

6.

Recent study demonstrated that hypoxia can enhance proliferation embryonic neural progenitors under *in vitro* condition. Dr. Bear hypothesized that effect of hypoxia on neural progenitors is mediated by over-expression of Brain-derived neurotrophic factor (BDNF, a kind of protein) which may be triggered by activation of hypoxia-inducible factor 1 (HIF-1, a kind of transcription factor). Please answer the following questions:

(a) Please describe the stages (interphase, prophase, prometaphase, metaphase, anaphase and telophase) of the mitotic proliferation. (10 pts)

(b) Please design a series of experiments by using cellular & molecular methods to prove Dr. Bear's hypothesis (hypoxia can increase expression of BDNF via activation of HIF-1). Your answer should include 1) experiment groups; 2) cellular and/or molecular method; 3) expected results (10 pts)

國立中山大學生物科學系 100 學年下學期
博士班資格考試(筆試)

科目：生物化學

◎請任選五題作答，每題 20 分。答題超過五題者，依考題題號順序批改五題計分。

7. Describe the fundamental structural unit in all proteins and how these structural units affect the structure of proteins.
8. Describe the protein separation methods used to purify proteins from cellular sources on the basis of their size, charge, and affinity differences.
9. Discuss the biological significance of chemical differences between DNA and RNA.
10. In general, the signal transduction consists of a receptor to perceive the signal, transducers to relay the signal, and the effectors to convert the signal into an intracellular response. Use hormone epinephrine secretion as the example to illustrate the signal transduction that results in glucose mobilization from stored glycogen in muscle cells.
11. Describe the overall structure of the F_1 and F_o components of ATP synthase and the binding change mechanism for ATP formation proposed by Paul Boyer.
12. An organism can coordinate its metabolic processes by controlling the catalytic activities of its component enzymes. Use specific examples to illustrate that enzyme activity may be controlled by covalent modification and allosteric regulation.

國立中山大學生物科學系 100 學年下學期
博士班資格考試(筆試)

科目：微生物免疫學

1. Influenza viruses continue to cause annual epidemics and pose the threat of a deadly global pandemic. Vaccination is the best approach for prevention and control of influenza infection. However, current influenza vaccines are only effective against closely matched circulating strains, and therefore must be updated and administered every year. Please describe recent developments in the search for better influenza vaccines, especially using the major virus surface glycoprotein hemagglutinins (HAs).
   (10 points)

2. Complement system is a major player in inflammatory responses. Describe the role of complement system in a single bacterial infection and a single viral infection. Please include in your answer the mechanisms whereby such potent molecules are maintained in the circulation and yet can function locally in the inflammatory response. (10 points)

3. What is the key immune component in the body's defense against the following microorganisms and explain why is this component vital to defense? (Total 15 points, 3 points for each)

   (a) Pneumococci
   (b) Virulent corynebacterium diphtheriae
   (c) Intestinal infection with poliomyelitis virus
   (d) Group A hemolytic streptococci
   (e) Candida albicans

4. Immunoglobulins and T cell receptors have clearly evolved from the same primordial gene. Thus, they share a number of features but differ in others. Compare and contrast the following aspect of their structure and/or function: (Notes: keep your answers brief and to the

point and avoid irrelevant drawing and cataloging) (Total 15 points, 3 points for each)

(a) Gene rearrangement
(b) Allelic exclusion
(c) Secreted vs membrane forms
(d) Somatic mutation
(e) Requirements for antigen recognition

〈續背面〉

5. Please name a bacterium that lacks cell wall. How is it protected from osmotic destruction? (10%)

6. Some RNA viruses are single stranded. Please describe what is the major difference between a + strand RNA virus and a – strand RNA virus. (10%)

7. Beer production requires an early period of rapid aerobic metabolism of glucose by yeast and then gives an anaerobic condition to produce alcohol. Base on yeast metabolic features, explain why it is necessary to have these two steps. (10%)

8. Why 70% alcohol is used to against microbes instead of 95% alcohol? (10%)

9. Mycorrhiza is a fungus growing in symbiosis with plant roots. There are 2 types of these fungi: endomycorrhiza and ectomycorrhiza. Explain the difference between these two types of mycorrhiza, and explain why mycorrhiza is beneficial to plant growth? (10%)

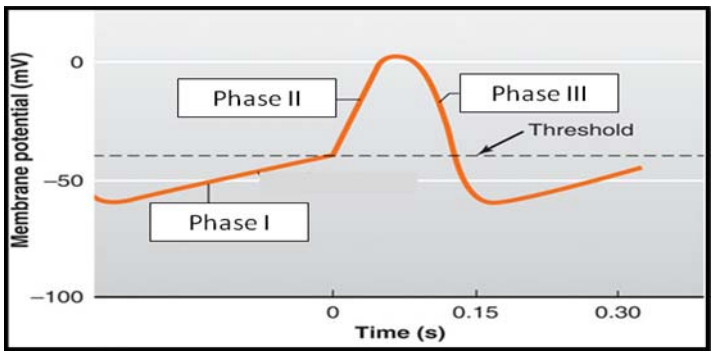
國立中山大學生物科學系 100 學年下學期
博士班資格考試(筆試)

科目：動物生理學

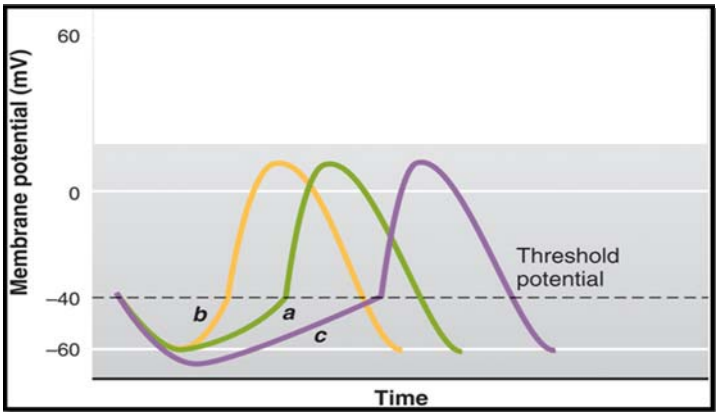
請自下列六個題目中任選四題作答，若答題超過四題者，以“最低分四題”計算成績；請於答案卷中註明題號。

1. Cardiovascular Physiology (25 %)

A. The figure depicts the pacemaker potential of the sinoatrial (SA) nodal cell in an adult rat. Please describe key ionic movements (Na^+, K^+, Ca^{2+}) in each phase. (10 %)



B. The slope “a” represents the baseline pacemaker potential slope during the baseline condition. When the bilateral cervical vagus nerve is electrically stimulated, will the slope of the pacemaker potential shift to left (slope b) or right (slope c) ? (5 %)



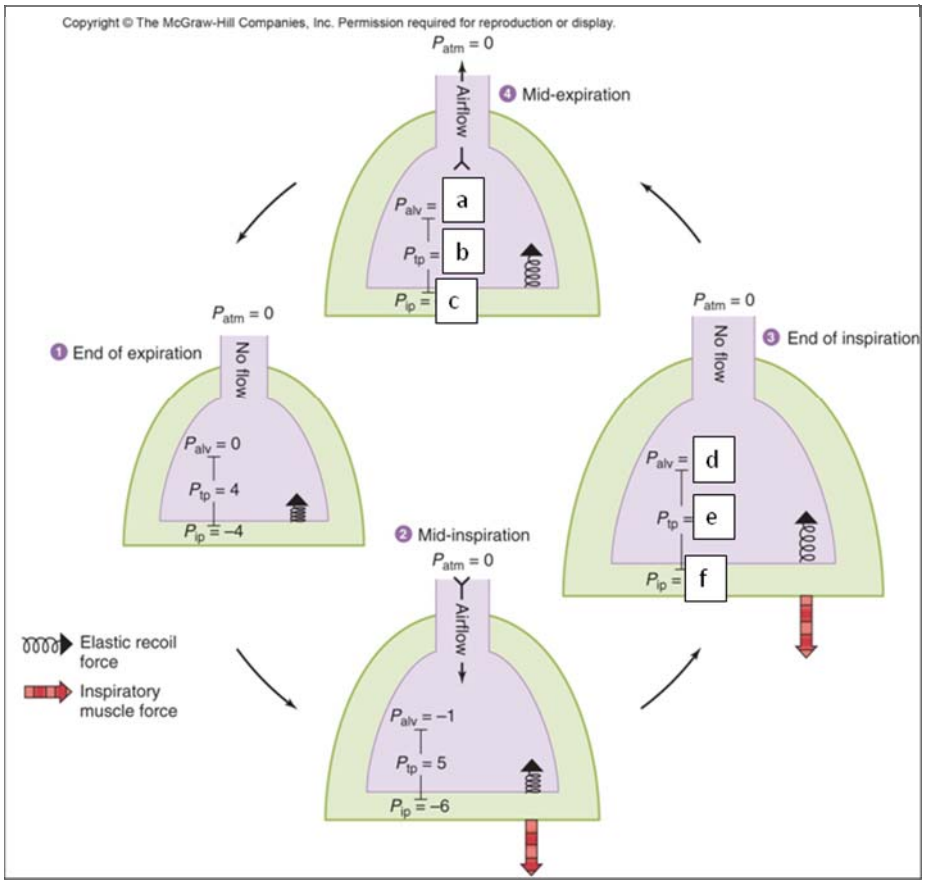
C. Please describe the detailed mechanism underlying the shift of the pacemaker potential slope when the vagus nerve is stimulated. Your answer should include these key

concepts: neurotransmitter, receptor, intracellular signal pathway, ion channel permeability. (10 %)

〈續背面〉

2. Respiratory Physiology (25 %)

The figure shows the summary of alveolar (Palv), transpulmonary (Ptp) and intrapleural (Pip) pressure changes during a respiratory cycle.



A. Based on the information from the figure, please fill the value in the inlet a-f. (9 %)

B. Please explain the definition of “pneumothorax” and describe the change of intrapleural pressure during pneumothorax. (8 %)

C. How do you measure the tidal volume ? Please explain the detailed mechanism. (8 %)

3. Renal Physiology (25 %)

During severe sweating, the body can trigger a series of compensatory responses to prevent sodium and water excretion. Please describe the detailed mechanism underlying these compensatory changes via the following concepts.

A. What kind of receptor can detect changes of water and sodium content of the body fluid ? Please also indicate the location of the receptor. (5 %)

B. Severe sweating can trigger release of various hormones. Please list two hormones which are involved in the body fluid regulation. Please also indicate the releasing source, target cell/tissue and detailed physiological function of these two hormones. (20 %)

4. What is synaptic plasticity? Describe the role and underlying molecular mechanism of glutamate in long-term potentiation. (25 %)

5. One of the major differences between central nervous system and peripheral nervous system is the regeneration of a neuron after injury. What's your opinion regarding to this issue? (25 %)

6. Describe the action and deaction of phototransduction cascade in rod cell. (25 %)

國立中山大學生物科學系 100 學年下學期
博士班資格考試(筆試)

科目：生態學

1) Explain in details the biodiversity patterns of global terrestrial environments.
(30 points)

2) What are the short-term and long-term effects on global biodiversity when human population continuously increases? (30 points)

3) Discuss and explain in details the origin and distinctiveness of fauna and flora of Taiwan (including islands surrounded). (40 points)

國立中山大學生物科學系 100 學年下學期
博士班資格考試(筆試)

科目：演化生物學

1. Information of genetic code is shared by all the living species of the world. Based on this assumption, can we say that the genetic code of a clade of mammals is a homologous trait? and if this genetic code is a synapomorphy of this mammal clade? Please explain in general what kinds of homologies can NOT be interpreted as synapormophic characters?(25%)

2. In a population if the allele frequencies do not change from one generation to the next one, this population is definitely in Hardy-Weinberg equilibrium. However, what processes may affect allele frequencies in a population? (25%)

3. What is an evolutionary 'arms race' ? and give two examples (25%)

4. What would you do when morphological and molecular methods clash in your dataset? (25%)

國立中山大學生物科學系100學年下學期
博士班資格考試(筆試)

科目：植物生理學

※請由 10 題中選 5 題做答並標明題號，每題配分為 20 分（答題超過 5 題者，以得分最低的 5 題計算成績）

01. (a) Please compare the CO_2 fixation of photosynthesis among C_3, C_4 and CAM (crassulacean acid metabolism) plants. (b) Explain why C_4 plant has higher photosynthesis efficiency than C_3 plant.

02. Please explain the possible mechanisms of transport (a) for water and minerals from root to shoot via the xylem and (b) for photosynthate from leaf source to sink via the phloem.

03. Auxin is the only plant growth regulator that exhibits polar transport and distribution characteristics.(a) Please explain how can auxin be transported from shoot apex to root apex and form polar distribution in plants? (b) Please give an example and explain how it is related to auxin polar transport and distribution.

04. Small RNA has been indicated recently to play important roles in plant development and stress response. Please give an example andexplain in detail how small RNA can affect plant development and/or stress response. Based on the example, design experiments andillustrate its possible agricultural and/or commercial applications.

05. The stem of deep water rice elongates under flooding situation. Please explain the possible mechanism.

06. Abscisic acid (ABA) plays important roles in plant development and/or stress response. (a) Please list 5 examples for ABA-related plant development and/or stress response. (b) ABA-responsive mutants such as ABA-deficient mutant aba1and ABA-overproducer mutant aboshowed altered ABA-responses and phenotypes compared to wild type plants. Please predict and explain the altered phenotypes/physiological responses in the examples you give.

〈續背面〉

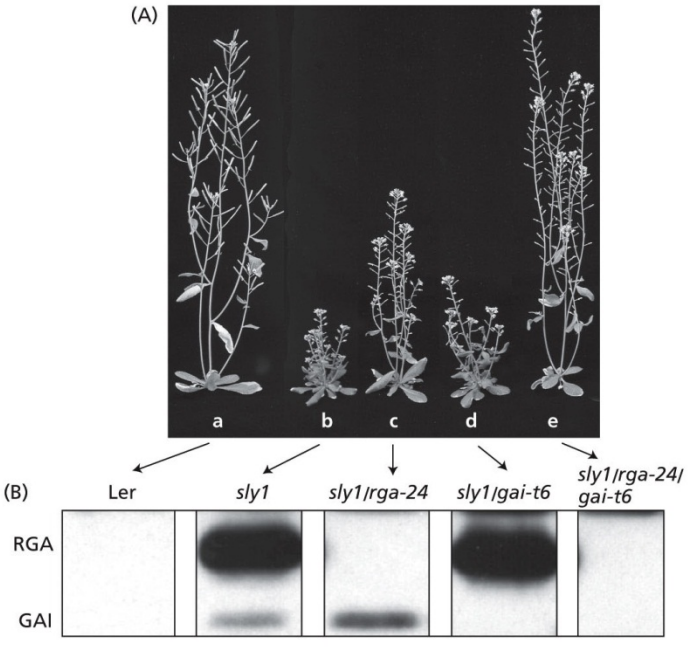
07. There are many different mechanisms that plants can use to cope with herbivore attack.

Please list and explain the possible mechanisms that plants adopt to protect themselves against herbivore attack.

08. (a) Please explain hypersensitive response (HR) and systemic acquired resistance (SAR), which are two different plant defense mechanisms to pathogens. (b) What kind of resistance (verticalor horizontal resistance) are they? (c) Compare the difference of HR and SAR in plant defense mechanisms to pathogenic microbes.

09. Under drought stress, the short term response of plants to water deficiency is to close the stomata for reducing continuous water loss from plants. Please explain how can the water deficiency cause plant stomatal closure?

10. Gibberellin (GA) in general promotes stem elongation in rosette and dwarf plants. The possible mechanism has been studied with GA mutants. The ga1 mutant is deficient in GA biosynthesis and dwarf in phenotype. The wild type *RGA*(repressor of the ga1 mutant) 及 *GAI*(GA-insensitive) encode similar repressor proteins of GA signaling. The rga and gai mutants result in different GA response and phenotype. The *SLY1* encodes an F-box domain containing protein, which modulate cellular RGA and GAI repressor protein amounts. Based on the information, please explain the correlation between mutant phenotypes of different genetic background and repressor protein amounts in the figure.



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