國立中山大學生物科學系 99 學年下學期
博士班資格考試(筆試)

科目：微生物免疫學

Qualifying Examination: Microbiology & Immunology

◎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。

◎Please choose 5 questions to answer, each question 20 points. If more than 5 questions are answered, only 5 questions in numerical order will be graded and counted in the total points.

1. 請分別說明兩種 MHC 分子之結構及其如何進行抗原呈獻、及被其呈獻之抗原特性。

2. Zinkernagel 及 Doherty 等人因發現 T 細胞及 B 細胞在抗原辨識使用不同機制而獲得 1996 年諾貝爾獎。請說明其主要發現。同時請比較 T 細胞及 B 細胞在抗原辨識機制之異同。

3. 請分別說明 T_{H1} 及 T_{H2} 細胞產生之 cytokines 及其參與調節之免疫反應。

4. Paul Ehrlich 曾提出 Horror Autotoxicus 理論，說明個體可能因喪失自我免疫耐受性(Self tolerance)而引發如風溼性關節炎、紅斑狼瘡，糖尿病等自體免疫疾病。請說明免疫耐受性(tolerance)形成之機制，並請說明 regulatory T cells (T_{reg} cells)之特性及其在免疫耐受性相關疾病機轉中所扮演之角色。

5. 請說明 gut-associated lymphoid tissue (GALT)之結構及其免疫相關細胞如何在病原功擊時啟動免疫抵抗機制?

6.請列表比較格蘭氏陽性與格蘭氏陰性細菌的異同。

7.請列表比較細菌內毒素與外毒素的異同。

8.請列表比較真核細胞與原核細胞的異同。

9.請就你所知，盡量條列出 *E.coli* 的所有特性。

10.請敍述古細菌的特性及其在生物分類體系上的地位。

國立中山大學生物科學系 99 學年下學期
博士班資格考試(筆試)

科目：生態學

問答題：每位考生必須選擇五題問題回答，每題 20 分；作答超過五題者，以得分最低的五題計算成績。

01. Illustrate three types of survivorship curves and give examples of each. What factors cause the three different types to appear in nature?

02. Discuss **at least four characteristics** of species that affect their potential rates of colonization and extinction.

03. Use examples to explain **how and why** the genotype and environment influence the phenotype of an organism.

04. Discuss and describe several different strategies that herbivores use to extract nutrients from a cellulose-rich diet.

05. Explain why most bird species are monogamous while most mammal species are polygynous.

06. Describe all possible outcomes of population growth of two competitive species according to the Volterra and Lotka competition model.

07. Describe the three alternative successional mechanisms proposed by Connell and Slatyer in 1977.

08. There are several different ways of describing species diversity. The most used graphic one is rank-abundance curves. Sketch an example and explain its content.

09. Describes the island biogeography model proposed by MacArthur and Wilson.

10. Why tree species number of temperate forest biome in Europe, eastern Asia and eastern North America are strikingly different even these three regions are with more or less the same area size?

國立中山大學生物科學系 99 學年下學期
博士班資格考試(筆試)

科目：生物化學(Biochemistry)

◎請任選五題作答，每題 20 分。答題數若超過五題，將依考題的題號順序批改五題計分。

◎**Please choose 5 questions to answer, each question 20 points. If more than 5 questions are answered, only 5 questions in numerical order will be graded and counted in the total points.**

1. Take hemoglobin as an example to describe the function of the primary, secondary, tertiary, and quaternary structure of this protein.

2. Describe how the cell synthesizes ATP in mitochondria.

3. Describe the mediation of hormone action by receptors.

4. Describe the reactions in protein synthesis.

5. The ubiquitin-proteasome pathway is responsible for the degradation of several important regulatory proteins, including proteins that control the cell proliferation and cell survival. Use the degradation of cyclin during the cell cycle as the example to illustrate the ubiquitin-proteasome pathway.

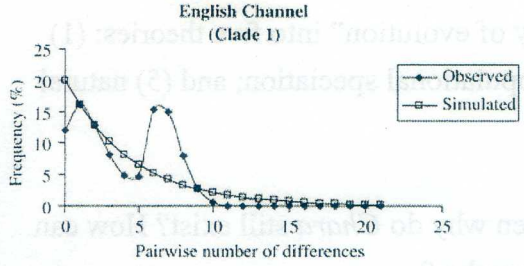
6. The import mechanisms of enzyme-mediated catalysis are proximity and orientation effects, acid-base catalysis, covalent catalysis, and preferential transition state binding. Explain each mechanism.

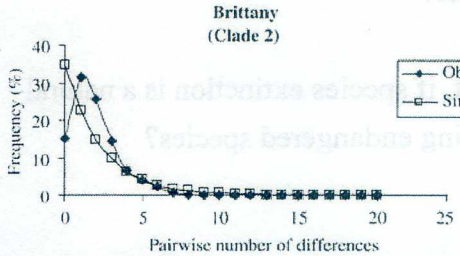
7. The function of glycogen in animal cells is to store metabolic fuel glucose and to release it rapidly when needed. Therefore, the glycogen metabolism is controlled according cellular needs. Describe the control of glycogen metabolism.

8. Describe the aerobic metabolism of glucose and discuss the advantages and disadvantages of aerobic metabolism.

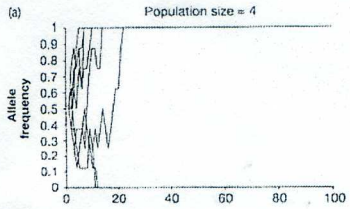
Evolutionary Biology – 由下面七題中挑五題回答，多答不記分

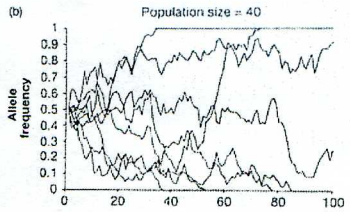
1. Based on figure of match–mismatch curves, please describe the population dynamic in these two kinds of populations?

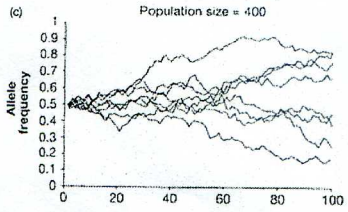




2. Based on figure showing below, the X-axis is the generation and Y is the allele frequency of one locus, please describe the dynamic in these three kinds of populations?







3.Suppose we have DNA sequencing data, (1) estimate the phylogeny of these taxa by plotting the changes on each of the three possible undirected networks, determine which network requires the fewest changes, and root that network based on long branch ?

Samples Test

	1	2	3	4	5	6	7	8	9	10	11	12
1-	G	G	G	A	T	A	A	C	T	G	A	T
2-	G	G	G	A	G	T	A	T	C	T	A	G
3-	A	T	A	G	T	T	G	T	C	T	C	G
4-	A	A	T	G	T	T	G	T	C	G	C	A

續背面

4. In the broad sense, "Evolution" is means the origin of entities possessing different states of one or more characteristics, and changes in the proportions over time. Isn't Evolution totally random?

5. Ernst Mayr (1982) has persuasively separated "Darwins's theory of evolution" into five theories: (1) evolution as such; (2) common descent; (3) gradualness; (4) populational speciation; and (5) natural selection. Please explain what mean of these five theories.

6. If *Chara* became land plant through the process of evolution, then why do *Chara* still exist? How can the process of evolution in one species affect the evolution of another?

7. In past geological history, there are five mass extinctions. Based on it, if species extinction is a natural part of life, why should we need to make great efforts about protecting endangered species?

國立中山大學生物科學系 99 學年下學期
博士班資格考試(筆試)

科目：動物生理學

Epithelia are tissues specialized for the vector transport of water, electrolyte solute and nutrients such as glucose and amino acids

a. describe transporters localized on the apical and basolateral membranes of epithelia
b. with amiloride (a potent diuretic agent), ATP, and Ouabain (an ATPase inhibitor) available in the lab. Please propose an experiment to evaluate the mechanisms of electrolyte (sodium ion) transport across a renal tubular epithelia membranes.
c. Researchers found out that nitric oxide (NO), when applied on to the apical side of the pulmonary epithelial membrane, may improve the alveolar fluid clearance. Please propose an appropriate experiment to elucidate its mechanisms on this function.

Figure 1. is a schematic draw of the pressure-volume loop of the left ventricle for a single cardiac cycle

a. point out the location representing diastolic filling phase of the cardiac cycle.
b. point out the locations at which aortic valves and atrial-ventricular valves are opening and/or closing.
c. Draw on the same panel new loops that may represent the effects of increase in the Preload, Afterload and the effects of the application of Epinephrine.
d. Explain why your new drawing (all the P-V loops you have drawed) would be just like that.
e. Indicate the segment of the line on the loop that will represent the stroke volume of the heart on each cardiac cycles.
f. How cardiac output can be estimated in the lab.
g. Discuss factors that may affect the value of the cardiac output in normal subjects taking exercise.

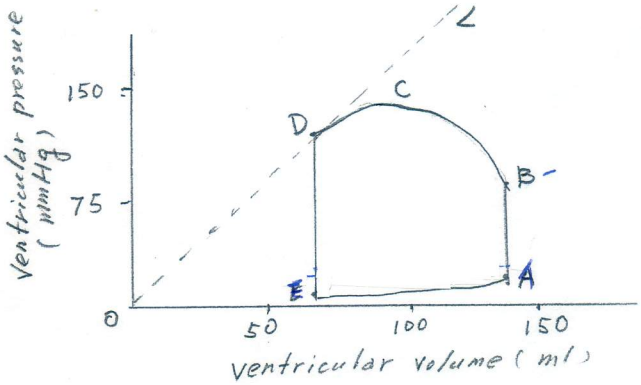


Fig. 1

續背面

Discuss the physiological role and underlying mechanism of neurotransmitter GABA (g-aminobutyric acid) in the mature and developing central nervous system.

How the autonomic nervous system regulate the rhythm and contractility of heart? Describe its molecular mechanism in detail.

Qualifying Examination: Molecular Cell Biology

◎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。

◎Please choose 5 questions to answer, each question 20 points. If more than 5 questions are answered, only 5 questions in numerical order will be graded and counted in the total points.

1. Membrane proteins carry out their functions in association with the lipid bilayer. Describe the structures of specific membrane proteins which are classified according to their mode of attachment to the membrane.

2. There are three general mechanisms to regulate the activities of cellular proteins: (1) interaction with small molecules; (2) covalent modification; and (3) interaction with other proteins. Describe each mechanism using specific examples.

3. Transport vesicles play a central role in the trafficking of molecules between different compartments of the secretory pathway. Progress in elucidation of the molecular mechanisms of vesicular transport has been made by several experimental approaches: (1) isolation of yeast mutants; (2) assay of vesicular transport in cell-free system; and (3) use of GFP fusion proteins. Describe each approach and discuss the advantages of each approach for understanding the particular aspects of the transport process.

4. Dominant-negative mutation and gene knockout are two commonly used molecular approaches to investigate gene function. Describe their mechanisms? Compare and contrast their applications.

5. Describe the molecular mechanism of RNA interference. What are the empirical rules for designing siRNAs with proper specificity and efficacy?

6. Describe in detail how spindle microtubules and their associated motors cooperate in controlling chromosome congression.

7. Regulation of gene expression is extremely important in multicellular organisms. Describe all the present known regulation processes of gene expression briefly.

8. DNA replication is one of the essential mechanisms in all kinds of living cells. Describe the similarities and the differences of DNA replication between prokaryotes and eukaryotes.

9. (A) The roles of telomere and telomerase are quite interesting. In the following experiments, telomerase-positive, immortal cells (36M; left panel of Fig. 1) and telomerase-negative, immortal cells (GM847; right panel of Fig. 1) were transfected with an expressing plasmid vector only, the plasmid expressing a wild-type (WT) or mutated (Mut) hTERT. Telomerase activity in cell extracts were measured using TRAP assay. What do you conclude about the effect of the mutant hTERT on telomerase activity in the transfected cells?

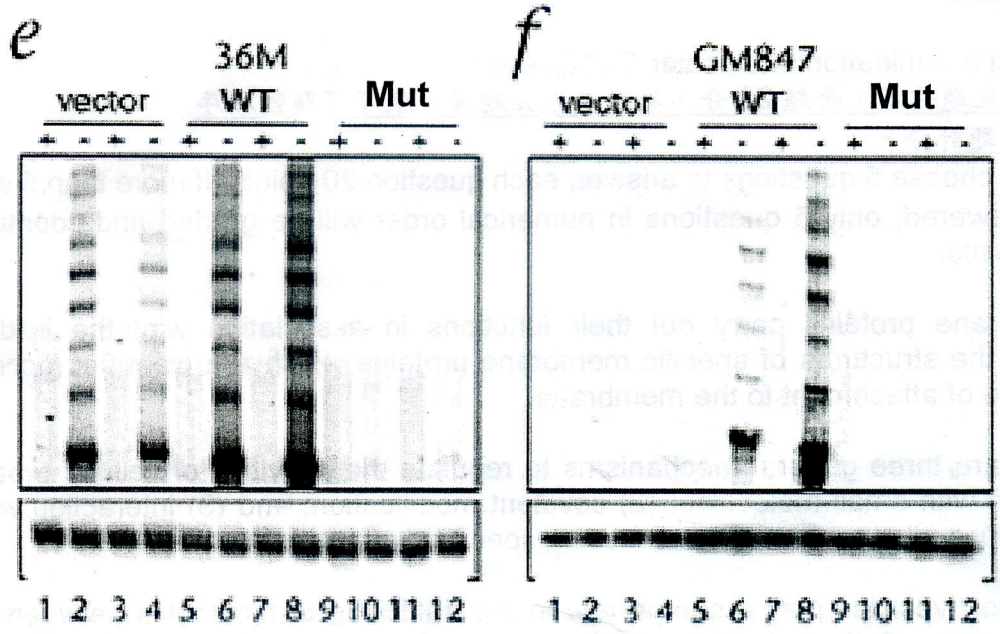


Fig. 1 Effects of WT-hTERT and mutant-hTERT on telomerase activity. +, heat treatment of samples before the TRAP assay; −, no heat treatment.

(B) Telomere length in the transfected cells was examined by Southern blot analysis of terminal restriction fragment (TRF). The results are shown in Fig. 2. What do you conclude about the lengths of the telomeres in 36M cells and GM847 cells after transfection with the wild-type (WT) or mutant (Mut) hTERT?

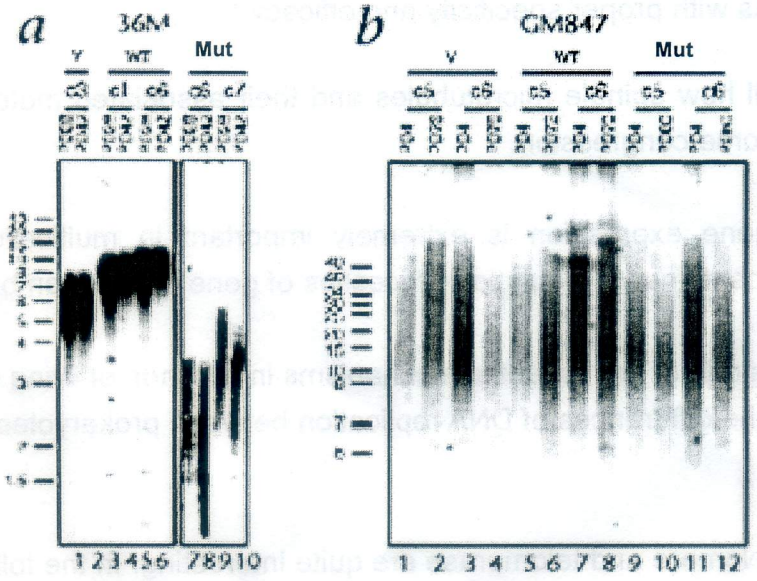


Fig. 2 Effects of Mut-hTERT expression on telomere length. PD, population doubling; *c*, clone number. Left margin, molecular size markers (kb). In panel a, all clones were harvested at PD28 and PD42. In panel b, c5 & c6 of vector-transfected, cells were collected at PD4 and PD78; c5 & c6 of WT hTERT-transfected, cells were collected at PD4 and PD70; and c5 & c6 of mutant hTERT-transfected, cells were collected at PD4 and PD80, respectively.