國立中山大學 生物科學系 九十八學年度

博士班 生態學資格考 試題

一、 請解釋下列的生態專有名詞，並舉例說明之 (40 %，每題 5 分)

1. Keystone species
2. Autotroph
3. Pyramid of biomass
4. Ecological niche
5. CAM plant (crassulacean acid metabolism)
6. Disclimax
7. Biological magnification
8. Compensation depth

二、 問答題 (60%)

1. 何謂生物多樣性？請說明其包含的內容及意義? (15%)

2. 何謂污染？請說明其定義及可能發生的原因以及如何用生態學的研究方法與結果作判定? (15%)

3. 請列述全球氣候暖化對環境生態可能之影響。(20%)

4. 下列為不同物種間相互作用型態的專有名詞及說明，請將所附說明之代號（A~I）填入最適當空格內。（10%，每個空格 1 分，全答對 10 分）

Type of interaction:

( ) 1. Competition: direct interference type, ( ) 2. Mutualism,
( ) 3. Predation (including herbivory), ( ) 4. Neutralism,
( ) 5. Competition: resource use type, ( ) 6. Parasitism,
( ) 7. Amensalism, ( ) 8. Commensalism,
( ) 9. Protocooperation.

General nature of interaction

A). Beneficial to population 1, but neutral or of no benefit to population 2.
B). Population 1 eat population 2 and their body sizes are generally larger than population 2.
C). Interaction favorable to both and obligatory.
D). Indirect inhibition when common food or space is in short supply.
E). Neither population affects the other.
F). Direct inhibition of each species by the other.
G). Population 1 inhibited, 2 not affected.
H). Population 1 eat population 2 and generally smaller than population 2, the host.
I). Interaction favorable to both but not obligatory.

Microbiology

Name：_____ Student #：_____

I. MULTIPLE CHOICE (50 %)

1)The appearance of gram-negative bacteria after completing the Gram stain.
A)Purple B) Red C) Colorless D) Brown E) Green

2)The resolution of a microscope can be improved by changing the
A)Coarse adjustment. B)Diaphragm. C)Condenser. D)Wavelength of light. E)Fine adjustment.

3)Which of the following statements is true?
A)Endospores are for reproduction. B)A cell can produce many endospores. C)A cell produces one endospore and keeps growing. D)Endospores allow a cell to survive environmental changes. E)Endospores are easily stained in a Gram stain.

4)What will happen if a bacterial cell is placed in distilled water with lysozyme?
A)Lysozyme will diffuse into the cell. B)The cell will undergo osmotic lysis. C)No change will result; the solution is isotonic. D)Water will leave the cell. E)The cell will plasmolyze.

5)Which of the following uses glucose for carbon and energy?
A)Chemoheterotroph B) Photoheterotroph C)Photoautotroph D) Chemoautotroph

6)The term facultative anaerobe refers to an organism that
A)Requires less oxygen than is present in air. B)Is killed by oxygen. C)Doesn't use oxygen but tolerates it.
D)Uses oxygen or grows without oxygen. E)Prefers to grow without oxygen.

7)During which growth phase will gram-positive bacteria be most susceptible to penicillin?
A)Log phase B)Stationary phase C)Lag phase D)Death phase E)The culture is equally susceptible during all phases.

8)Which group of microorganisms is most likely to spoil a freshwater trout preserved with salt?
A)Anaerobes B)Thermophiles C)Facultative halophiles D)Psychrophiles E)Hyperthermophiles

9)Which of the following statements about archaea is false?
A)They evolved before bacteria. B)They are prokaryotes. C)Some produce methane from carbon dioxide and hydrogen.
D)They lack peptidoglycan in their cell walls. E)Some are thermoacidophiles; others are extreme halophiles.

10)Which of the following is NOT a characteristic of spirochetes?
A)Gram-negative B)Difficult to culture in vitro C)Easily observed with brightfield microscopy
D)Helical shape E)Possess an axial filament

11)You have isolated a bacterium that grows in a medium containing an organic substrate and nitrate in the absence of oxygen. The nitrate is reduced to nitrogen gas. You can be sure that this bacterium is
A)Using anaerobic respiration. B)A chemoautotroph. C)Gram-positive. D)A photoautotroph. E)A photoheterotroph.

12)*Escherichia coli* belongs to the
A)Spirochetes. B)Proteobacteria. C)Gram-positive bacteria. D)Green sulfur bacteria. E)Actinomycetes.

13)Actinomycetes differ from fungi in that actinomycetes
A)Cause disease. B)Lack a membrane-bounded nucleus. C)Require light. D)Are decomposers.
E)Are chemoheterotrophs.

14)A viroid is A)An infectious protein. B)A capsid without a nucleic acid. C)A provirus.
D)A nonenveloped, infectious piece of RNA. E)A complete, infectious virus particle.

15)Some viruses, such as human herpesvirus 1, infect a cell without causing symptoms; these are called
A)Phages. B)Unconventional viruses. C)Lytic viruses. D)Latent viruses. E)Slow viruses.

16)A nosocomial infection is
A)Only a result of surgery. B)Always caused by pathogenic bacteria. C)Always present but is inapparent at the time of hospitalization. D)Acquired during the course of hospitalization. E)Always caused by medical personnel.

17)Transient microbiota differ from normal microbiota because transient microbiota
A)Cause diseases. B)Are present for a relatively short time. C)Are acquired by direct contact.
D)Never cause disease. E)Are found in a certain location on the host.

18)Which of the following is NOT a communicable diseases?
A)AIDS B)Tuberculosis C)Typhoid fever D)Tetanus E)Malaria

19)A sexually transmitted disease is an example of
A)Fomite. B)Vector. C)Droplet transmission. D)Direct contact. E)Vehicle transmission.

20)Which of the following statements about exotoxins is generally false?
A)They are composed of proteins. B)They are produced by gram-positive bacteria. C)They are more potent than endotoxins. D)They are not destroyed by heat. E)They have specific methods of action.

21)Which of the following is NOT transmitted by the respiratory route?
A)Chickenpox B)Rubella C)Measles D)Trichophyton E)Smallpox

22)Which of the following is NOT caused by prions?
A)Sheep scrapie B)Elk chronic wasting disease C)Creutzfeldt-Jakob disease D)Kuru E)Rabies

23)Which of the following is NOT a characteristic of *Bacillus anthracis*?
A)Gram-positive B)Produces endotoxins C)Found in soil D)Forms endospores E)Aerobic

24)Human-to-human transmission of plague is usually by
A)Rat flea. B)The respiratory route. C)Unsanitary conditions. D)Dog flea. E)Wounds.

25)You advise your pregnant friend to give her cat away because
A)She could get listeriosis. B)She could contract plague. C)You don't like cats and want to see your friend without one.
D)She could give the cat tularemia. E)She could get toxoplasmosis.

26)Most of the microorganisms in the soil are found at a depth
A)Between 65 and 75 cm. B)Between 20 and 25 cm. C)Between 3 and 8 cm. D)Between 35 and 40 cm.
E)Evenly distributed from the surface to 76 cm.

27)Biochemical oxygen demand (BOD) is a measure of
A)The number of bacteria present in a water sample. B)The amount of nitrogen in a water sample.
C)The amount of undissolved solid matter present in a water sample. D)The amount of oxygen present in a water sample.
E)The amount of organic matter present in a water sample.

28)Who was the first to observe microorganisms with a microscope?
A)Koch B)Weizmann C)Pasteur D)van Leeuwenhoek E)Hooke

29)Which of the following groups include members that lack DNA?
A)Protozoa B)Bacteria C)Viruses D)Fungi E)Helminths

30)The counterstain in the acid-fast stain is
A)An acid dye. B)A mordant. C)A basic dye. D)A negative stain. E)Necessary to determine acid-fast cells.

31)The purpose of a mordant in the Gram stain is
A)To remove the simple stain. B)To make gram-negative cells visible. C)To make the flagella visible.
D)To prevent the crystal violet from leaving the cells. E)To make the bacterial cells larger.

32)Which of the following is NOT a characteristic of the plasma membrane?
A)Is composed of a phospholipid bilayer B)Contains proteins C)Is the site of cell wall formation
D)Maintains cell shape E)Is selectively permeable

33)Which of the following have a cell wall?
A)Animal cells B)L forms C)Fungi D)Mycoplasmas E)Protoplasts

34)Which of the following structures is NOT found in prokaryotic cells?
A)Axial filament B)Flagellum C)Cilium D)Peritrichous flagella E)Pilus

35)Which of the following is NOT a chemical component of a bacterial cell wall?
A)Teichoic acids B)N-acetylmuramic acid C)Peptidoglycan D)Cellulose E)Peptide chains

36)Where are phospholipids most likely found in a prokaryotic cell?
A)Ribosomes B)Flagella C)Plasma membrane D)Around organelles E)B and C

37)Fatty acids are catabolized in
A)Glycolysis. B)The pentose phosphate pathway. C)The Entner Doudoroff pathway. D)The electron transport chain. E)The Krebs cycle.

38)Which of the following statements about anaerobic respiration is false?
A)It involves glycolysis only. B)It requires cytochromes. C)It generates ATP. D)It involves the Krebs cycle. E)It involves the reduction of nitrate.

39)Salts and sugars work to preserve foods by creating a
A)Depletion of nutrients. B)Hypotonic environment. C)Hypertonic environment. D)Lower pH. E)Lower osmotic pressure.

40)A culture medium consisting of agar, human blood, and beef heart is a
A)Complex medium. B)Selective medium. C)Differential medium. D)Reducing medium. E)Chemically defined medium.

41)Which of the following is the best definition of generation time?
A)The length of time needed for lag phase B)The time needed for nuclear division C)The duration of log phase D)The length of time needed for a cell to divide E)The minimum rate of doubling

42)Patients with indwelling catheters are susceptible to infections because
A)Bacteria cause infections. B)Their immune systems are weakened. C)Biofilms develop on catheters. D)Injected solutions are contaminated. E)Infections can be transmitted from other people.

43)An enzyme produced in response to the presence of a substrate is called
A)An operator. B)An inducible enzyme. C)A promoter. D)A repressible enzyme. E)A restriction enzyme.

44)Genetic change in bacteria can be brought about by
A)Transduction. B)Mutation. C)Conjugation. D)Transformation. E)All of the above.

45)According to the operon model, for the synthesis of an inducible enzyme to occur, the
A)Repressor must bind to the operator. B)End-product must not be in excess. C)Repressor must not be synthesized. D)Substrate must bind to the enzyme. E)Substrate must bind to the repressor.

46)The mechanism by which the presence of glucose inhibits the arabinose operon is
A)Repression. B)Translation. C)Induction. D)Catabolite repression. E)DNA polymerase.

47)An enzyme that cuts double-stranded DNA at specific nucleotide sequences.
A)Restriction enzyme B)DNA polymerase C)DNA ligase D)RNA polymerase E)Transposase

48)PCR can be used to identify an unknown bacterium because
A)DNA polymerase will replicate DNA. B)All cells have DNA. C)All cells have RNA. D)The RNA primer is specific. E)DNA can be electrophoresed.

49)If two organisms have similar rRNA sequences, you can conclude that
A)They live in the same place. B)They evolved from a common ancestor. C)They will both ferment lactose. D)They mated with each other. E)They will have different G-C ratios.

50)The phylogenetic classification of bacteria is based on
A)rRNA sequences. B)Diseases. C)Gram reaction. D)Habitat. E)Cell morphology.

II. Please describe bacterial categories based on oxygen requirements and how bacteria deal with toxic forms of oxygen? (25%)
(Please give your answer on the back of this sheet)

III. How viruses are classified by Baltimore? Please describe the life cycle and give some examples of each class. (25%)
(Please give your answer on the back of this sheet)

◎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.

Qualifying Examination: Biochemistry

◎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。

1. The location of a gene may reside in either forward strand or reverse strand of DNA in cells. What determine the site/location of a gene exists in forward or reverse strand?
2. Cells having DNA replication in process mean these cells are undergoing proliferation. How would you design at least 2 different types of experiments to prove the cells/tissues/specimens you are working on having signs of DNA replication?
3. Since completion of genome projects of many organisms, comparative genomics has been used in studies of various biological researches. If a graduate student is working on a novel gene, how can she/he find out a putative conserved functional domain of the product of this gene?
4. Every protein has a unique three-dimensional structure that reflects its function. Describe how to study the structure of proteins.
5. The activities of metabolic pathways in cells are commonly regulated by controlling the activities of certain enzymes. Give specific examples to illustrate the ways.
6. The DNA sequence of a new gene is just known and a gradate student is assigned to study the function of its protein product. Describe how the student determines the function of the protein product.
7. Cholesterol is an essential molecule in humans, but is not required in the diet. Describe the biosynthesis of cholesterol, the transport of cholesterol in the blood, the uptake by cells, and the normal regulation of cholesterol synthesis.

Neural Sciences

1. List all events in sequence which will occur between the exposure of Retina to the light and the firing of Action potentials in the Optic nerves. (20%)

2. In study the neural control of cardiopulmonary systems, the animal are usually Decerebrated before starting the core experiment. Answer the following questions relating to decerebration of experimental animals. (20%)
   (a). What is Decerebrate Rigidity?
   (b). Why the operation is necessary in these experiments?
   (c). Describe rules of Cerebellum on modulating decerebrate rigidity.
   (d). What would happen by cutting dorsal roots of the spinal nerves in animals with decerebrate rigidity, why?

3. Describe neural connections (both afferent and efferent connection) of basal ganglia. (5%)

4. Discuss neurophysiological mechanisms in Parkinson's disease. (5%)

5. Describe the molecular mechanisms in long-term potentiation in hippocampus. (25%)

6. Toxin X is a neurotoxin with lots of negative charges in its structure and is considered to be a peripheral neurotoxin. The preliminary tests show the animals injected with X die in respiratory failure. Discuss every possibility of its underlying mechanisms. (25%)

Qualify Examination

Behavioral Ecology (10 points for each question)

1. What is game theory? Please use the hawk-dove model to explain the concept of evolutionary stable strategy.
2. Give at least three hypotheses for the evolution of signal design relating to ritualization.
3. Why are most birds monogamous whereas most mammals polygynous?
4. Explain the hypotheses which have been proposed for the reason(s) for male aggregating into leks.
5. What are the topics often appear in the text books on behavioral ecology?
6. How does the phylogeny help to understand the evolution of one particular behavior? Please give an example.
7. Blue magpies have helper at nest. How could the helping behavior evolve in this species of bird?
8. In a chorus of Taipei tree frogs, some are calling and others are silent. Please state two possible hypotheses to explain the occurrence of these two alternative strategies.
9. Why are there only two sexes in sexual reproduction?
10. Are all signals honest? Please state the reasons according to your answer.

中山生科所 2010　演化生物試題—博士班資格考

題目分甲、乙兩部份,均需作答,但請分別寫在不同答題紙上

甲、(四選二, 一題 25 分)

1. 假設你的老闆要你使用至少兩個基因序列重建一個親緣關係假說，並依其推測一群生物在體型上的雌雄二型性的演化趨勢，請問你認爲把這樣的一個研究做好應該具備什麼樣的步驟流程？

2. 請介紹三個演化生物學門的期刊，並比較這些期刊收錄文章的異同。(註明：請自行設定評比項目，且不能是針對特定分類群而設立的期刊，如 Zoological Journal of the Linnean Society)

3. 請說明至少一種方法偵測一群生物的分化乃肇因於 allopatric speciation？sympatric speciation？或是 peripatric speciation？

4. 生殖器的形態乃是 lock-and-key hypothesis 的關注重點之一，如果有一種陸生生物的雄性生殖器形態具有高度的種內變異，然雌性生殖器的形態卻缺乏與之相對應的變化，這很可能違反了生殖隔離預測下的 mechanical isolating mechanism，請問有什麼樣的假說能夠解釋這種現象呢？

乙、利用圖來對比下列成對的演化生物相關關鍵詞(16 選 10，每題 5 分)

作答原則

A. 以能明確區分兩個對比關鍵詞爲答題目標，文字請以註記圖爲限，整句部份不計分

B. 優先考慮以有 X-Y 軸概念之圖來表達,均須明確註明 X,Y 軸各代表什麼,每題不限一個圖

C. 自選最有把握的回答，若超過 10 題則自行劃掉次佳的答案，可用鉛筆，以利自己修改

Directional selection vs disruptive selection

Founder effect vs bottleneck effect

Gene flow vs genetic drift

Microevolution vs macroevolution

Autopolyploidy vs allopolyploidy

Positive selection vs negative selection

Sibling species vs sister species

synonymous vs nonsynonymous substitution

Stasis vs gradualism

Dispersal vs vicariance hypotheses

Allopatric vs sympatric

Convergence vs common ancestry

Monophyletic vs paraphyletic groups

Underdominance vs overdominance

Blending vs particulate inheritance

Allometry vs isometry

博士班資格考－細胞分子生物學

細胞分子生物學 試題 (I)

註：以下 5 題中，1、2、3 題任選兩題，4、5 題必答。(You may select any two of the first 3 questions to answer, but you must answer the last two questions)。

1．研究證明，粒線體(mitochondria)的 DNA 複製呈現不間斷的連續複製過程，與細胞核內 DNA 的複製形成反差。請問為何粒線體 DNA 的複製與核 DNA 不同步？(Replication of mitochondria is not synchromatic to the nuclear genome. Explain the mechanism)。（10%）

2．恆河猴(在臺灣也稱臺灣彌後，在中國大陸也稱黃猴或廣西猴)的基因組(genome)與人類具有高達 99%的相似性，請說明兩者為何具有如此重大的區別？(The genome of Guangxi monkey has over 99% identical to *Homo sapiens*, but both of them are different in many ways including IQ. Explain the genetic mechanism)。（10%）

3．請詳解大腸桿菌部份二倍體 $\begin{pmatrix} F' \ Lac\ I^+ \ Lac\ O^+ \ Lac\ Z^- \ Lac\ Y^+ \\ G \ \ Lac\ I^+ \ Lac\ O^- \ Lac\ Z^+ \ Lac\ Y^- \end{pmatrix}$ 中，$Lac\ I^+$ 及 $Lac\ Y^+$ 基因表達有何特點？(Explain the expression control of gene $Lac\ I^+$ and gene $Lac\ Y^+$ in partial diploid in *E. coli*)。（10%）

4．試論激發子 (activator) 在真核基因表達中的作用。(On the activator in gene expression in eukaryotes)。（15%）

5．霍亂菌（*Vibrio cholerae*）中多毒性基因表達的研究給予我們什麼啟示？(On the molecular mechanism of the expression of multiple toxic genes in *V. cholerae*)。（15%）

細胞分子生物學 試題 (II)

Questions for Molecular Cell Biology (II) 50%:

You may choose any 3 from the following 4 questions to answer.

1. Gene expression is critical for living cells/tissues/organisms. Please describe in detail the components required and involved in the transcription-initiation complex of eukaryotes.
2. The ability of cells' to respond theirs environment is essential to theirs survival. Explain why some hormonal ligands can induce modifications in cells within seconds, whereas others may take several days to effect changes.
3. What is the significance of checkpoints in the context of cell cycle of eukaryotes?
4. MicroRNAs are a recently discovered class of small non-coding RNAs that have been shown critical in multicellular eukaryotes. What are the major functions/roles of these microRNAs?

博士班資格考—生理學

題目分兩部份，均需作答，請分別寫在不同答題紙上，並註明題號。

第一部份(任選 **50%**以上，總分 **50** 分)

1. Luteinizing hormone secretion is in a pulsatile pattern. Describe the pulse frequency changes during ovulation period. (10%)
2. Compare the differences between protein hormones and steroid hormones in terms of cellular signal transduction. (10%)
3. There are 25,000 genes in human genome, however the variety of antibody molecule is much more than this number. Why? (10%)
4. What is the role of major histocompatability complex gene product in cell-mediated immunity? (optional 10%)
5. Anemia is usually a serious problem in renal failure patient. What is the role of kidney in erythropoiesis? (optional 10%)
6. The concentration of urea in urine is much higher than the concentration in plasma. Why? (10%)
7. Large molecule protein must be digested into amino acid or small peptide for intestinal absorption. How can new born baby absorb antibody from mother's milk and achieve passive immunity? (optional 10%)
8. A fatty meal consumed before the alcohol ingestion may decrease the rate of getting drunk. Why? (10%)

第二部份(任選 **50%**以上，總分 **50** 分)

9. The following questions are about muscle physiology, please write your answer in detail. (30%)
   (a). Draw schematic diagrams of Action Potentials that can be recorded from Skeletal muscles, Cardiac Muscles, and Smooth Muscles.
   (b). Describe mechanisms that can be used to explain the shape of each diagram you have drawn on question (a).
   (c). Describe and compare Excitation-Contraction coupling of skeletal muscle and cardiac muscles.
10. The following two questions are about Cardiac events during a normal cardiac cycle in most mammals. (20%)
    (a). Draw schematic diagrams describing sequential changes of events including: Electrocardiogram (EKG) ; Blood pressure curves in Left Ventricle ; Blood Volume alteration in Left ventricle; Blood pressure in aorta; Blood Pressure in pulmonary artery; and Phonocardiogram (Heart sounds).
    (b). Describe mechanisms that may explain causes of the sequential changes in the above events.
11. List all events in sequence which will occur between the exposure of Retina to the light and the firing of action potentials in the Optic nerves. (20%)
12. Compare pathways by which increased arterial P_{CO_2} and increased hydrogen ion accumulation stimulate ventilation of the lung. (10%)

免疫學

1. 簡論T-淋巴細胞信號傳遞與細胞增殖的關係。(20%)
   (On the relationships between Signal transduction and cell proliferation in T-cell)。
2. 簡論經典補體途徑組成份缺失的病理形成機制。(15%)
   (Briefing of the pathogenesis due to component deficiency of classical pathway in complement system)。
3. 試論自體免疫現象的免疫學基礎。
   (Briefing of the immunological basis of autoimmunity)。(15%)
4. 請說明何謂病原 pattern recognition receptors (PRRs)，並請分別說明 membrane bound PRRs 及 cytoplasmic PRRs 及其在 innate immunity 所扮演之角色及運作機制？ (20%)
   (Define pathogen pattern recognition receptors and briefly describe membrane-bound and cytoplasmic PRRs, their role and mechanism in innate immunity.)
5. 請說明後天免疫系統用以達成抗原呈獻及確認之機制？(15%)
   (Describe the mechanism used for antigen presentation and recognition in adaptive immune system)
6. 請說明抗體分子之affinity maturation，其在後天免疫反應有何重要性?其形成之參與分子及作用機轉為何？(15%)
   (What is antibody affinity maturation? Why is it important for adaptive immune response? Describe the molecules participate and mechanism in this process.)