

# 國立中山大學 110 學年度 碩士暨碩士專班招生考試試題

科目名稱：普通生物學【生科系碩士班甲組】

## — 作答注意事項 —

考試時間：100 分鐘

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題號：421004

※本科目依簡章規定「不可以」使用計算機(問答申論題)

共 1 頁第 1 頁

所有題目皆為申論題，回答時請留意術語的定義、議題的重要性、主要的發展脈絡、重要的假說與觀點，並在最後需要提供結論。答題時最好能同時使用文字與圖示來表達你的意圖與概念。

一、請舉例說明性擇與天擇力量如何同時作用在同一個性狀上，並對個體的適存度(fitness)造成衝突的效應？(20%)

二、假設我們想要瞭解台灣的石虎的族群相對於臨近地區國家石虎的遺傳多樣性是否很低，並且因為近一世紀的森林破壞而造成瓶頸效應，那麼我們應該使用那些族群遺傳學以及演化生物學方法來檢驗這些猜測？(20%)

三、保育團體擔憂光電板對淡水溼地造成破壞，但也有學者認為光電板的設置可以改善人工湖泊或池塘優養化的問題。若要請你衡量光電板設置於平地池塘的生態衝擊，請問你會如何以什麼樣的質化與量化指標來評估其在再生能源與生態保育之間的利弊得失？(20%)

四、有個學生想要使用鬥魚兩兩對峙後的輸贏來檢測「勝者效應」(winner effect)，所以他打算去水族館買很多鬥魚來做實驗，記錄下鬥魚打鬥後的勝負記錄。你認為他這樣做正確嗎？若不正確，原因是什麼？而在這樣的實驗中有那些生物性與非生物性因素應該要被當成控制變因？(20%)

五、請將這段話翻譯成達意精確的中文，並請留意英文與中文在標點符號與句構上的差異 (20%)

Climate change is altering environmental temperature, a factor that influences ectothermic organisms by controlling rates of physiological processes. Demographic effects of warming, however, are determined by the expression of these physiological effects through predator-prey and other species interactions. Using field observations and controlled experiments, we measured how increasing temperatures in the Arctic affected development rates and mortality rates (from predation) of immature Arctic mosquitoes in western Greenland. We then developed and parametrized a demographic model to evaluate how temperature affects survival of mosquitoes from the immature to the adult stage.

# 國立中山大學 110 學年度 碩士暨碩士專班招生考試試題

科目名稱：生態學【生科系碩士班甲組】

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科目名稱：生態學【生科系碩士班甲組】

題號：421002

※本科目依簡章規定「不可以」使用計算機(混合題)

共 3 頁第 1 頁

## 一、選擇題(單選，共 45 分，每題 3 分)

1. Fish such as salmon, which are born in freshwater streams but spend most of their adult lives in the ocean, are termed
  - A. ahedonistic
  - B. anadromous
  - C. androgynous
  - D. oscillatory
  - E. olderous
2. Which of the following environments usually experience the most extreme seasonal variation?
  - A. Tide pools
  - B. Tropical forests
  - C. Open oceans
  - D. Boreal forests
  - E. Coastal lakes
3. Orchid species that have lost their ability to photosynthesize, and instead parasitize fungi for their energy needs, are examples of
  - A. chemosynthetic organisms
  - B. hyperparasites
  - C. holoparasites
  - D. hemiparasites
  - E. heterotrophs
4. The \_\_\_\_\_ pathway, which provides high concentrations of CO<sub>2</sub> to the Calvin cycle, substantially reduces photorespiration.
  - A. C<sub>3</sub> photosynthetic
  - B. C<sub>6</sub> photosynthetic
  - C. ATP
  - D. NADPH
  - E. C<sub>4</sub> photosynthetic
5. Grasshoppers, crickets, and locusts share many similar characteristics such as elongated hind wings (which they use for jumping) and particular wing structures. The similarities among these insects are primarily the result of
  - A. common descent
  - B. natural selection
  - C. adaptive radiations
  - D. genetic drift
  - E. mutation
6. After large seeds became more common, the average beak size of the medium ground finch increased in size over the course of a few years. This change was most likely a case of
  - A. disruptive selection
  - B. directional selection
  - C. stabilizing selection
  - D. balancing selection
  - E. genetic drift



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題號：421002

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共 3 頁第 2 頁

7. Which of the following would be most likely to be semelparous?
- A. A giant Pacific octopus.
  - B. A large mammal.
  - C. A perennial plant.
  - D. A pine tree.
  - E. A spruce tree.
8. The distribution of the saguaro cactus in Arizona is limited primarily by
- A. the presence of creosote bush.
  - B. biotic factors.
  - C. extended periods of below freezing temperature.
  - D. rainfall.
  - E. genets.
9. Which of the following is most likely to lead to population cycles?
- A. Demographic stochasticity
  - B. Genetic drift
  - C. Habitat fragmentation
  - D. Delayed density dependence
  - E. Logistic growth
10. A predatory wasp that feeds exclusively on ants would be an example of a(n) \_\_\_\_\_ and part of the \_\_\_\_\_ trophic level.
- A. herbivore; first
  - B. herbivore; second
  - C. omnivore; third
  - D. carnivore; second
  - E. carnivore; third
11. In most regions of the open ocean the primary limiting factor of NPP is nitrogen, yet there is evidence that in the equatorial Pacific Ocean the limiting factor is
- A. potassium
  - B. phosphorus
  - C. sulfur
  - D. carbon
  - E. iron
12. In models relating species richness to community function, a \_\_\_\_\_ species has a minimal effect on community function.
- A. driver
  - B. passenger
  - C. redundant
  - D. complementary
  - E. disposable
13. Regional species diversity is referred to as \_\_\_\_\_ diversity.
- A. alpha
  - B. beta
  - C. gamma
  - D. delta
  - E. turnover

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共 3 頁第 3 頁

14. Communities are least likely to form when disturbance is \_\_\_\_\_ in intensity and \_\_\_\_\_.
- A. very high; common
  - B. very high; rare
  - C. low; rare
  - D. low; common
  - E. Communities are likely to form under any disturbance regime.
15. Species that feed on more than one trophic level are called
- A. tertiary consumers.
  - B. herbivores
  - C. primary producers
  - D. omnivores
  - E. secondary consumers

## 二、簡答題(共 55 分)

1. Defining “Biosphere” (5 points).
2. Describe “Density-dependent factors”? (5 points).
3. Defining “Energy Flow” (5 points).
4. Defining “gross primary production” (5 points)
5. Defining “Biogeography” (5points)
6. Defining “alternative stable states” (5 points)
7. Defining “ecosystem engineer” (5 points)
8. Defining “keystone species” (5 points)
9. Defining “Commensalism” (5 points)
10. Defining “endoparasite” (5 points)
11. Defining “Shannon index” (5 points)

# 國立中山大學 110 學年度 碩士暨碩士專班招生考試試題

科目名稱：生物化學【生科系碩士班乙組】

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科目名稱：生物化學【生科系碩士班乙組】

題號：421001

※本科目依簡章規定「不可以」使用計算機(選擇題)

共 8 頁第 1 頁

## 一、選擇題每題 2 分(100%) 單選

1. What makes carbon such an abundant element in biomolecules?
  - a. It can form up to five bonds by sharing its electrons.
  - b. It forms only single bonds.
  - c. It provides low bond energy.
  - d. It forms stable covalent bonds by electron pair sharing.
  - e. It does not usually bond to other carbons, allowing a more diverse combination of elements.
2. Arrays of filaments in eukaryotic cells that give the cell its shape and its capacity to move are called the:
  - a. plasma membrane.
  - b. smooth endoplasmic reticulum.
  - c. cytoskeleton.
  - d. lysosome.
  - e. Golgi body.
3. All of the following functions of an enzyme are true EXCEPT:
  - a. Enzymes help to catalyze virtually every metabolic reaction.
  - b. Enzymes mediate the rates of cellular reaction in proportion to cellular requirements.
  - c. Enzymes are sensitive to temperature, pH, and concentration changes.
  - d. An increased activity of an enzyme increases the amount of energy produced.
  - e. Enzymes are used as a catalyst to increase reaction rates many orders of magnitude.
4. Buffers have all of the following characteristics EXCEPT:
  - a. They have relatively flat titration curves at the pH(s) where they buffer.
  - b. They resist changes in their pH as acid or base is added.
  - c. They are typically composed of a weak acid and its conjugate base.
  - d. They buffer best for polyprotic acids half-way between the two pKa values.
  - e. Buffer where the amounts of conjugate base are nearly equivalent to the amounts of weak acid.
5. The hydrolysis of a phosphate from which of the following molecules is most thermodynamically favorable?
  - a. ADP
  - b. glucose phosphate
  - c. adenosine-5'-diphosphate
  - d. phosphoenolpyruvate
  - e. adenosine-5'-triphosphate
6. To predict whether pairs of coupled reactions will proceed spontaneously:
  - a. Subtract the smaller from the larger  $\Delta G$ .
  - b. Sum the  $\Delta G^{\circ}$ 's for each reaction.
  - c. Add the  $\Delta S$  values for each reaction at constant temperature.
  - d. The absolute value of the positive  $\Delta G^{\circ}$  must be larger than the value of the negative  $\Delta G^{\circ}$ .
  - e. None are true.

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共 8 頁第 2 頁

7. The difference between serine and homoserine is the same as between cysteine and homocysteine. This change from the common amino acid is:
- one additional  $-\text{CH}_2-$  group.
  - one additional  $-\text{COOH}$  group.
  - two additional  $-\text{NH}_2$  groups.
  - presence of a ring system.
  - one additional  $-\text{NH}_2$  group.
8. All of the amino acids EXCEPT \_\_\_\_\_ have both free  $\alpha$ -amino and free  $\alpha$ -carboxyl groups.
- aspartic acid
  - proline
  - asparagine
  - lysine
  - valine
9. The amino acid with a side-chain  $\text{pK}_a$  near neutrality and which therefore plays an important role as proton donor and acceptor in many enzyme catalyzed reactions is:
- histidine.
  - cysteine.
  - proline.
  - serine.
  - methionine.
10. Ninhydrin has all these properties EXCEPT:
- It reacts with an amino acid by oxidatively deaminating its amino group.
  - It can be used to detect the location of amino acids following chromatography.
  - It produces a purple colored product upon reaction with alanine.
  - It produces a yellow product upon reaction with histidine.
  - It can be used to quantify most amino acids.
11. Proteins with two different polypeptide chains are:
- monomeric proteins.
  - trimeric proteins.
  - homodimeric proteins.
  - heterodimeric proteins.
  - none of the above.
12. Fibrous proteins, such as collagen, have which one of the following properties?
- Highly soluble in water.
  - Their hydrophilic residues are directed into the interior of the protein.
  - Exhibit enzymatic activity.
  - Serve structural roles in the cell.
  - Monomeric.

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共 8 頁第 3 頁

13. Molecules of a given protein have all EXCEPT:
- a fixed amino acid composition.
  - a defined amino acid sequence.
  - a sequence read from C-terminal end to N-terminal end.
  - an invariant molecular weight.
  - a nucleotide sequence from which they are encoded.
14. A protein's particular conformations are all EXCEPT:
- The overall three-dimensional architecture of the protein.
  - Achieved by breaking and reforming covalent bonds.
  - Achieved by rotations about each single bond along the peptide backbone.
  - The result of amino acid side-chain interactions.
  - None, all are true.
15. Why should the core of most globular and membrane proteins consist almost entirely of  $\alpha$ -helix and  $\beta$ -sheets?
- Hydrogen bonded structures must be kept away from water solvent.
  - Highly polar N-H and C=O moieties of the peptide backbone must be neutralized in the hydrophobic core of the protein.
  - Hydrogen bonding only occurs in the core of proteins.
  - Trapped water stabilizes the helix and sheet structures.
  - None are true.
16. All are structural and functional advantages to quaternary structure EXCEPT:
- cooperativity.
  - stability.
  - bringing catalytic sites together.
  - genetic economy and efficiency.
  - all are true.
17. How do catalysts work to accelerate a chemical reaction?
- They raise the average energy of the reactants.
  - They provide a means of acceleration by being completely consumed in the reaction.
  - They lower the energy of activation.
  - They lower the overall free energy change of the reaction.
  - They raise the overall free energy change of the reaction.
18. All are true for  $k_{cat}$  EXCEPT :
- referred to as the molecular activity of the enzyme.
  - called the turnover number of the enzyme.
  - measures the maximal catalytic activity or kinetic efficiency of an enzyme.
  - defines the number of substrate molecules converted into product/enzyme molecule/unit of time when the enzyme is saturated with substrate.
  - all are true.

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題號：421001

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共 8 頁第 4 頁

19. The enzyme-catalyzed reaction rate will be increased if the energy level of ES can be increased by all EXCEPT:
- destabilization of ES by strain.
  - loss of entropy due to binding of E and S.
  - destabilization of ES by distortion.
  - destabilization of ES by solvation.
  - destabilization of ES by electrostatic effects.
20. The good transition state analog is one which would serve also as an effective:
- competitive inhibitor.
  - noncompetitive inhibitor.
  - allosteric inhibitor.
  - mixed-noncompetitive inhibitor.
  - irreversible inhibitor.
21. All are true for low-barrier hydrogen bonds EXCEPT:
- The hydrogen is centered between the two heteroatoms.
  - The interactions are more covalent.
  - The bond order approaches 0.5 for both O-H interactions.
  - The barrier that the hydrogen atom must surmount to exchange oxygens becomes lower.
  - All are true.
22. The mechanism of chymotrypsin involves which of the following elements?
- deprotonation of an active site Asp residue by His to start the reaction
  - formation of an acyl-enzyme intermediate that must be hydrolyzed to complete the reaction
  - stabilization of the positively charged His by a Gln residue
  - direct deprotonation of water by His to generate a hydroxide ion for initiation of the reaction
  - both a and b occur
23. Which statement below about contrasting Hb and Mb is FALSE?
- Hb shows sigmoidal, whereas Mb shows hyperbolic oxygen saturation curves.
  - Hb shows cooperativity, whereas Mb does not.
  - Hb binds O<sub>2</sub> more tightly than Mb.
  - Oxygen binds to a ferrous ion in both proteins.
  - Hb-oxygen binding is dependent on physiological changes in pH, whereas Mb-oxygen binding is not.
24. Carbon dioxide affects O<sub>2</sub> binding to Hb by:
- Hb competing with carbonic anhydride for CO<sub>2</sub>.
  - directly binding to heme-Fe in the oxygen binding site.
  - forming iron carbonate with the heme-iron.
  - forming H<sup>+</sup> + HCO<sup>3-</sup> where the H<sup>+</sup> is an antagonist to oxygen binding to Hb.
  - forming HCO<sup>3-</sup> that combines with H<sup>+</sup> to increase CO<sub>2</sub> binding.
25. The enantiomer of D-mannose would be:
- D-galactose.
  - L-glucose.
  - D-glucose.
  - L-mannose.
  - L-arabinose.



# 國立中山大學 110 學年度碩士暨碩士專班招生考試試題

科目名稱：生物化學【生科系碩士班乙組】

題號：421001

※本科目依簡章規定「不可以」使用計算機(選擇題)

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26. Cellulose is a:
- (1→4)-  $\alpha$ -D-mannopyranan.
  - (1→4)-  $\beta$ -D-glucopyranan.
  - (1→6)-  $\alpha$ -D-glucopyranan.
  - (1→4)-  $\beta$ -D-galactopyranan.
  - (1→6)-  $\alpha$ -D-mannopyranan.
27. Which of the following lipids is correctly defined?
- triacylglycerol: formed from glycerol and 3 fatty acids, primary lipid of membranes
  - phospholipid: contains glycerol with 2 fatty acids and a phosphate, very often forms bilayers
  - wax: contains a fatty acid and alcohol, used primarily for energy storage
  - cholesterol: the primary component of "saturated" fats
  - palmitic acid: the most commonly produced unsaturated fatty acid in animals
28. Membranes with unsaturated fatty acids in their components are more flexible and fluid because:
- Unsaturated fatty acids pack closely together to form ordered arrays.
  - Unsaturated fatty acids bend at the double bond preventing close packing.
  - Saturated fatty acids have a "kink" that produces more fluid aggregates.
  - Unsaturated fatty acids have cis double bonds that prevent formation of the "kink."
  - All of the above are correct.
29. Hydropathy plots for transport proteins are utilized to reveal:
- Amino acid residues which may be highly modified.
  - Amino acid residues which may be directly involved in facilitated transport.
  - Stretches of amino acid residues that make up hydrophobic regions, which may be directly associated with the lipid bilayer.
  - Amino acid residues which are hyper-reactive due to their location.
  - Whether there is interaction between N-terminal and C-terminal amino acids.
30. Which of the following is the major advantage of a multi-enzyme complex?
- It's large size enables it to span an entire membrane
  - The product of one enzyme is passed directly to the next enzyme without the possibility of diffusion
  - Multi-enzyme complexes are much less likely to be inhibited
  - all of the above
  - none of the above
31. The enzymes of glycolysis and those of the citric acid cycle are found in which cellular compartments in muscle cells?
- both in the cytoplasm
  - glycolysis in cytoplasm and citric acid cycle in mitochondria
  - both in mitochondria
  - glycolysis in cytoplasm and citric acid cycle in lumen of the endoplasmic reticulum
  - both in the lumen of the endoplasmic reticulum

國立中山大學 110 學年度碩士暨碩士專班招生考試試題

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32. Which of the following has the most highly exergonic hydrolysis (considering that only the highest energy bond is hydrolyzed)?
- phosphoenolpyruvate
  - fructose-6-phosphate
  - 1,3-bisphosphoglycerate
  - 2,3-bisphosphoglycerate
  - fructose-1,6-bisphosphate
33. The oxidation of one mole of glucose by anaerobic glycolysis yields a net of:
- two moles of lactate and two moles of ATP.
  - two moles of lactate, two moles of NADH, and two moles of ATP.
  - two moles of lactate and six moles of ATP.
  - two moles of pyruvate and two moles of ATP.
  - two moles of pyruvate, two moles of NADH, and four moles of ATP.
34. The following statements are correct about the reaction catalyzed by the pyruvate dehydrogenase complex EXCEPT:
- It is the link between glycolysis and the TCA cycle
  - The activity of the complex is regulated by the phosphorylation of  $E_{PDH}$ .
  - $NAD^+$  is the direct oxidant of reduced lipoamide.
  - An FAD is covalently linked to the  $E_{DL}$ , the lipoamide dehydrogenase component.
  - Although  $E_{PDH}$  is called "pyruvate dehydrogenase" it is not a dehydrogenase.
35. Which enzymes of the TCA cycle catalyze oxidative decarboxylation reactions?
- malate dehydrogenase and citrate synthase
  - fumarate and succinate dehydrogenase
  - $\alpha$ -ketoglutarate dehydrogenase and succinate dehydrogenase
  - isocitrate dehydrogenase and  $\alpha$ -ketoglutarate dehydrogenase
  - aconitase and succinate dehydrogenase
36. Does electron transport stop if rotenone is added? Why?
- Yes, there is not an electron source.
  - No, rotenone is not strong enough to inhibit all of the electron transport chain.
  - No, there is still a source of electrons from Complex II.
  - Yes, rotenone inhibits complex III, therefore, electrons can not be passed on.
  - Can not be determined from the information given.
37. Which complex will be affected if rotenone is added?
- complex I
  - complex II
  - complex III
  - complex IV
  - none, it is an uncoupler

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38. Chloroplasts consist of a folded inner membrane called the \_\_\_\_\_, which is organized into paired folds called \_\_\_\_\_.
- thylakoid membrane; stroma
  - lamellae; thylakoid membrane
  - thylakoid membrane; lamellae
  - stroma; thylakoid membrane
  - lamellae; stroma
39. Carotenoids have primary roles in photosynthesis as:
- accessory light-harvesting and photooxidation.
  - accessory light-harvesting and photoprotection from reactive oxygen species.
  - resonance transfer pigments and photooxidation.
  - resonance transfer and photodiffusion protection.
  - none are true.
40. Many chlorophyll molecules absorb light and direct the energy to the reactive centers. The transfer of this absorbed energy is called:
- fluorescence transfer.
  - redox transfer.
  - resonance energy transfer.
  - photochemical emission.
  - energy transduction.
41. The endoplasmic reticulum bound enzyme that hydrolyzes glucose-6-phosphate to glucose in liver is:
- glucokinase.
  - glucose oxidase.
  - hexokinase.
  - phosphoglucomutase.
  - glucose-6-phosphatase.
42. The energy input for the synthesis of glycogen occurs during which of the following enzyme catalyzed steps?
- phosphoglucomutase
  - UDP-glucose pyrophosphorylase
  - glycogen synthase
  - amylo-(1,4→1,6)-transglycosylase
  - none of the above require energy input
43. Fatty acids are mobilized from adipose cells in response to all of the hormones EXCEPT:
- ACTH (adrenocorticotrophic hormone).
  - glucagon.
  - insulin.
  - epinephrine (adrenaline).
  - all are true.

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44. The product of  $\beta$ -oxidation, acetyl-CoA, can be used for all EXCEPT:
- synthesis of ketone bodies.
  - synthesis of amino acids.
  - catabolism in the TCA cycle.
  - synthesis of glucose.
  - none of the above.
45. The main source(s) of NADPH for fatty acid biosynthesis is (are):
- TCA cycle.
  - oxidative phosphorylation.
  - malic enzyme and the pentose phosphate pathway.
  - the conversion of OAA to malate by malate dehydrogenase.
  - glycolysis.
46. The committed step in fatty acid biosynthesis, formation of malonyl-CoA, is catalyzed by:
- fatty acid synthase.
  - pyruvate carboxylase.
  - propionate carboxylase.
  - acetyl-CoA carboxylase.
  - ATP-citrate lyase.
47. Animals are totally dependent on plants and microorganisms for nitrogen fixation and nitrate assimilation because animals:
- do not have the reducing power (NADPH) to fix nitrogen.
  - lack the enzyme aminotransferase.
  - lack the enzymes to reduce  $N_2$  and  $NO_3^-$  to  $NH_4^+$ .
  - lack carbamoyl-phosphate synthetase I.
  - lack glutamate dehydrogenase.
48. The involvement of ATP in the nitrogenase complex is because ATP is needed to:
- provide electrons.
  - phosphorylate the enzyme.
  - break the  $N_2$  triple bond.
  - transfer electrons from ferredoxin.
  - all are true.
49. Which of the following statements explains why sulfonamides are effective antibiotics?
- serve as analogs of p-aminobenzoic acid and block bacterial synthesis of folate
  - act as inhibitors of bacterial dihydrofolate reductase, thus preventing production of tetrahydrofolate
  - act as suicide substrates for the enzyme dihydropteroate synthetase
  - do not affect humans because folate is a vitamin
  - both a and d are correct
50. What is the importance of the purine nucleoside cycle?
- It participates in the conversion of purines into pyrimidines.
  - It generates fumarate, which inhibits the formation of AMP from IMP.
  - It provides fumarate as an anaplerotic enhancement of the citric acid cycle.
  - It inhibits the citric acid cycle in skeletal muscles.
  - It is used in energy metabolism in the liver.

# 國立中山大學 110 學年度 碩士暨碩士專班招生考試試題

科目名稱：分子生物學【生科系碩士班乙組】

## — 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

# 國立中山大學 110 學年度碩士暨碩士專班招生考試試題

科目名稱：分子生物學【生科系碩士班乙組】

題號：421003

※本科目依簡章規定「不可以」使用計算機(選擇題)

共 7 頁第 1 頁

單選題：每題 2 分

1. DNA-binding proteins primarily recognize a specific sequence of double-stranded DNA through \_\_\_\_\_.
  - A. interactions with the exposed chemical groups in the DNA sugar-phosphate backbone
  - B. interactions with the exposed chemical groups in the minor groove of the DNA
  - C. interactions with the exposed chemical groups in the major groove of the DNA
  - D. attraction between the protein and negative charges on DNA
2. Which one of the following statements about the structure of RNA is NOT true?
  - A. RNA is capable of forming secondary structure.
  - B. RNA is capable of forming tertiary structure.
  - C. RNA is capable of forming pseudoknots.
  - D. RNA is capable of forming  $\beta$ -sheets.
3. Consider an experiment in which nucleic acids are separated using agarose gel electrophoresis. In the gel you load the following samples:  
Lane 1: a population of linearized 3000-bp double-stranded DNA (dsDNA) molecules.  
Lane 2: a population of circular 3000-bp double-stranded DNA (dsDNA) molecules  
Which population of nucleic acids would most likely migrate through the gel fastest, and in which direction through the gel will these molecules migrate?
  - A. The linearized dsDNA would most likely migrate faster than the circular dsDNA. All DNA molecules would migrate toward the positive end of the gel.
  - B. The linearized dsDNA would most likely migrate faster than the circular dsDNA. All DNA molecules would migrate towards the negative end of the gel.
  - C. The circular dsDNA would most likely migrate faster than the linearized dsDNA. All DNA molecules would migrate toward the positive end of the gel.
  - D. The circular dsDNA would most likely migrate faster than the linearized dsDNA. All DNA molecules would migrate toward the negative end of the gel
4. Which of the following bioinformatics analyses involves scanning sequences in the genomes of related organisms to identify conserved non-coding regions, which may represent unknown regulatory elements?
  - A. BLAST
  - B. VISTA
  - C. genome annotation
  - D. genome editing
5. In a linear eukaryotic chromatin sample, which of the following strands is looped into domains by scaffolding?
  - A. the 30-nm chromatin fiber
  - B. the metaphase chromosome
  - C. DNA with H1 only
  - D. the 10-nm chromatin fiber
6. Which of the following statements is true about histones?
  - A. The mass of histone in chromatin is approximately nine times the mass of DNA.
  - B. The carboxyl end of each histone extends outward from the nucleosome and is called a "histone tail."
  - C. Histones are found in mammals, but not in other animals or in plants or fungi.
  - D. Histone H1 is not present in the nucleosome bead; instead, it draws the nucleosomes together.



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共 7 頁 第 2 頁

7. Why do histones bind tightly to DNA?
- A. Histones are highly hydrophobic, and DNA is hydrophilic.
  - B. Both histones and DNA are strongly hydrophobic.
  - C. Histones are covalently linked to the DNA.
  - D. Histones are positively charged, and DNA is negatively charged.

**Use the following information to answer questions 8 and 9.**

**A group of six students has taken samples of their own cheek cells, purified the DNA, and used a restriction enzyme known to cut at zero, one, or two sites in a particular gene of interest.**

8. Why might they be conducting such an experiment?
- A. to find the location of this gene in the human genome
  - B. to collect population data that can be used to assess natural selection
  - C. to collect population data that can be used to study genetic drift
  - D. to find which of the students has which alleles
9. Their next two steps, in order, should be
- A. electrophoresis of the fragments, followed by Southern blotting using a probe.
  - B. electrophoresis of the fragments followed by autoradiography.
  - C. use of a ligase that will anneal the pieces, followed by Southern blotting.
  - D. use of a fluorescent probe for the gene sequence, then electrophoresis.
10. In recombinant DNA methods, the term vector can refer to
- A. a DNA probe used to identify a particular gene.
  - B. a Single nucleotide polymorphism marker.
  - C. a plasmid used to transfer DNA into a living cell.
  - D. the sticky end of a DNA fragment.
11. Double-stranded DNA absorbs less UV light than single-stranded DNA because:
- A. base stacking in double-stranded DNA increases the absorbance of white light and causes a decrease in the amount of UV light it can absorb. This decrease in UV absorbance is called the hyperchromic effect.
  - B. the bases are on the inside of the helix, inaccessible to the UV light in double-stranded DNA.
  - C. in single-stranded DNA the bases are not interacting, which adds to the light already absorbed by the pentose rings.
  - D. of the hypochromic effect that results when hydrogen bonding and base stacking in double-stranded DNA limits resonance in the aromatic rings of the bases.
12. A genome is ...
- A. All of the DNA in a cell.
  - B. A haploid set of chromosomes plus one copy of any organelle DNA present.
  - C. A haploid set of chromosomes.
  - D. A diploid set of chromosomes.
13. DNA microarrays have made a huge impact on genomic studies because they
- A. dramatically enhance the efficiency of restriction enzymes.
  - B. can be used to introduce entire genomes into bacterial cells.
  - C. allow the expression of many or even all of the genes in the genome to be compared at once.
  - D. allow physical maps of the genome to be assembled in a very short time.



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共 7 頁第 3 頁

14. Which of the following best describes the complete sequence of steps occurring during every cycle of PCR?
1. The temperature decreased for primers hybridize to the target DNA.
  2. The reaction mixture is heated to a high temperature to denature the double-stranded target DNA.
  3. Fresh DNA polymerase is added.
  4. DNA polymerase extends the primers to make a copy of the target DNA.
- A. 3, 4, 2  
B. 3, 4, 1, 2  
C. 2, 3, 4  
D. 2, 1, 4  
E. 2, 1, 3, 4
15. Which of the following modifications is least likely to alter the rate at which a DNA fragment moves through a gel during electrophoresis?
- A. neutralizing the negative charges within the DNA fragment
  - B. altering the nucleotide sequence of the DNA fragment
  - C. methylating the cytosine bases within the DNA fragment
  - D. increasing the length of the DNA fragment
16. At a specific area of a chromosome, the sequence of nucleotides below is present where the chain opens to form a replication fork: 3' C C T A G G C T G C A A T C C 5' An RNA primer is formed starting at the underlined T (T) of the template. Which of the following represents the primer sequence?
- A. 3' G C C T A G G 5'
  - B. 5' G C C U A G G 3'
  - C. 5' A C G T T A G G 3'
  - D. 5' A C G U U A G G 3'
17. Which of the following methods is effective for separating proteins on the basis of their net charge?
- A. ion-exchange chromatography
  - B. gel-filtration chromatography
  - C. affinity chromatography
  - D. polyacrylamide gel electrophoresis
18. A nucleosome forms hydrogen bonds with what part of the DNA?
- A. with the phosphodiester backbone and with bases via the minor groove
  - B. only with bases via the major groove
  - C. only with bases via the minor groove
  - D. with the phosphodiester backbone and with bases via the major groove
19. Which of the following answer choices represents the correct evolutionary relationship between complexity of organisms and gene density (genes/Mb)?
- A. Less complex organisms have increased gene density.
  - B. Less complex organisms have increased gene density.
  - C. Most organisms have a similar gene density.
  - D. There is no relationship between organismal complexity and gene density.

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共 7 頁第 4 頁

20. The “intergenic” parts of the human genome (i.e., the portion of the genome that does not encode proteins or structural RNAs) consist of which types of DNA sequence
- A. genome-wide repeats, microsatellite DNA, and regulatory sequences
  - B. introns, gene fragments, and pseudogenes
  - C. genome-wide repeats, pseudogenes, and microsatellite DNA
  - D. introns, regulatory sequences, and microsatellite DNA
21. Which of the statements best describes the mutational event pictured below?
- Wild-type sequence ACC CAC UCU GGA UUU AAG GCA  
Peptide encoded thr his ser gly leu lys ala
- Mutant sequence ACC CAC UCU UGA UUU AAG GCA  
Peptide encoded thr his ser stop phe lys ala
- A. A transversion mutation leading to a nonsense codon
  - B. A frameshift mutation leading to a missense amino acid substitution
  - C. A transition mutation resulting in a silent amino acid substitution
  - D. A transition mutation leading to a nonsense codon
  - E. An insertion mutation resulting in a frameshift of the amino acid sequence
22. A mutant protein has been designated as G189A. What does this designation reveal about the mutation?
- A. That a G nucleotide has been exchanged for an A nucleotide 189 bases from the 5' end of the coding region.
  - B. That a glycine in position 189 of the protein is now an alanine.
  - C. That an A nucleotide has been exchanged for a G nucleotide 189 bases from the 5' end of the coding region.
  - D. That a glycine is now in position 189 of the protein instead of an alanine.
  - E. That a nonsense mutation occurred at position 189 of the protein.
23. Which of the following is a correct pairing of a base to the product of its deamination?
- A. Thymidine → uracil
  - B. Cytosine → thymine
  - C. Adenine → xanthine
  - D. 5-methylcytosine → thymine
24. Which of the following are the results of external mutagens?
- A. Template slippage during replication
  - B. Addition of bulky adducts to the DNA
  - C. Depurination
  - D. Recombination errors
  - E. Replication errors
25. What is the main difference between mismatch repair (MMR) in eukaryotes and prokaryotes?
- A. Eukaryotes lack a functional Mut H and Dam methylase.
  - B. Eukaryotes have proteins homologous to MutS and MutH but not MutL.
  - C. Eukaryotes only repair the lagging strand.
  - D. Prokaryotic MMR can repair small loops of unpaired nucleotides, whereas eukaryotes cannot.
  - E. Both use exonucleases to eliminate the mismatched strand but eukaryotes only require 3'-5' exonucleases.

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26. Why does mismatch repair not lead to mutation upon repair of heteroduplex DNA?
- A. The incorrect base is recognized because it is methylated.
  - B. The strand containing the misincorporated base is methylated.
  - C. The strand containing the misincorporated base is not methylated.
  - D. The strand containing the misincorporated base is phosphorylated.
  - E. Actually, mismatch repair does lead to mutation about 50% of the time.
27. Why is transcription-coupled repair (TCR) considered particularly efficient when compared to nucleotide excision repair (NER)?
- A. The exonuclease employed in TCR removes a smaller fragment containing the damage.
  - B. TCR targets transcriptionally active regions for repair over damage in less active parts of the genome.
  - C. It uses error-prone polymerases so it can move through damaged areas faster.
  - D. It directly repairs the damage rather than removing and replacing the damaged strand.
  - E. TCR requires less protein interactions.
28. Which of the following eukaryotic recombination proteins is structurally and functionally similar to RecA?
- A. Spo11 B. RuvAB C. RuvC D. Dmc1
29. Which of the following is NOT a component of the mating-type switch mechanism?
- A. HO nuclease B. Rad51 C. Synthesis-dependent strand annealing (SDSA) D. RecA
30. Which one of the following factors significantly contributes to the ability of eukaryotic cells to complete DNA replication during the short window of time offered by S phase?
- A. The next round of replication begins before the cell exits S phase.
  - B. Eukaryotic DNA polymerases have dramatically increased processivity compared to DNA polymerases in organisms with smaller genomes.
  - C. Multiple origins of replication are activated per chromosome.
  - D. Origins of replication can initiate again after they have been replicated and before
31. Which of the following is NOT a step in non-homologous end joining?
- A. Phosphorylation of the Ku70-Ku80 complex
  - B. Degradation of any single-strand overhangs or hairpins from the broken ends of the chromosomes to be repaired
  - C. Binding of the Ku70-Ku80 complex to the broken chromosome ends
  - D. Binding of a kinase and a nuclease to the Ku70-Ku80 complex on the DNA
32. *Salmonella typhimurium* can change flagella proteins to evade immune response by host systems. What is this process called?
- A. Lysogeny B. Bacterial transduction C. Phase variation D. Transposition
33. Which of the following will NOT result from site-specific recombination?
- A. Inversion B. Deletion C. Insertion D. Translocation
34. P1 bacteriophage can be used as an experimental vehicle to move genes from one cell to another because occasionally large pieces of host DNA are accidentally packaged into phage heads. What is this process called?
- A. Lysogeny B. Bacterial transduction C. Phase variation D. Transposition

國立中山大學 110 學年度碩士暨碩士專班招生考試試題

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35. Which of the following mechanisms is used by retrotransposons?  
A. Cut-and-paste transposition                      B. Replicative transposition  
C. Transposition via an mRNA intermediate      D. Bacterial transduction
36. The processivity of a DNA polymerase depends on all of the following actions, EXCEPT for \_\_\_\_\_.  
A. interaction between the thumb domain of DNA polymerase and the DNA  
B. association of the DNA polymerase with a sliding clamp (like eukaryotic PCNA)  
C. interaction between the minor groove of DNA and the palm domain of the DNA polymerase  
D. loss of the hydrogen from the 3'-OH of the primer due to interaction with a divalent metal ion associated with the palm domain of the DNA polymerase
37. Which of the following statements correctly describes the role of telomerase in eukaryotic cells?  
A. It synthesizes the Okazaki fragment needed to prevent loss of genetic information at the 5' end of the chromosome.  
B. It synthesizes new DNA (using a RNA template) at the 3' end of the chromosome.  
C. It synthesizes new DNA (using a DNA template) at the 5' end of the chromosome.  
D. It synthesizes DNA on both the 5' and 3' ends of the chromosome.
38. Which of the following components are required for integration of bacteriophage  $\lambda$  genome into the host bacterial genome?  
A. attB, attP,  $\lambda$ Int, IHF  
B. attB, attP,  $\lambda$  Int, Xis  
C. attL, attR,  $\lambda$  Int, IHF  
D. attB, attP,  $\lambda$  Int
39. Upon the initial infection of a host cell by bacteriophage  $\lambda$ , the first two proteins produced from expression of the phage genome are:  
A. cI and cII   B. N and cI   C. N and Cro   D. Cro and cI
40. The *int/xis* encoded enzyme of bacteriophage  $\lambda$  is required to:  
A. excise the prophage from the host genome.  
B. degrade phage mRNA during lysogenic growth.  
C. bypass terminator structures downstream from the N and Cro genes.  
D. combine multiple DNA segments to make new genes.
41. Ribosomal proteins that can act as translational repressors:  
A. are not encoded by the same mRNA that they repress.  
B. bind to a site on the mRNA near the start site of one gene in the operon.  
C. bind to its mRNA with higher affinity than to the appropriate rRNA molecule.  
D. bind to the mRNA when sensing that levels of r-protein are low relative to rRNA.
42. How does the RecA protein contribute to the increased expression of SOS genes?  
A. RecA protein competes with LexA protein for binding to the operator sequences.  
B. RecA protein binds to LexA protein bound to the operator, directly lowering the affinity of LexA protein for DNA.  
C. RecA protein binds to free LexA protein, mediating the self-cleavage of the repressor.  
D. RecA protein binding to the promoter region recruits RNA polymerase.

# 國立中山大學 110 學年度碩士暨碩士專班招生考試試題

科目名稱：分子生物學【生科系碩士班乙組】

題號：421003

※本科目依簡章規定「不可以」使用計算機(選擇題)

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43. Which of the following is **NOT** a characteristic of a riboswitch?  
A. They are structures that exist in the 5' untranslated region of some mRNA molecules.  
B. They exert gene expression control only at the level of translation.  
C. They physically bind to small-molecule metabolites.  
D. Ligand-binding to the riboswitch can sequester the Shine-Delgarno sequence.
44. Which of the following is **NOT** true of the regulation of the arabinose operon?  
A. CRP activates expression when bound to cAMP.  
B. AraC protein recruits RNA polymerase when bound to arabinose.  
C. Arabinose binds to AraC protein, decreasing its affinity for a DNA site near the promoter.  
D. Arabinose binding alters the conformation of the dimerization domain of the AraC protein.
45. Catabolite repression of the lac operon restricts expression when:  
A. glucose is absent. B. lactose is absent. C. glucose is present. D. lactose is present.
46. The binding of \_\_\_\_\_ to the Lac repressor causes the protein to dissociate from the operator.  
A. lactose B. glucose C. fructose D. allolactose
47. Which of the following is **NOT** true of the imprinting of the mammalian gene for insulin growth factor-2 (IGF-2)?  
A. CTCF binds to the methylated *IGF2* gene insulator.  
B. *IGF2* gene is activated when the insulator is methylated.  
C. The maternally inherited copy of *IGF2* is normally repressed in egg cells.  
D. The insulator of both the paternal and maternal *IGF2* alleles lies between the promoter and the enhancer.
48. DNA microarrays have made a huge impact on genomic studies because they  
A. dramatically enhance the efficiency of restriction enzymes.  
B. can be used to introduce entire genomes into bacterial cells.  
C. allow the expression of many or even all of the genes in the genome to be compared at once.  
D. allow physical maps of the genome to be assembled in a very short time.
49. The upstream activator sequences (UASs) of yeast are analogous to \_\_\_\_\_ in higher eukaryotes.  
A. Promoters B. TATA boxes C. operators D. enhancers
50. The enzyme that cleaves the mRNA transcript targeted by siRNA is:  
A. Drosha. B. Dicer. C. Argonaut. D. RNase A.