

國立臺灣師範大學 101 學年度碩士班招生考試試題

科目：生物化學

適用系所：生命科學系

注意：1.本試題共 7 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

一、單選題(每題 2 分，共 80 分)

- Which of the following enzymes **does not** require DNA as templates?
 - Reverse transcriptase
 - DNA polymerase
 - RNA polymerase
 - Telomerase
 - Primase
- The statements regarding “reverse transcriptase polymerase chain reaction (RT-PCR)” are correct **except**:
 - RNAs are used as initial template
 - DNA polymerase is not required
 - DNA primers are required for the reaction
 - Can be used to synthesize cDNA
 - Can be used to quantify the relative expression levels of gene
- In analyzing a signaling pathway. Suppose:
 - loss-of A gene function gives repressed reporter gene expression.
 - loss-of B gene function gives constitutive reporter gene expression
 - A double mutation in A and B gives constitutive reporter expression.From the above results, we can conclude that
 - A activates B
 - B represses A
 - A acts up-stream of B
 - B acts up-stream of A
 - A and B do not act in the same pathway
- The following techniques can be used for studying protein-protein interaction except
 - Yeast two hybridization assay
 - GST-pull down assay
 - Co-Immunoprecipitation
 - Electro Mobility Shift Assay
 - Bimolecular fluorescence complementation
- E. coli* is cultured under the following conditions:
 - no lactose and high glucose
 - high lactose and high glucose
 - high lactose and no glucoseThe expression level of *lacZ* gene?
 - 1>2>3
 - 2>1>3
 - 3>1>2
 - 2>3>1
 - 3>2>1
- Gal4 protein is a transcription factor that activates the expression of the gal gene in yeast. Gal4 contains a DNA binding domain (BD) and an activation domain (AD). To activate the expression of the gal gene, BD binds to the the up-stream activation sequence (UAS) of the

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gal, and AD recruits co-activators to initiate the transcription of the gal gene. What will happen when BD of Gal4 is overexpressed in yeast cells?

- (A) The expression of the gal gene is decreased
- (B) The expression of the gal gene is increased
- (C) The expression of the Gal4 protein is increased
- (D) The association of BD and UAS is decreased
- (E) The association of BD and UAS is increased

7. Eukaryotic RNA polymerase III transcribes the following RNAs except:

- (A) microRNA
- (B) 5S rRNA
- (C) snRNA U6
- (D) RNA of signal recognition particle
- (E) tRNAs

8. The following protein domains can bind DNA except:

- (A) Helix-Turn-Helix
- (B) Ankyrin repeat domain
- (C) Zinc fingers
- (D) Homeodomain
- (E) Leucine zippers

9. Silencer is

- (A) a segment of DNA that interacts with RNA polymerases
- (B) a segment of DNA that confers repression of nearby genes
- (C) a protein that forms RNA induced silencer complex (RISC)
- (D) a protein that separates double strand siRNA
- (E) a protein that represses the expression of down-stream gene

10. Chromatin-remodeling is required in the following processes **except**:

- (A) Transcription control
- (B) DNA replication
- (C) RNA Splicing
- (D) DNA repair
- (E) DNA recombination

11. The following conditions can lead to transcriptional inactivation **except**:

- (A) Hypoacetylation of Histone
- (B) Hypermethylation of CpG islands
- (C) Methylation of Histone H3 at lysine 4
- (D) Tri-methylation of Histone H3 at lysine 9
- (E) Overexpression of Histone deacetylase

12. The following descriptions regarding the features of microRNA (miRNA) and short interfering RNA (siRNA) are correct **except**:

- (A) miRNAs and siRNAs are different in origin
- (B) Both miRNAs and siRNA can knock down the expression of genes
- (C) Both miRNAs and siRNA require Dicer for maturation
- (D) miRNA usually causes mRNA degradation and siRNA usually causes translational inhibition
- (E) Both miRNAs and siRNA form RNA-induced silencing complex (RISC) to target specific mRNAs

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13. A bacterial expression vector contains:
- (A) Ni²⁺
 - (B) UAS
 - (C) IPTG
 - (D) Promoter
 - (E) lacZ gene
14. When performing DNA Microarray experiments,
- (A) RNAs are spotted on a chip
 - (B) Restriction enzymes are used
 - (C) Antibodies are used
 - (D) Probes are labeled
 - (E) Samples are labeled
15. Which of the following statement regarding “morphogen” is **not correct**?
- (A) are signals that act in a graded fashion
 - (B) plays an important during animal development.
 - (C) A cell that receives more of a signal takes on one fate, a cell that receives less takes on a different fate.
 - (D) Some signals act in a relay fashion, in which a signal induces one cell to produce a different signal that instructs cells farther away from the original signal source.
 - (E) are all diffusible signal molecules
16. Which of the following statements regarding the “melting temperature (T_m) of DNA” are corrected **except**
- (A) is the temperature at which 50% of double stranded DNA dissociate into single strands
 - (B) Higher AT%, higher T_m
 - (C) is affected by the ionic strength of the solution
 - (D) is affected by the addition of organic solvent
 - (E) can be determined by spectrophotometer
17. At which site does the charged initiator tRNA bind during protein synthesis?
- (A) E site
 - (B) P site
 - (C) T site
 - (D) A site
 - (E) M site
18. Nitrous acid (HNO₂) is considered to be a mutagen because it usually induces
- (A) Depurination
 - (B) Deamination
 - (C) Tautomeric shifts
 - (D) Alkylation
 - (E) Pyrimidine dimer
19. Formation of nucleosomes requires the following Histions **except**:
- (A) Histone H1
 - (B) Histone H2A
 - (C) Histone H2B
 - (D) Histone H3
 - (E) Histone H4

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20. During DNA replication
- (A) Primase synthesizes RNA primers
 - (B) Okazaki fragments are formed at leading strand
 - (C) Leading strand DNA is synthesized first
 - (D) Helicase relaxes the tension of DNA
 - (E) Gyrase breaks the hydrogen bonds of base pairs
21. In which organelle that posttranscriptional modifications of eukaryote mRNAs are occurred?
- (A) Nucleus
 - (B) Cytoplasm
 - (C) Mitochondrion
 - (D) Lysosome
 - (E) Golgi
22. Which of the following codon and amino acid pair is required for the translation initiation of a prokaryotic gene?
- (A) AUG: Methionine
 - (B) GUA: Methionine
 - (C) UAG: Formylmethionine
 - (D) AUG: Formylmethionine
 - (E) UGA: Formylmethionine
23. Which of the following statements regarding nuclear receptor (NR) is **not correct**?
- (A) The response element (RE) of NR contains inverted or direct repeats
 - (B) The DNA binding domain of NR is C4 zinc finger
 - (C) Homodimeric NR binds inverted repeated RE
 - (D) Heterodimeric NRs are in cytoplasm when hormone is not presented
 - (E) Hormone-binding domain is located at the C-terminus of NRs
24. Which of the following statement regarding repeat DNA sequence is **not correct**?
- (A) can be found in the telomere
 - (B) is present as satellite DNA
 - (C) can be used for forensic DNA testing
 - (D) is highly complex
 - (E) can be found in the centromere
25. Which of the following statements regarding RNA editing is not correct?
- (A) Change of the nucleotide sequence of a pre-mRNA before translation
 - (B) It can cause substitution edition
 - (C) it can cause insertion/deletion editing
 - (D) it can cause alternative splicing
 - (E) it can result in the production of proteins with different function
26. 將 1 M acetic acid 與 1 M sodium acetate 依照下表配置出三種緩衝液。根據 Henderson-Hasselbalch 公式，pH 值大小何者正確？
- | | 1 M acetic acid | 1 M sodium acetate |
|----------|-----------------|--------------------|
| Buffer 1 | 10 mL | 100 mL |
| Buffer 2 | 50 mL | 50 mL |
| Buffer 3 | 100 mL | 10 mL |
- (A) buffer 1 > buffer 2 > buffer 3
 - (B) buffer 1 = buffer 2 = buffer 3
 - (C) buffer 1 < buffer 2 < buffer 3
 - (D) 以上皆非，因為 acetic acid 的 pKa 值仍未知。

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27. 構成蛋白質的 20 種胺基酸中，含有硫原子的胺基酸為：
- (A) cysteine and serine.
 - (B) cysteine and threonine.
 - (C) methionine and cysteine
 - (D) methionine and serine
 - (E) threonine and serine.
28. 分類為相同 families or superfamilies 的蛋白質，它們具有相近的：
- (A) evolutionary origin.
 - (B) physico-chemical properties.
 - (C) structure and/or function.
 - (D) subcellular location.
 - (E) subunit structure.
29. 下列何者對於蛋白質折疊(folding of proteins)過程沒有幫助？
- (A) Chaperonins
 - (B) Disulfide interchange
 - (C) Heat shock proteins
 - (D) Peptide bond hydrolysis
 - (E) Peptide bond isomerization
30. 肌紅素(Myosin) 的蛋白質結構主要是由何種結構所組成？
- (A) β structure.
 - (B) α helix.
 - (C) the Fab domain.
 - (D) the light chain.
 - (E) the meromyosin domain.
31. 藉由結合在酵素非催化中心部位，並能降低酵素活性的小分子稱為：
- (A) allosteric inhibitor.
 - (B) alternative inhibitor.
 - (C) competitive inhibitor.
 - (D) stereospecific agent.
 - (E) transition-state analog.
32. Lectins 的生物功能是源自於它特殊的生化特性，亦即它能結合何種分子？
- (A) amphipathic molecules.
 - (B) hydrophobic molecules.
 - (C) specific lipids.
 - (D) specific oligosaccharides.
 - (E) specific peptides or proteins.
33. 下列何種物質為固醇類(sterols)衍生物？
- (A) Arachidonic acid
 - (B) Gangliosides
 - (C) Phosphatidylglycerol
 - (D) Prostaglandins
 - (E) Vitamin D

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34. 下列何種物質水解時的自由能(free-energy, G'°)最大?
(A) 1,3-bis phosphoglycerate
(B) 3-phosphoglycerate
(C) ADP
(D) Phosphoenolpyruvate
(E) Thioesters (for example, acetyl-CoA)
35. 哺乳類肝臟細胞不能利用下列何種物質來進行糖質新生作用(gluconeogenesis)?
(A) alanine
(B) glutamate
(C) palmitate
(D) pyruvate
(E) α -ketoglutarate
36. 下列有關酵素活性的調控機制，何者為不可逆的調控?
(A) Activation by cleavage of an inactive zymogen.
(B) Allosteric response to a regulatory molecule.
(C) Alteration of the synthesis or degradation rate of an enzyme.
(D) Covalent modification of the enzyme.
(E) Interactions between catalytic and regulatory subunits.
37. 檸檬酸循環(citric acid cycle)中的反應，並未包括下列何種反應?
(A) formation of α -ketoglutarate.
(B) generation of NADH and FADH₂.
(C) metabolism of acetate to carbon dioxide and water.
(D) net synthesis of oxaloacetate from acetyl-CoA.
(E) oxidation of acetyl-CoA.
38. 會將脂肪酸轉變成 acetoacetate 的主要組織或器官是：
(A) adipose tissue.
(B) intestinal mucosa.
(C) kidney.
(D) liver.
(E) muscle.
39. ATP 水解反應為一自發反應(spontaneous reaction)，標準自由能差(G'°)是負值，然而 ATP 在水溶液中卻很穩定，不易發生水解的原因是？
(A) ATP 水解產生的磷酸 (phosphates) 中具有電子共振效應 (resonance stabilization)，很穩定
(B) ATP 水解反應具有高活化能 (activation energy)
(C) ATP 結構中具有電子共振效應 (resonance stabilization)
(D) ATP 水解反應需要吸收能量 (endergonic)
40. 萌芽中的植物種子細胞可以利用其儲存的脂質，最關鍵的代謝途徑是？
(A) Glyoxylate cycle
(B) β Oxidation
(C) Glycolysis
(D) Citric acid cycle

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二、簡答題(每一題 5 分，共 20 分)

目前已知許多神經退化性疾病是因為 polyglutamine (polyQ) proteins 發生遺傳變異所造成，以下的研究論文在探討一種 polyQ 疾病的致病機制及檢測方法。請詳閱以下論文摘要，並根據內容回答問題。(請注意！你的答案必須是來自摘要內容，其他任何自我心得或申論均不給分)

題目：Identifying polyglutamine protein species in situ that best predict neurodegeneration.

出處：Nature Chemical Biology 2011 Oct 30;7(12):925-34.

摘要：Polyglutamine (polyQ) stretches exceeding a threshold length confer a toxic function to proteins that contain them and cause at least nine neurological disorders. The basis for this toxicity threshold is unclear. Although polyQ expansions render proteins prone to aggregate into inclusion bodies, this may be a neuronal coping response to more toxic forms of polyQ. The exact structure of these more toxic forms is unknown. Here we show that the monoclonal antibody 3B5H10 recognizes a species of polyQ protein in situ that strongly predicts neuronal death. The epitope selectively appears among some of the many low-molecular-weight conformational states assumed by expanded polyQ and disappears in higher-molecular-weight aggregated forms, such as inclusion bodies. These results suggest that protein monomers and possibly small oligomers containing expanded polyQ stretches can adopt a conformation that is recognized by 3B5H10 and is toxic or closely related to a toxic species.

1. PolyQ proteins 發生何種遺傳變異時，會造成神經性疾病？
2. 變異的 polyQ 蛋白造成疾病的機制目前仍不清楚，但是就蛋白性質而言，它與正常的蛋白有甚麼明顯差異？
3. 作者利用何種方法來確認具有毒性的 polyQ protein？
4. 本實驗證明具有較強毒性的 polyQ proteins 的構型應該為何？