注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 115 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院
甲組(生物與醫學科學組)

科目代碼：0405

考試科目：細胞生物學

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 提早交卷者不可攜出試題，請將試題連同答案卷(卡)交予監考人員，攜出將以違規論處。當節考試結束後試題將置於講台，可自行取回，本試場不負保管責任。
7. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 115 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院甲組、丁組

考試科目（代碼）：細胞生物學(0405、0705)

I. Multiple Choice - Select the Single Best Answer (50%)

1. What is the diameter of microtubules?
   A) 15 nm
   B) 20 nm
   C) 25 nm
   D) 30 nm
   E) 35 nm

2. What is the smallest subunit of a microtubule?
   A) tubulin
   B) alpha-tubulin
   C) beta-tubulin
   D) alpha/beta-tubulin
   E) protofilament

3. What is the angle of a branched actin filament powered by Arp2/3?
   A) 45degrees
   B) 70degrees
   C) 90degrees
   D) 100degrees
   E) 120degrees

4. Which actin binding protein depolymerizes actin at the plus-end?
   A) Gelsolin
   B) Profilin
   C) ADF/Cofilin
   D) Myosin
   E) Formin

5. Which actin binding protein makes the tightest bundles such as in microvilli?
   A) Alpha-actinin
   B) Fimbrin
   C) Filamin
   D) Spectrin
   E) Formin

6. What is the smallest subunit of a muscle?
   A) Muscle fiber
   B) Muscle fibril
   C) Actin
   D) Myosin
   E) Sarcomere

7. Where do we find basal bodies?
   A) Stress Fiber
   B) Filopodia
   C) Microvilli
   D) Stereocilia
   E) Primary cilia

8. Which process needs GTP?
   A) Actin polymerization
   B) Tubulin polymerization
   C) Dynein movement
   D) Kinesin movement
   E) Myosin movement

9. Which drug stabilizes microtubules?
   A) Colchicine
   B) Nocodazole
   C) Latrunculin
   D) Taxol
   E) Phalloidin

10. In which cell type can we find keratin?
   A) Muscle cell
   B) Fibroblasts
   C) Hair cell
   D) Neurons
   E) Nuclear envelope

11. Where do we find troponin?
A) In thin filaments
B) In thick filaments
C) In microvilli
D) Bound to tubulin
E) Bound to desmin

12. What is the function of the sarcoplasmic reticulum?
A) It's a neuromuscular junction
B) It is to channel the action potentials in muscles
C) It's the membrane of myofibrils
D) It is to store calcium
E) It is to store ATP

13. In smooth muscle cells what is needed to activate myosin?
A) Nerve impulse or hormone signal
B) Calcium
C) Calmodulin
D) MLCK
E) All of above

14. In cell-cell adhesion what do integrins bind?
A) Glycoproteins
B) P-Selectin
C) E-Cadherin
D) N-CAM
E) ICAM

15. What is a primary physiological role of aquaporins in plant cells?
A) They facilitate the transport of glucose across the cell membrane.
B) They transport ions to help establish and maintain electrochemical gradients.
C) They enable the rapid movement of water molecules across the membrane, essential for maintaining turgor pressure.
D) They are involved in the synthesis of ATP through proton gradients.
E) They facilitate the passive diffusion of amino acids necessary for protein synthesis in the cytoplasm.

16. What antibodies are found in a person with blood type A?
A) Anti-A antibodies
B) Anti-B antibodies
C) Anti-A and Anti-B antibodies
D) No antibodies
E) All of above

17. Which of the following would yield the most highly mobile phospholipid (listed as number of carbons and number of double bonds, respectively)?
A) 24 carbons with one double bond
B) 15 carbons with two double bonds
C) 20 carbons with two double bonds
D) 16 carbons with no double bond
E) 20 carbons with one double bonds

18. What is the function of the cell surface's carbohydrate layer?
A) Energy storage
B) DNA replication
C) Protein transport
D) Cell-cell recognition
E) Nutrient absorption

19. Which of the following cellular responses does NOT normally occur as part of the unfolded protein response (UPR)?
A) Upregulation of ER chaperone proteins
B) Temporary inhibition of global protein synthesis
C) Expansion of the endoplasmic reticulum
D) Induction of apoptosis when ER stress is severe or prolonged
E) Increased transport of misfolded proteins to lysosomes

20. Which of the following molecules can diffuse rapidly across the lipid bilayer?
A) Glucose
B) K^+
C) O_2
D) Amino acids
E) Na^+

21. In a resting animal cell, what is the typical state of the K^+ leak channels?
A) Closed and unresponsive to external stimuli
B) Open, allowing K^+ to move down its concentration gradient
C) Active, transporting K^+ into the cell
D) Open, transporting K^+ against its concentration gradient
E) Inactivated, preventing K^+ movement

22. Where does glycosylation of proteins initially occur?
A) In the cytosol
B) In the Golgi apparatus
C) In the endoplasmic reticulum
D) In the plasma membrane
E) In the ribosomes

23. A drug that specifically inhibits voltage-gated calcium channels would most directly inhibit
A) depolarization of nerve cell membranes.
B) repolarization after depolarization of nerve cell membranes.
C) hyperpolarization of nerve cell membranes.
D) presynaptic neurotransmitter release.
E) postsynaptic receptor signal response.

24. What is the driving force for the secondary active transport mechanism?
A) Concentration gradients of ions like Na^+ or H^+
B) Hydrolysis of ATP
C) Light energy
D) Phosphorylation
E) Hydrolysis of glucose

25. Both excitatory and inhibitory neurons form junctions with muscles. By what mechanism do inhibitory neurotransmitters prevent the postsynaptic cell from firing an action potential?
A) By closing Na^+ channels
B) By preventing the secretion of excitatory neurotransmitters
C) By opening K^+ channels
D) By opening Cl^- channels
E) By blocking voltage-gated Ca^{2+} channels

II. Short-Answer Questions (50%)

1. Explain the cellular mechanism by which botulinum toxin A (Botox) acts to cause muscle paralysis (5%).

2. Collagen secreted by fibroblasts in connective tissue is a critical component of the extracellular matrix and is derived from procollagen. Please answer the following questions (10%):
   A) Identify one specific structural difference between collagen and procollagen.
   B) Indicate the location where procollagen is converted into collagen.
   C) Describe how this conversion occurs.

3. Insulin, which is secreted by pancreatic endocrine β-cells and plays a critical role in glucose metabolism, is derived from proinsulin. Please answer the following questions (10%):
   A) Identify one specific structural difference between insulin and proinsulin.
   B) Indicate the location where proinsulin is converted into insulin.
   C) Describe how this conversion occurs.

4. A scientist has been studying the three most abundant proteins found in *Fungus amungus* plasma membranes. He calls them proteins A, B, and C. When he treats the membranes with a high-salt solution, he no longer detects protein B in the membrane, even though controls show that his detection procedure is working properly. The salt treatment has no effect on proteins A and C. (10 %)
   A) Please briefly describe the three main classes of membrane proteins.
   B) What should the scientist conclude about protein B? Explain your answer.

5. Transverse diffusion (flip-flop) is very infrequent in artificial bilayers, yet can be observed readily in biological membranes. What is the explanation for this phenomenon? (3 %)

6. *Pseudomonas* toxin will transfer from the Golgi apparatus to the endoplasmic reticulum in mammalian cells. The C-terminal 24 amino acids of the B subunit of *Pseudomonas* toxin are shown below: (6 %)

   KEQAISALPD YASQPGKKPPR KDEL

   A) From inspection of these sequences, what is the most likely targeting receptor responsible for the transfer of *Pseudomonas* toxin from the Golgi apparatus to the endoplasmic reticulum?

B) What coat protein complex is most likely required for this transfer? Explain your answer.

7. A mutation in a Gαs protein was found to decrease its intrinsic GTPase activity (6 %).
   A) What is the downstream 2nd messenger of the Gαs protein?
   B) How would this mutation affect the cellular concentration of this 2nd messenger? Explain your answer.