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 114 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. 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 114 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)

 *請在【答案卷】作答

I. 單選題（每題 3 分，共 45 分）

1. Which organelle is primarily involved in the synthesis of lipids?
   A. Rough endoplasmic reticulum
   B. Smooth endoplasmic reticulum
   C. Golgi apparatus
   D. Lysosome
   E. Peroxisome
2. Which of the following organelles is directly involved in sorting and packaging proteins for secretion?
   A. Nucleus
   B. Golgi apparatus
   C. Endoplasmic reticulum
   D. Peroxisome
   E. Vacuole
3. Microfilaments are characterized by which of the following?
   A. Composed of tubulin dimers
   B. Involved in intracellular transport with dynein
   C. Provide tensile strength to cells
   D. Form the core of microvilli
   E. Major component of mitotic spindles
4. The primary structural feature of flagella includes:
   A. A 9+2 arrangement of microtubules
   B. Actin filament bundles
   C. Intermediate filaments linked by plectin
   D. Membrane-bound axonemes
   E. Protein scaffolds formed by spectrin
5. Integrins are involved in:
   A. Degrading the ECM during apoptosis
   B. Transmitting signals from the ECM to the cytoskeleton
   C. Synthesizing proteoglycans
   D. Vesicular transport across membranes
   E. Activating lysosomal pathways

6. During synaptic transmission, calcium influx triggers:
   A. Hyperpolarization of the postsynaptic cell
   B. Vesicle fusion and neurotransmitter release
   C. Activation of voltage-gated sodium channels
   D. Downregulation of synaptic plasticity
   E. Increased potassium efflux
7. Which of the following ions has the highest relative permeability and is the most important one in generating the resting membrane potential?
   A. Sodium ions
   B. Potassium ions
   C. Chloride ions
   D. Calcium ions
   E. All of the above
8. The wobble hypothesis explains how:
   A. mRNA is transcribed from the DNA template
   B. tRNA anticodons can recognize multiple codons for the same amino acid
   C. protein synthesis is terminated by stop codons
   D. aminoacyl-tRNA synthetases proofread the tRNA-amino acid linkage
   E. ribosomes align codons and anticodons during elongation
9. What is the main function of aminoacyl-tRNA synthetases?
   A. Bind the tRNA to the ribosome
   B. Catalyze the formation of peptide bonds
   C. Attach the correct amino acid to its corresponding tRNA
   D. Terminate translation at stop codons
   E. Proofread mRNA sequences during translation
10. A eukaryotic cell G2-M checkpoint assesses the status of
   A. DNA replication.
   B. chromosome attachment to kinetochore microtubules.
   C. nutrient abundance.
   D. mitotic cyclin degradation.
   E. the presence of growth factors.

11. In the cell cycle, controlled degradation of regulatory proteins occurs via the
A. P450-protease pathway.
B. Cyclin-Cdk pathway.
C. Ubiquitin-proteasome pathway.
D. Kinase inhibition pathway.
E. PI3K-Akt pathway.

12. Each of the following would **inhibit** cell progression through the cell cycle *except*
A. DNA damage during replication.
B. Kinase phosphorylation of mitotic Cdk.
C. APC activity during M phase.
D. Unphosphorylated Rb activity during G1.
E. TGFβ signaling.

13. Each of the following can contribute to proliferation of cancer cells *except*
A. Anchorage-independent growth.
B. Inhibition of apoptosis.
C. Density-dependent inhibition of growth.
D. Tumor-suppressor inactivation.
E. All can contribute to immortalization.

14. The promotion phase of carcinogenesis is enhanced by
A. Prolonged or repeated exposure to foreign or natural agents that stimulate cell proliferation.
B. Inactivation of Ras activity.
C. Natural selection of cells exhibiting enhanced growth rate and invasive properties.
D. A single exposure to a carcinogen.
E. A single base-pair change in genomic DNA.

15. Most hereditary forms of breast and ovarian cancer arise in women who inherit a mutant copy of either the *BRCA1* or *BRCA2* gene, each of which encodes a protein involved directly in
A. Inhibiting apoptosis.
B. Repairing DNA double-strand breaks.
C. Passing through the G1 restriction point.
D. A spindle assembly checkpoint.
E. Activating Rho proteins to increase cell motility.

II. **多選題（每題 3 分，共 30 分。答對一個選項得 0.6 分，答錯一個選項倒扣 0.6 分，直到該題 0 分）**

1. Which molecule diffuse most readily across the lipid bilayer?
   A. Glucose
   B. Steroids
   C. Oxygen
   D. Chloride ions
   E. Glycine
2. Which of the following are consequences of the sodium-potassium pump's activity?
   A. Maintains the resting membrane potential
   B. Creates an electrochemical gradient for secondary active transport
   C. Balances intracellular and extracellular sodium and potassium levels
   D. Requires ATP to function
   E. Directly transports glucose into the cell
3. Which organelle allow proteins to enter in their UNFOLDED state?
   A. Endoplasmic reticulum
   B. Nucleus
   C. Peroxisome
   D. Mitochondria
   E. Chloroplast
4. Which of the following lipids are enriched in lipid rafts?
   A. Triglycerides
   B. Cholesterol
   C. Phosphatidylinositol
   D. Sphingolipids
   E. Phosphatidylcholine
5. Which of the following biomolecules are synthesized by the endoplasmic reticulum?
   A. Proteins
   B. Lipids
   C. Nucleic acids
   D. Cholesterol
   E. Cellulose

6. Which amino acid residues are phosphorylated by the protein kinases?
   A. Serine
   B. Aspartate
   C. Cysteine
   D. Tyrosine
   E. Treonine
7. Which of the following descriptions of G-protein-coupled receptors (GPCRs) are CORRECT?
   A. GPCRs are α-helical transmembrane proteins.
   B. GPCRs have intrinsic GTPase activity.
   C. Activated GPCRs can activate 10-100 Gα proteins.
   D. Activated GPCRs increase GDP release from Gα
   E. GPCRs are desensitized by phosphorylation.
8. Which of the following receptors are receptor tyrosine kinases?
   A. Epinephrine receptor
   B. Epidermal growth factor receptor
   C. Fibroblast growth factor receptor
   D. Transforming growth factor-α receptor
   E. Transforming growth factor-β receptor
9. Which of the following organelles are part of the endomembrane system?
   A. The Golgi complex.
   B. The rough endoplasmic reticulum.
   C. The smooth endoplasmic reticulum.
   D. The endosome.
   E. The peroxisome.
10. Which of the following statements regarding coated vesicles are CORRECT?
   A. COPI coating mediates the transport of vesicles from the Golgi apparatus to the ER.
   B. COPII coating mediates the transport of vesicles from the ER to the Golgi apparatus.
   C. Clathrin-coated vesicles facilitate receptor-mediated endocytosis and the transport of proteins from the trans-Golgi network (TGN) to the endosomes.
   D. The coat protein is required for vesicle fusion with the membrane.
   E. Small GTPases direct coat assembly at the donor membrane.

III. 問答題（共 25 分）

1. A novel coronavirus, SARS-coronavirus 2 (SARS-CoV-2) is believed to be the etiologic agent of the outbreak of new coronavirus disease (COVID-19). To prevent the spreading and infection of coronavirus disease 2019 (COVID-19), it is encouraged to wash your hands with soap and water for 20 seconds. It is known that the envelope of the SARS-CoV-2 virus is composed of a lipid bilayer. Why washing your hands with soap can destroy the SARS-CoV-2 virus? (2%)

2. As a cell grows, its plasma membrane expands. Does this involve endocytosis or exocytosis? Explain. (4 %)

3. You are studying cells that normally respond to epidermal growth factor (EGF) by increasing their rate of cell division. You measure the cell division rate in the normal cells and the cells where a GTPase-activating protein (GAP) for Ras has been knocked down using small interfering RNA (siRNA). When the two types of cells are exposed to the same concentration of EGF, what differences in response to EGF do you expect? Explain your answer. (4 %)

4. Acetylcholine-gated cation channels do not discriminate between Na^+, K^+, and Ca^{2+} ions, allowing all to pass through them freely. So why is it that when acetylcholine binds to this protein in the plasma membrane of muscle cells, the channel opens and there is a large net influx of primarily Na^+ ions? (5%)

5. Ouabain is an African plant derivative that has been used historically to make poison-tipped hunting arrows. it disables the main Na^+/K^+ ATPase in neurons. How would the resting potential of neurons in an organism exposed to ouabain change relative to the normal solution? (5%)

6. The drug Taxol, extracted from the bark of yew trees, has an opposite effect to the drug chochicine, an alkaloid form autumn crocus. Taxol binds tightly to microtubules and stabilizes them when added to cells, it causes much of the free tubulin to assemble into microtubules. In contrast, chochicine prevents microtubule formation. Taxol is just as harmful to dividing cells as chochicine, and both are used as anticancer drugs. Based on your knowledge of microtubule dynamics, suggest why both drugs are toxic to dividing cells despite their opposite action. (5%)