

國立清華大學 101 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 甲組（分子生醫工程組）

考試科目（代碼）：普通生物學(2205)

*請依題序，順序在【答案卷】作答

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單選題: (20%; 2 points/question)

1. Which of the following organelles is the most numerous in a eukaryotic cell?
 - (A) mitochondria
 - (B) lysosomes
 - (C) ribosomes
 - (D) golgi bodies
 - (E) peroxisomes

2. What is the essential problem faced by DNA replication on the lagging strand?
 - (A) the DNA polymerase physically can't fit into the replication fork
 - (B) all the nucleoside triphosphates required for strand elongation are used up by the leading strand
 - (C) the template strand is opened up section by section, requiring the DNA polymerase to start all over again because it can move in only one direction
 - (D) the DNA polymerase can move in either direction but all the machinery from the leading strand gets in its way and prevents it from moving
 - (E) there is no way to join the Okazaki fragments together

3. What is the essential role of RNA primase in DNA replication?
 - (A) once the process is completed, it makes an RNA copy of the DNA
 - (B) the primase makes an RNA primer required to get the DNA polymerase enzyme started
 - (C) RNA primase travels down the length of the single stranded DNA molecule and makes a new strand of DNA using the old as a template
 - (D) It plays an essential role in repairing nicks in the recently copied strand
 - (E) It replaces the short pieces of RNA primer with DNA

4. Which of the following human cells would have the greatest total amount of DNA in it?
 - (A) a somatic cell in the G1 phase of the cell cycle
 - (B) a sperm cell
 - (C) a daughter cell resulting from mitosis
 - (D) a cell entering prometaphase of mitosis
 - (E) a daughter cell resulting from meiosis I

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5. During the cloning of an exotic gene in a bacterial plasmid, why is it useful for the plasmid to be carrying an antibiotic resistance gene?
- (A) to allow you to kill all the bacteria so you can recover just the plasmid
 - (B) it allows you to select for the growth of only the bacteria that contain the plasmid
 - (C) because the plasmid needs this gene to be able to survive in the cytoplasm of the bacterium
 - (D) because the antibiotic resistance gene directly protects the exotic gene from antibiotic which would normally mutate the gene
 - (E) antibiotic assists gene expression
6. A new strain of bacteria is collected from a hot spring area (95°C), where it grows very well. Based on the plasma membrane fluidity theory, you would expect to find a predominance of _____ in the bacterial membrane.
- (A) phospholipids with short hydrocarbon chains.
 - (B) charged fatty acids.
 - (C) phospholipids with unsaturated fatty acids.
 - (D) phospholipids with saturated fatty acids.
 - (E) degraded fatty acids.
7. Which of the following changes takes place when a skeletal muscle contracts?
- (A) Z disks move farther apart
 - (B) myosin filaments contract
 - (C) sarcomeres becomes shorter
 - (D) actin filament becomes shorter
 - (E) Z disks becomes shorter
8. During photosynthesis, carbon dioxide
- (A) is a process byproduct
 - (B) is a coenzyme of oxidation-reduction
 - (C) is reduced to glucose
 - (D) is not involved
 - (E) is converted to essential amino acids

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9. If evolution occurs, we would expect different biogeographical regions with similar environments to

- (A) all contain the same mix of plants and animals
- (B) each has its own specific mixes of plants and animals
- (C) have plants and animals with similar adaptations
- (D) have plants and animals with different adaptations
- (E) both (B) and (C) are correct

10. Crossing-over occurs between

- (A) sister chromatids of the same chromosome
- (B) duplicated centrosomes
- (C) two different kinds of chromosomes
- (D) nonsister chromatids of a bivalent
- (E) two daughter nuclei

Q&A:

1. (15%)

Certain human conditions result from changes in the DNA sequence. The following is a segment of the template strand of an open reading frame of a functional gene.

3'...GTTTCATCTAACCCCTGAGGAG...5'

- (A) Using the segment shown above, determine the sequence of the corresponding mRNA sequence. Indicate the 5' and 3' ends.
- (B) Using the table provided, determine the amino acid sequence of the polypeptide fragment.

		Second base					
		U	C	A	G		
U	UUU	Phe	UCU	UAU	Tyr	UGU	Cys
	UUC		UCC	UAC	Ser	UGC	
	UUA	Leu	UCA	UAA	Stop	UGA	Stop
	UUG		UCG	UAG	Stop	UGG	Trp
C	CUU		CCU	CAU	His	CGU	
	CUC	Leu	CCC	CAC	Pro	CGC	Arg
	CUA		CCA	CAA	Gln	CGA	
	CUG		CCG	CAG		CGG	
A	AUU		ACU	AAU	Asn	AGU	Ser
	AUC	Ile	ACC	AAC		AGC	
	AUA		ACA	AAA	Lys	AGA	Arg
	AUG	Met or start	ACG	AAG		AGG	
G	GUU		GCU	GAU	Asp	GGU	
	GUC	Val	GCC	GAC		GGC	Gly
	GUA		GCA	GAA	Glu	GGA	
	GUG		GCG	GAG		GGG	

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(C) The mutation results in the following sequence:

3'...GTTTCATCTAACCCCTGTGGAG...5'

Determine the change in the primary structure of the protein due to this mutation, and explain how this change may lead to a change in the function of the protein.

(D) Describe ONE common human genetic condition this is caused by this type of mutation, including the effect of the change in protein function on the health of the affected individual.

(E) Describe TWO techniques that can be used to identify the presence of this type of genetic change.

2. (5%)

How does changing electric charge on the two sides of a nerve cell plasma membrane during depolarization cause voltage-gated ion channel proteins to change shape?

3. (10%)

(A) Differentiate between *exocytosis* and *endocytosis*.

(B) Describe how the plasma membrane breaks and reforms during exocytosis and endocytosis. How does the fluidity of the membrane allow this?

4. (10%)

Thyroid stimulating hormone (TSH) causes the release of thyroid hormone (TH) from thyroid gland cells. Starting with contact between a molecule of TSH and a thyroid gland cell, describe the steps that happen inside the cell that result in TH being released from the cell. If you are not sure of a particular mechanism you may describe one you are familiar with that *could* work to help produce the hormone product.

5. (5%)

Describe how X-ray irradiation affects the cell cycle.

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6.

(A) (4%) Define osmosis and its relationship with cell membranes in a biological system.

(B) (6%) It is known that 150 mM NaCl solution is an isotonic solution for mammalian cells. What happens to the mammalian cells if they were placed into: (1) pure water (2) 150 mM NaCl or (3) 2 M NaCl solutions?

7. Osamu Shimomura, Martin Chalfie and Roger Y. Tsien shared the Nobel Prize (2008) for their discovery on green fluorescence protein (GFP).

(A) (6%) Explain how GFP might be used to study: (1) gene expression and (2) cell tracking.

(B) (4%) Fluorescence microscope can be used to monitor various fluorescent probes such as fluorescein isothiocyanate (FITC) and GFP. Regarding its applications, explain the following terms: (1) excitation wavelength / emission wavelength and (2) photobleaching.

(C) (5%) Flow cytometry is often used to determine the percentage of GFP-expressed cells. Explain how it works.

8.

(A) (5%) Explain the differences between heterotrophs, chemoautotrophs and photoautotrophs.

(B) (2%) Photoautotrophs capture the energy of sunlight by means of the pigment : _____ , found in chloroplasts.

(C) (3%) Identify each of the following examples as photoautotrophs, aerobic chemoautotrophs or anaerobic chemoautotrophs.

a. A human eats a piece of beef steak.

b. Bacteria grow in an unopened can of cooked fish.

c. Cyanobacteria are growing in a lake.