

問答題：

1. Please explain how the photon energy can be absorbed and converted into chemical energy during light reaction of photosynthesis. (8 points)
2. In plant, the water potential determines the water flow direction of guard cells and affects the stomatal closure. Plant growth regulator, abscisic acid (ABA), plays a key role that affects the water potential of guard cells and stomatal closure. Please explain how ABA affects the water potential of guard cells and stomatal closure under drought stress. (7 points)
3. (10 points)
 - (a) Please explain photoperiod, long-day plant, short day plant and day-neutral plant.
 - (b) The continuous long night generally is important and affects floral transition of long-day plant and short-day plant. In continuous long night, a flash of white light, red light, or far-red light may cause significant and different influence on floral transition of long-day and short-day plants. Please predict the effects (promotion or inhibition) of the flash of white, red, or far-red light on floral transition of long-day plant and short-day plant, respectively.
4. Compare and contrast the characteristics of gene expression in prokaryotic and eukaryotic cells in term of the factors (cis or trans) involved, location and regulatory mechanism. (15 points)
5. Bicycle riding has become a very popular activity in recent years. Being a person jumping on the band wagon, you also take on the bicycle riding activity. In one hot and sunny summer morning you joined your group of friends for a bicycle ride. While waiting for the group member to arrive, someone challenged you for a 500-meter dashing strip race on the bicycle. After several rounds of strip racing, you finally took off on the long ride with your group of fair-weather friends.
 - (A) When you did the strip racing, a certain group of skeletal muscle fibers with specific metabolic and contraction characteristics were called up for this activity. What kind of metabolic and contraction features do they have? What about those muscle fibers that are less involved in the dashing race? What kind of metabolic and contraction features do they have? (8 points)

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- (B) After riding with your group for 90 minutes under the hot sun, you became very sweaty and thirsty. The group leader decided to take a break in front of a 7-Eleven. You went in the store and bought a liter-size beer to drink. One of the group members, a physician in sports medicine, strongly suggested that you do not drink that beer. Based on your knowledge in physiology, please explain his concern in details. (8 points)
- (C) Feeling arrogant and invincible, thinking that bad things will never happen to you, you ignored the physician's suggestion and finished that liter-size beer. Your group started riding again soon after. Thirty minutes later, you got the muscle cramp in both of your legs, then you blacked out, falling off your bike, and urinated yourself copiously. Luckily you did not hit your head on the way down. Please explain why you blacked out. Please give an explanation for your muscle cramp, and your copious urination. Were they related to your black out? If yes, why? If not, why not? (9 points)

解釋名詞

1. 此部份每小題 3 分共計 15 分
 - (a) Endosymbiosis
 - (b) Cambrian explosion
 - (c) Biological species concept (BSC)
 - (d) Mutualism
 - (e) Global warming

2. 此部份每小題 2 分共計 10 分
 - (f) microRNA
 - (g) totipotent stem cell
 - (h) Proteomics
 - (i) genomic imprinting
 - (j) telomerase

繪圖題：

1. 請繪圖比較無體腔、假體腔與真體腔動物的差異 (10 分)

單選題 (60分, 每題 1.5分)

- Which of the following refers to particularly stable arrangements of amino acid residues in a protein that give rise to recurring patterns?
 - primary structure
 - secondary structure
 - tertiary structure
 - quaternary structure
- In a mixture of the five proteins listed below, which should elute second in size-exclusion (gel-filtration) chromatography?

A) cytochrome <i>c</i>	$M_r = 13,000$
B) immunoglobulin G	$M_r = 145,000$
C) ribonuclease A	$M_r = 13,700$
D) serum albumin	$M_r = 68,500$
- By adding SDS (sodium dodecyl sulfate) during the electrophoresis of proteins, it is possible to:
 - determine a protein's isoelectric point.
 - determine the amino acid composition of the protein.
 - preserve a protein's native structure and biological activity.
 - separate proteins exclusively on the basis of molecular weight.
- The functional differences, as well as differences in three-dimensional structures, between two different enzymes from *E. coli* result directly from their different:
 - amino acid sequences.
 - roles in DNA metabolism.
 - roles in the metabolism of *E. coli*.
 - secondary structures.
- In an α -helix, the R groups on the amino acid residues:
 - are found on the outside of the helix spiral.
 - cause only right-handed helices to form.
 - generate the hydrogen bonds that form the helix.
 - stack within the interior of the helix.
- Amino acid residues commonly found in the middle of β turn are:
 - Ala and Gly.
 - hydrophobic.
 - Pro and Gly.
 - those with ionized R-groups.

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7. Determining the precise spacing of atoms within a large protein is possible only through the use of:
 - A) electron microscopy.
 - B) light microscopy.
 - C) molecular model building.
 - D) x-ray diffraction.

8. Which one of the following is not among the six internationally accepted classes of enzymes?
 - A) Hydrolases
 - B) Oxidoreductases
 - C) Polymerases
 - D) Transferases

9. Enzymes are potent catalysts because they:
 - A) are consumed in the reactions they catalyze.
 - B) drive reactions to completion while other catalysts drive reactions to equilibrium.
 - C) increase the equilibrium constants for the reactions they catalyze.
 - D) lower the activation energy for the reactions they catalyze.

10. The steady state assumption, as applied to enzyme kinetics, implies:
 - A) the enzyme is regulated.
 - B) the ES complex is formed and broken down at equivalent rates.
 - C) the K_m is equivalent to the cellular substrate concentration.
 - D) the maximum velocity occurs when the enzyme is saturated.

11. The Lineweaver-Burk plot is used to:
 - A) determine the equilibrium constant for an enzymatic reaction.
 - B) illustrate the effect of temperature on an enzymatic reaction.
 - C) solve, graphically, for the rate of an enzymatic reaction at infinite substrate concentration.
 - D) solve, graphically, for the ratio of products to reactants for any starting substrate concentration.

12. Allosteric enzymes:
 - A) are regulated primarily by covalent modification.
 - B) usually have more than one polypeptide chain.
 - C) usually have only one active site.
 - D) usually show strict Michaelis-Menten kinetics.

13. How is trypsinogen converted to trypsin?
 - A) A protein kinase-catalyzed phosphorylation converts trypsinogen to trypsin.
 - B) An increase in Ca^{2+} concentration promotes the conversion.
 - C) Proteolysis of trypsinogen forms trypsin.
 - D) Trypsinogen dimers bind an allosteric modulator, cAMP, causing dissociation into active trypsin monomers.

14. Which of the following is *not* a reducing sugar?
- A) Fructose
 - B) Glucose
 - C) Ribose
 - D) Sucrose
15. In glycoproteins, the carbohydrate moiety is always attached through the amino acid residues:
- A) asparagine, serine, or threonine.
 - B) aspartate or glutamate.
 - C) glutamine or arginine.
 - D) glycine, alanine, or aspartate.
16. The difference between a ribonucleotide and a deoxyribonucleotide is:
- A) a deoxyribonucleotide has an -H instead of an -OH at C-2.
 - B) a deoxyribonucleotide has α configuration; ribonucleotide has the β configuration at C-1.
 - C) a ribonucleotide has an extra -OH at C-4.
 - D) a ribonucleotide has more structural flexibility than deoxyribonucleotide.
17. The DNA oligonucleotide abbreviated pATCGAC:
- A) has 7 phosphate groups.
 - B) has a hydroxyl at its 3' end.
 - C) has a phosphate on its 3' end.
 - D) has an A at its 3' end.
18. The nucleic acid bases:
- A) absorb ultraviolet light maximally at 280 nm.
 - B) are all about the same size.
 - C) are relatively hydrophilic.
 - D) are roughly planar.
19. Chargaff's rules state that in typical DNA:
- A) $A = G$.
 - B) $A = C$.
 - C) $A + T = G + C$.
 - D) $A + G = T + C$.
20. In double-stranded DNA:
- A) only a right-handed helix is possible.
 - B) sequences rich in A-T base pairs are denatured less readily than those rich in G-C pairs.
 - C) the sequence of bases has no effect on the overall structure.
 - D) the two strands have complementary sequences.

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21. Which of the following deoxyoligonucleotides will hybridize with a DNA containing the sequence 5'-AGACTGGTC-3'?
- A) 5'-CTCATTGAG-3'
 - B) 5'-GACCAGTCT-3'
 - C) 5'-GAGTCAACT-3'
 - D) 5'-TCTGACCAG-3'
22. Which of the following is *not* true of sterols?
- A) Cholesterol is a sterol that is commonly found in mammals.
 - B) They are commonly found in bacterial membranes.
 - C) They are precursors of steroid hormones.
 - D) They have a structure that includes four fused rings.
23. An integral membrane protein can be extracted with:
- A) a buffer of alkaline or acid pH.
 - B) a chelating agent that removes divalent cations.
 - C) a solution containing detergent.
 - D) a solution of high ionic strength.
24. Facilitated diffusion through a biological membrane is:
- A) driven by a difference of solute concentration.
 - B) driven by ATP.
 - C) endergonic.
 - D) not specific with respect to the substrate
25. The anaerobic conversion of 1 mol of glucose to 2 mol of lactate by fermentation is accompanied by a net gain of:
- A) 1 mol of ATP.
 - B) 1 mol of NADH.
 - C) 2 mol of ATP.
 - D) 2 mol of NADH.
26. Which of these cofactors participates directly in most of the oxidation-reduction reactions in the fermentation of glucose to lactate?
- A) ADP
 - B) ATP
 - C) FAD/FADH₂
 - D) NAD⁺/NADH
27. The main function of the pentose phosphate pathway is to:
- A) give the cell an alternative pathway should glycolysis fail.
 - B) supply energy.
 - C) supply NADH.
 - D) supply pentoses and NADPH.

28. Glycogen is converted to monosaccharide units by:
- A) glucose-6-phosphatase
 - B) glycogen phosphorylase.
 - C) glycogen synthase.
 - D) glycogenase.
29. If an aerobic organism (e.g., the bacterium *E. coli*) were fed each of the following four compounds as a source of energy, the energy yield per mole from these molecules would be in the order:
- A) glucose > alanine > palmitate (16:0)
 - B) glucose > palmitate > alanine
 - C) palmitate > alanine > glucose
 - D) palmitate > glucose > alanine
30. Almost all of the oxygen (O_2) one consumes in breathing is converted to:
- A) acetyl-CoA.
 - B) carbon dioxide (CO_2).
 - C) carbon monoxide and then to carbon dioxide.
 - D) water.
31. Uncoupling of mitochondrial oxidative phosphorylation:
- A) allows continued mitochondrial ATP formation, but halts O_2 consumption.
 - B) halts all mitochondrial metabolism.
 - C) halts mitochondrial ATP formation, but allows continued O_2 consumption.
 - D) slows down the citric acid cycle.
32. During oxidative phosphorylation, the proton motive force that is generated by electron transport is used to:
- A) create a pore in the inner mitochondrial membrane.
 - B) generate the substrates (ADP and P_i) for the ATP synthase.
 - C) induce a conformational change in the ATP synthase.
 - D) oxidize NADH to NAD^+ .
33. The relative concentrations of ATP and ADP control the cellular rates of:
- A) glycolysis.
 - B) oxidative phosphorylation.
 - C) the citric acid cycle.
 - D) all of the above.
34. Which of these can be synthesized by plants but *not* by humans?
- A) Linoleate (18:2, $\Delta^{9,12}$)
 - B) Palmitate (16:0)
 - C) Pyruvate
 - D) Stearate (18:0)

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35. Which of these statements about the regulation of cholesterol synthesis is *not* true?
- A) Cholesterol acquired in the diet has essentially no effect on the synthesis of cholesterol in the liver.
 - B) Failure to regulate cholesterol synthesis predisposes humans to atherosclerosis.
 - C) High intracellular cholesterol stimulates formation of cholesterol esters.
 - D) Some metabolite or derivative of cholesterol inhibits HMG-CoA reductase.
36. Nonessential amino acids:
- A) are amino acids other than those required for protein synthesis.
 - B) are synthesized by plants and bacteria, but not by humans.
 - C) can be synthesized in humans as well as in bacteria.
 - D) may be substituted with other amino acids in proteins.
37. Glutathione is a(n):
- A) enzyme essential in the synthesis of glutamate.
 - B) methyl-group donor in many biosynthetic pathways.
 - C) product of glutamate and methionine.
 - D) tripeptide of glycine, glutamate, and cysteine.
38. An intermediate of purine degradation in humans is:
- A) NH_4^+ .
 - B) succinate.
 - C) urea.
 - D) uric acid.
39. When blood glucose is abnormally low, the pancreas releases:
- A) epinephrine.
 - B) glucagon.
 - C) glucose.
 - D) insulin.
40. The largest energy store in a well-nourished human is:
- A) ATP in all tissues.
 - B) liver glycogen.
 - C) muscle glycogen.
 - D) triacylglycerols in adipose tissue.

解釋名詞 (40 分, 每題 4 分)

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|---------------------------|------------------------------|
| 1. Dideoxy method | 6. Oxidative phosphorylation |
| 2. Aquaporin | 7. Phenylketonuria (PKU) |
| 3. Eicosanoid | 8. Competitive inhibitor |
| 4. Gluconeogenesis | 9. Fluid mosaic model |
| 5. Isoelectric point (pI) | 10. Ribozyme |