

國立清華大學 111 學年度學士後醫學系單獨招生試題

考試科目：生物與生化

[單選題]每題 2.5 分，共計 150 分。答錯一題倒扣 0.625 分，未作答，不給分亦不扣分。

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1. Which of the following descriptions about brown algae is **NOT** correct?
 - (A) They are the smallest and least complex algae.
 - (B) They are multicellular and mostly marine.
 - (C) They contain chlorophylls and carotenoids in their plastids for photosynthesis
 - (D) Some species, such as Japanese “kombu”, are eaten as human food.
 - (E) Their cell walls contain gel-forming polysaccharides called algin.

2. Which of the following descriptions about fungi is **NOT** correct?
 - (A) They are a group of eukaryotic organisms that includes yeasts, molds, and mushrooms.
 - (B) They are incapable of photosynthesis.
 - (C) Fungal membranes contain a unique steroid called ergosterol, which is a drug target of athlete’s foot treatment.
 - (D) Mycorrhizal fungi form symbiotic relationships only with legumes.
 - (E) Fungal cell walls are made of chitin.

3. Which of the following descriptions about methicillin-resistant *Staphylococcus aureus* (MRSA) is **NOT** correct?
 - (A) *Staphylococcus aureus* is a type of bacteria found on healthy people’s skin
 - (B) *Staphylococcus aureus* causes lung infection and other infection
 - (C) People with MRSA skin infections often can get swelling, warmth, redness, and pain in infected skin.
 - (D) MRSA strains are resistant to all aminoglycosides including kanamycin and gentamicin.
 - (E) The resistance of MRSA strains is caused by the acquisition of the *mecA* gene implicated in the biosynthesis of bacterial cell wall.

4. Which of the following descriptions about Crassulacean acid metabolism (CAM) is **NOT** correct?
 - (A) The benefit of CAM to the plant is the ability to leave most leaf stomata closed during the day.
 - (B) During the night, CAM plants allow CO₂ to enter and be fixed as organic acids.
 - (C) During the day, the stomata of CAM plants close to conserve water, and the organic acids stored in the vacuoles of bundle sheath cells are released.

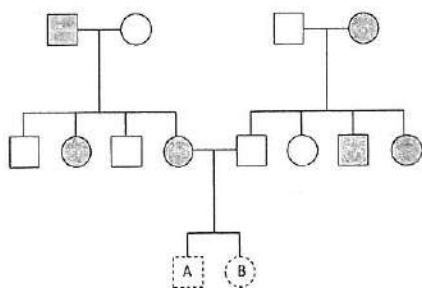
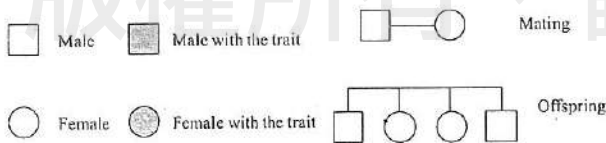
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- (D) Pineapple is the economically valuable crop possessing CAM.
 (E) Cactus utilize the CAM as an adaptation for arid conditions.
5. Which of the following plant pigments mostly absorb red and far-red light to regulate plant responses, including seed germination and shade avoidance?
 (A) Phytochrome
 (B) Phototropin
 (C) Cryptochrome
 (D) ZEITLUPE
 (E) UVR8
6. During the development, the ectoderm eventually gives rise to?
 (A) Nervous system
 (B) Muscle
 (C) Lungs
 (D) Connective tissue
 (E) Digestive tube
7. Which of the following is not a feature of insects?
 (A) Book lung
 (B) Malpighian tubules
 (C) Open circulatory system
 (D) Tracheal system
 (E) Exoskeleton

8. This is a genealogy that has a common genetic trait. Given that one gene pair is involved, what is the inheritance pattern?



- (A) Autosomal dominant
 (B) Sex-linked dominant

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- (C) Autosomal recessive
 (D) Sex-linked recessive
 (E) The probability that individual A has the trait is 25%
9. The coat color phenotype of Labrador Retriever mainly has three main colors: black, chocolate and yellow, which are affected by the genes of the unlinked B (black) and E (pigment distribution) loci. What kinds of offspring would you expect from the cross of a black female (BbEe) and a yellow male (Bbee)?
 (A) Black, BBEe: 1/8
 (B) Yellow, BBee: 1/4
 (C) Chocolate, bbEe: 1/16
 (D) Yellow, Bbee: 1/8
 (E) Black, BbEe: 1/8
10. Which of the following should be consistent among identical twins?
 (A) The set of T cell antigen receptors produced.
 (B) The set of major histocompatibility (MHC) molecules produced.
 (C) The susceptibility to a particular virus.
 (D) The set of antibodies produced.
 (E) Epigenetic modifications.
11. About Down syndrome, which of the following statements is **NOT** correct?
 (A) Down syndrome is usually the result of an extra chromosome 21, which means that each body cell has 47 chromosomes.
 (B) The frequency of Down syndrome increases with the mother's age.
 (C) This is mainly caused by nondisjunction during meiosis I, but not meiosis II.
 (D) Chromosomal mutation can be easily studied by analysis of Karyotypes.
 (E) Recent data suggest that by age 35, nearly 100% of people with Down syndrome develop Alzheimer syndrome.
12. Which of following is not a mechanism altering allele frequencies over time to cause evolutionary change?
 (A) Random mating.
 (B) Genetic drift.
 (C) Natural selection.
 (D) Gene flow.
 (E) All above cause evolutionary change.
13. Xeroderma pigmentosum (XP) is a rare clinical disease associated with sun sensitivity and a high risk for skin malignancy in sun-exposed areas. Which of the

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- following defective DNA repair systems may be involved?
- (A) Nucleotide excision repair, NER
 - (B) Mismatch excision repair, MMR
 - (C) Base excision repair, BER
 - (D) Non-homologous end joining, NHEJ
 - (E) Double-strand breaks repair, DSB
14. Half of the Nobel Prize in Physiology or Medicine 2021 was awarded to the discovery of *piezo1 and 2*, which are responsible for the
- (A) Olfaction
 - (B) Vision
 - (C) Hearing
 - (D) Touch
 - (E) Taste
15. At neuromuscular junction, the receptor on the muscle to receive the signal from the presynaptic neuron is a
- (A) Voltage-gated channel
 - (B) ligand-gated channel for acetylcholine
 - (C) ligand-gated channel for epinephrine
 - (D) metabotropic receptors for acetylcholine
 - (E) metabotropic receptors for epinephrine
16. Which of the following one about oligodendrocytes is true?
- (A) One type of glia cell in the periphery nervous system
 - (B) Wrapping dendrites to form myelin sheaths
 - (C) Decrease the speed of electronic conduction
 - (D) Only in mammalian system
 - (E) None of above
17. Parkinson's disease is characterized by a range of motor symptoms and mainly caused by
- (A) the loss of dopamine-producing nerve cells.
 - (B) the degeneration of the upper motor and lower motor neurons.
 - (C) rapid and uncoordinated electrical firing in the brain.
 - (D) autoimmune disease producing antibodies to the acetylcholine receptors on skeletal muscle fibers.
 - (E) imbalances of autonomic nervous system

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18. Circadian rhythms are coordinated by suprachiasmatic nucleus in the
- (A) Hippocampus
 - (B) Hypothalamus
 - (C) Amygdala
 - (D) Cerebellum
 - (E) Cerebral cortex
19. Which of the following hormone increases during the luteal phase of the ovarian cycle?
- (A) Androgens
 - (B) Follicle-stimulating hormone
 - (C) Luteinizing hormone
 - (D) Estrogens
 - (E) Progesterone
20. Which body response is correct under dehydration?
- (A) The hypothalamus produces atrial natriuretic peptide to induce aquaporin
 - (B) Juxtaglomerular apparatus releases the enzyme renin to degrade angiotensin II
 - (C) Aldosterone increase reabsorption of K^+ and water in the distal tubules and collecting tube
 - (D) Low blood pressure stimulates parasympathetic system to decrease heart rate and cardiac contraction
 - (E) None of above
21. Which of the following is a strategy for bony fish in sea water to regulate osmolarity?
- (A) Drinking sea water
 - (B) High concentrations of urea and trimethylamine oxide (TMAO) in body fluids
 - (C) Uptake ions by gill
 - (D) Excretion of large amounts of water in urine
 - (E) All of above
22. The primary function of the descending limb of the loop of Henle is
- (A) Filtration of ions
 - (B) Reabsorption of water
 - (C) Secretion of ions
 - (D) Excretion of water

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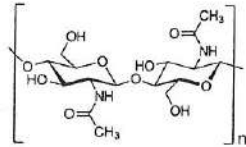
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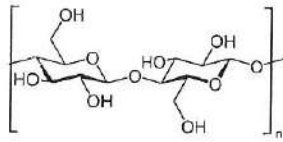
(E) Excretion of ions

23. Which of the following structures is stored primarily in the cells of the liver and skeletal muscle?

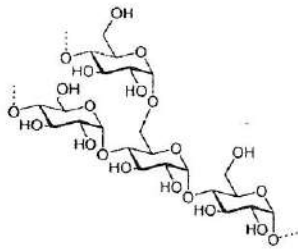
(A)



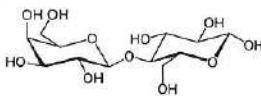
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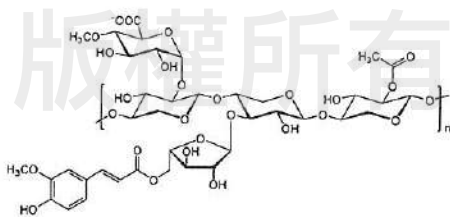
(C)



(D)



(E)



24. At a later stage of this immune response, the change in B cell production from one antibody class to another antibody class that responds to the same antigen is due to _____.

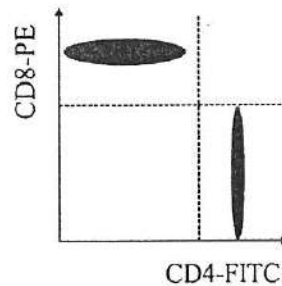
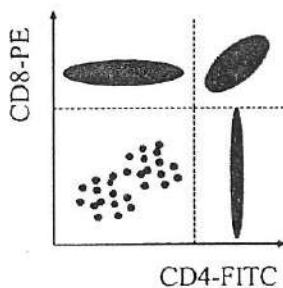
- (A) the rearrangement of V region genes in that clone of responsive B cells.
- (B) a switch in the kind of antigen-presenting cell involved in the immune response.
- (C) allows responsive B cells to repeat somatic recombination of light chain gene segments.

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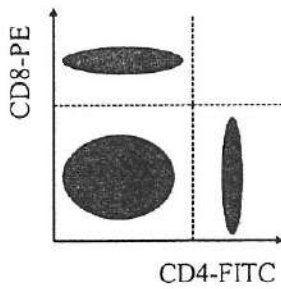
- (D) a patient's reaction to the first kind of antibody made by the plasma cells.
 (E) the rearrangement of immunoglobulin heavy-chain C region DNA.
25. Adenosine deaminase (ADA) deficiency is an inherited disorder that damages the immune system and causes severe combined immunodeficiency (SCID). All of the following steps were performed for gene therapy when a patient with defective ADA was treated. **Except?**
- (A) Human leukocyte antigen (HLA) testing should be performed before gene therapy.
 (B) Haematopoietic stem cells were collected from the patient's bone marrow.
 (C) CD34 positive cells were transduced with a viral vector expressing functional ADA.
 (D) The transfected cells were grown in culture to ensure ADA gene is active.
 (E) The transfected cells are reinfused into the same patient.
26. Which of the following core technical principles is **NOT** involved in RNA vaccine technology?
- (A) N1-Methylpseudouridine
 (B) Aluminum-containing adjuvants
 (C) Lipid Nanoparticle (LNP) platform
 (D) In vitro transcription
 (E) Target DNA sequence design
27. CD4 and CD8 are molecules present on the surface of T cells where they interact with major histocompatibility (MHC) molecules. Which of the staining pattern of lymphocytes in different lymphoid organs by FITC-anti-CD4 and PE-anti-CD8 antibodies is correct?
- (A) Thymus
 (B) Spleen



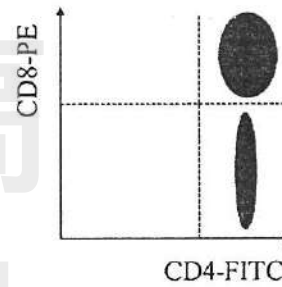
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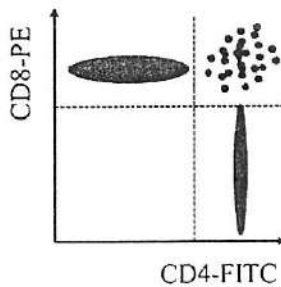
(C) Bone marrow



(D) Tonsil



(E) Lymph node



28. Alpha-D-glucose undergoes conversion to beta-D-glucose in solution. If at 300K there is 70% conversion, what is the ΔG (J/mole) for the reaction?

ln1	= 0.00
ln2	= 0.69
ln3	= 1.10
ln4	= 1.39
ln5	= 1.61
ln6	= 1.79
ln7	= 1.95
ln8	= 2.08
ln9	= 2.20

- (A) 2120
- (B) 2369
- (C) 2743
- (D) 4864
- (E) 5487

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29. Which of the following statements about peptidoglycan is **incorrect**?
- (A) It is the main component of bacterial cell wall, which helps bacteria maintain a certain shape and resist hypotonic environments.
- (B) The polysaccharide chain of peptidoglycan is a $\beta(1-4)$ linked copolymer of N-acetylglucosamine and N-acetylmuramic acid.
- (C) The polysaccharide chains of peptidoglycan are cross-linked together through tetrapeptides.
- (D) One end of the tetrapeptide chain links to a N-acetylglucosamine in the polysaccharide chain at the C-2 position.
- (E) In many Gram negative bacteria, two adjacent tetrapeptide chains are joined directly between the ϵ -amino group of lysine in one chain and the carboxyl group of D-alanine in the other.
30. For the same mass of glycogen, amylose, amylopectin, and cellulose, rank the initial rate of hydrolysis of these polysaccharides by alpha-1,4-glucosidase.
- (A) cellulose > amylopectin > glycogen > amylose
- (B) glycogen > amylose > cellulose > amylopectin
- (C) amylose > cellulose > amylopectin > glycogen
- (D) amylopectin > glycogen > amylose > cellulose
- (E) glycogen > amylopectin > amylose > cellulose
31. The K_m and V_{max} of hexokinase I for glucose are $100 \mu\text{M}$ and $30 \mu\text{M}/\text{min}$ and the K_m and V_{max} of hexokinase II for glucose are 10mM and $50 \mu\text{M}/\text{min}$, respectively. Which of the following descriptions about the kinetics of the two enzymes is most likely to be **correct**?
- (A) If the glucose concentration is $50 \mu\text{M}$, the reaction velocity of hexokinase I will be $\sim 20 \mu\text{M}/\text{min}$.
- (B) If the glucose concentration is $50 \mu\text{M}$, the reaction velocity of hexokinase I will be $\sim 25 \mu\text{M}/\text{min}$.
- (C) If the glucose concentration is 1.0mM , the reaction velocity of hexokinase II will be $\sim 30 \mu\text{M}/\text{min}$.
- (D) If the glucose concentration is 30mM , the reaction velocity of hexokinase II may reach $50 \mu\text{M}/\text{min}$.
- (E) Compared to hexokinase II, hexokinase I is more efficient when the glucose concentration is higher than 10mM .

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32. Which of the following statements about fibrous proteins is **incorrect**?
- (A) Fibrous proteins usually have good mechanical strength and play a structural role in living organisms.
 - (B) The central rod domain of α -keratin is an α -helix structure flanked by non-helical N- and C- terminal domains.
 - (C) Pairs of right-handed α -helices of α -keratin wrap around each other to form a left-twisted coiled coil.
 - (D) Collagen is an extensible and low glycine content fibrous protein.
 - (E) Silk fibroin is primarily composed of stacked antiparallel β sheets.
33. Which of the following descriptions about phenylalanine hydroxylase deficiency is **not true**?
- (A) The ability of cells to produce tyrosine is reduced.
 - (B) It may result in the accumulation of pyruvate in the body.
 - (C) The amount of phenylpyruvate excreted in the urine is greatly increased.
 - (D) The resulting disease is called phenylketonuria, which often affects intellectual development in untreated patients.
 - (E) Such patients can be treated with a diet low in phenylalanine.
34. Which of the following antimitotic drugs stimulates microtubule polymerization and stabilizes microtubules?
- (A) taxol
 - (B) nocodazole
 - (C) colchicine
 - (D) vincristine
 - (E) vinblastine
35. Protein acetylation is an important mode of regulation. Which of the following statements about reversible protein acetylation is **incorrect**?
- (A) Protein acetylation usually uses acetyl-CoA as the acetyl group donor.
 - (B) The deacetylation reaction often involves the participation of NAD^+ as a cofactor.
 - (C) The reaction typically occurs at the α -amino group of a lysine in the target protein.
 - (D) Almost all enzymes in the TCA cycle can be regulated by protein acetylation
 - (E) Sirtuin-3 is a mitochondrial deacetylase that activates a TCA cycle enzyme - isocitrate dehydrogenase.

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36. The kinetic constants for wild-type and mutant ATPase are listed in the table. Which of the following statements of this ATPase is **TRUE**?

Enzyme	K_m (μM)	k_{cat} (sec^{-1})
Wild-type	1	50
R160A	80	20
R160E	200	22
R160K	10	30
E36A	4	0.1
E36Q	3	0.3

- (A) Among the mutants, E36A has the highest catalytic efficiency.
 (B) The positive charge of residue R160 is important for ATP hydrolysis.
 (C) Residue E36 stabilizes the phosphate group.
 (D) Residue E36 is likely to be a catalytic residue.
 (E) Increase in ATP concentration can increase the catalytic efficiency of R160 mutants.
37. Which of the following statements about sickle cell anemia is **incorrect**?
- (A) The red blood cells have a crescent shape making them difficult to pass through the capillaries.
 (B) Hb S (sickle hemoglobin) differs from normal Hb A by only one amino acid substitution.
 (C) The difference between the molecular structures of Hb S and normal Hb A is the presence of a hydrophobic protrusion on the surface of Hb S protein.
 (D) The solubility of deoxyHb S is lower than that of deoxyHb A, so insoluble Hb S fibers may be observed frequently.
 (E) When binding with oxygen, Hb S can interact with the cell membrane and cause cell damage.
38. Binding of oxygen to hemoglobin may be affected by many effectors. Which of the following statements about these effects is **correct**?
- (A) Metabolically active tissues produce more acid and CO_2 , which can promote the binding of oxygen to hemoglobin.
 (B) $\text{NO}\cdot$ is a low-affinity ligand for hemoglobin so nitric oxide poisoning rarely occurs.
 (C) $\text{NO}\cdot$ irreversibly binds to the -SH functional group of Cys 93 in the β chain of hemoglobin resulting in inactivation of the hemoglobin.
 (D) The binding of 2,3-bisphosphoglycerate to hemoglobin can promote the

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release of oxygen from hemoglobin.

(E) The reason why the adult-type and fetal-type hemoglobins have different O₂ binding ability is because that the two proteins have different heme binding activities.

39. Which of the following statements about the characteristics of allosteric enzymes is **correct**?

(A) Allosteric enzymes are often monomeric.

(B) The effectors of allosteric enzymes are typically enzyme inhibitors.

(C) Reactions catalyzed by allosteric enzymes generally follow Michaelis-Menten kinetics.

(D) Most allosteric enzymes are regulated through protein phosphorylation.

(E) Binding of an effector molecule on a non-catalytic site of the enzyme can result in a change in substrate binding affinity.

40. According to its function and structure, the electron transport chain can be divided into four complexes. Which of the following descriptions about these complexes is **incorrect**?

(A) Complex I oxidizes NADH and reduces coenzyme Q.

(B) Complex II oxidizes succinate and reduces coenzyme Q.

(C) Complex III transfers electrons from coenzyme Q to cytochrome c.

(D) Coenzyme Q is a highly hydrophilic molecule that is confined by the mitochondrial membrane.

(E) Complex IV obtain electron from cytochrome c.

41. Acetoacetic acid is one of the major components of ketone bodies. In case, 1 mole acetoacetic acid is completely oxidized in cells. How many moles of high-energy bond will be generated?

(A) 13

(B) 18

(C) 23

(D) 26

(E) 28

42. The process of β -oxidation of saturated fatty acids involves a repeated sequence of four reactions which do **not** include:

(A) Stearoyl-CoA desaturase introduces double bonds in the long-chain fatty acids.

(B) Enoyl-CoA hydratase adds an OH group at the β carbon position of the fatty

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acid.

(C) L-hydroxyacyl-CoA dehydrogenase and NAD^+ oxidize the newly generated β -hydroxyl group to produce a ketoacyl-CoA derivative.

(D) Ketoacyl thiolase transfers a two-carbon unit from β -ketoacyl-CoA to another CoA molecule to form acetyl-CoA.

(E) One of the four acyl-CoA dehydrogenases introduces a double bond at the α carbon of the fatty acid.

43. Regarding the structure and function of plasma membrane, which of the following statement is incorrect for plasma membrane?

(A) Plasma membrane consists of three classes of amphipathic lipids: phospholipids, glycolipids, and sterols.

(B) Plasma membranes are involved in a variety of cellular processes including cell adhesion

(C) Glycolipids embedded in the outer lipid layer.

(D) Phosphatidylserine is a component of the plasma membrane and is distributed dominantly in the outer plasma membrane.

(E) Plasma membrane has large amount of proteins, usually around half of membrane volume.

44. Which of the following peptides would be the most likely to have an N-myristoyl anchor?

(A) YRPQNLC

(B) GAREFDR

(C) MGRCVLN

(D) NILWAKG

(E) SIPGNYT

45. Which of the following is **true** about the distribution of phospholipids on cell membranes?

(A) Under normal physiological conditions, the lateral diffusion rate of phospholipids in the cell membrane is approximately several nanometers per second.

(B) Compared with lateral movement, the transverse movement of phospholipids between the inner and outer leaflets of the cell membrane is much faster.

(C) Floppase can actively transport amphiphilic lipids from the inner leaflet to the outer leaflet.

(D) When phosphatidylserine is found in the outer leaflet, scramblase uses the

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energy of ATP to move it to the inner leaflet.

(E) The distribution ratio of phosphatidylserine in the inner and outer leaflets of the cell membrane is approximately the same.

46. Which of the following is a semi-essential amino acid; that is, this amino acid is essential in infants but not in adult.
- (A) Proline
 - (B) Histidine
 - (C) Leucine
 - (D) Tyrosine
 - (E) Lysine
47. Allopurinol is in a class of medications which can alleviate the production of uric acid in the body. Which of the following statement is incorrect for allopurinol?
- (A) Allopurinol is used to reduce gout attacks.
 - (B) Allopurinol undertakes metabolism in the liver where it transforms into its active metabolite.
 - (C) Allopurinol is a structural isomer of hypoxanthine.
 - (D) Allopurinol is a uricosuric, it cannot be used in people with poor kidney function.
 - (E) Allopurinol is an inhibitor of the enzyme xanthine oxidase.
48. Phenylketonuria is an inborn error of metabolism that results in decreased metabolism of the amino acid phenylalanine. The unavailability of the following factor might result in phenylketonuria?
- (A) thiamine
 - (B) biotin
 - (C) tetrahydrobiopterin
 - (D) tetrahydrofolate
 - (E) lipoamine
49. Comparing the ubiquitination and sumoylation pathways, which of the following statements are **TRUE**?
- (1) Both types of protein modification can target proteins for proteasome-mediated degradation
 - (2) Both types of protein modification can be used to regulate DNA repair.
 - (3) Before modification, SUMOs need to be proteolytically processed.
 - (4) Both types of modification can provide a new binding site for an interacting

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partner.

(5) For both types of modification, ligation occurs between a Gly residue on substrate proteins and a Lys residue on the modifiers.

- (A) 234
- (B) 135
- (C) 245
- (D) 123
- (E) 345

50. The polymerase chain reaction (PCR) is a powerful technology to amplify DNA. If the detection sensitivity of DNA agarose gel is 10^5 molecules of double-stranded DNA and the starting material contains 100 double-stranded DNA molecules, what is the minimal number of PCR cycles to detect the DNA by agarose gel electrophoresis? (assume the efficiency of every PCR cycle is 100%)

- (A) 5
- (B) 8
- (C) 10
- (D) 16
- (E) 32

51. RNA interference is a technique commonly used to modulate gene expression. Which of the following descriptions about this technology is **incorrect**?

- (A) Double-stranded RNA usually produces better interference effect than single-stranded RNA does.
- (B) The RNA delivered into the cell is first trimmed into 21-23 nucleotide siRNA by the endoribonuclease Dicer.
- (C) siRNA binds to the target gene promoter and prevents transcription through the action of the RNA-induced silencing complex (RISC).
- (D) RISC has RNA helicase and RNase H activities.
- (E) RISC can cleave the mRNA bound by siRNA, so that the protein cannot be translated.

52. mRNA is a single-stranded RNA that corresponds to the sequence of a gene; meanwhile, mRNA is read by a ribosome in the process of protein synthesis. Which of the following statement is incorrect for mRNA and its role on RNA processing?

- (A) mRNA is derived from its upstream precursor hnRNA.
- (B) Caps are regularly observed on the 5'-end of mRNA with unmodified pppA and pppT structure.

國立清華大學 111 學年度學士後醫學系單獨招生試題

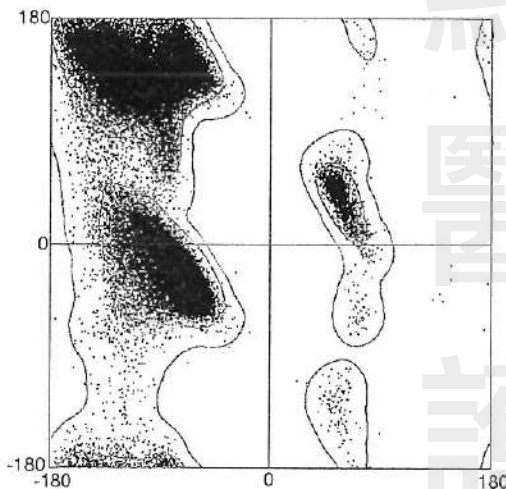
考試科目：生物與生化

共 18 頁，第 16 頁

- (C) Poly A tails are polymers of 200 to 300 adenylated residues linked with phosphodiester bonds.
- (D) All hnRNA introns have a guanine-uracil sequence on the 5' border of their intron/exon junctions.
- (E) Polyadenylation assists stabilize mRNA.

53. In the Ramachandran plot as shown below, clusters of dots show:

- (1) where the phi and psi angles are energetically favorable
- (2) the tertiary structure
- (3) the folding energy
- (4) where beta strands occur
- (5) where alpha helices, beta strands, and turns do not occur



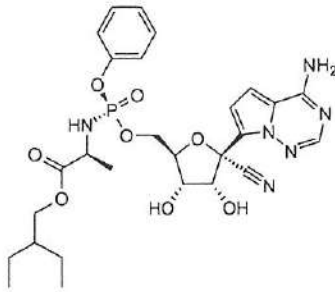
- (A) 2, 5
- (B) 1, 5
- (C) 2, 3
- (D) 1, 4
- (E) 4, 5

54. Remdesivir is an FDA approved antiviral treatment for Covid-19. The structure of remdesivir is shown below. Which of the following statement about remdesivir is correct?

國立清華大學 111 學年度學士後醫學系單獨招生試題

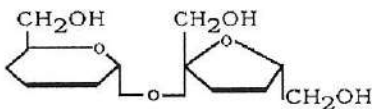
考試科目：生物與生化

共 18 頁，第 17 頁



- (A) The structure of this antiviral drug mimics ribonucleotide.
 (B) It is subjected to phosphorylation to form bioactive bisphosphate in cells.
 (C) It is a guanine nucleotide analog.
 (D) It targets DNA-dependent RNA polymerase.
 (E) It inhibits viral entry.
55. Which of the following amino acid contains two chiral centers?
 (A) Proline
 (B) Isoleucine
 (C) Tyrosine
 (D) Phenylalanine
 (E) Tryptophan

56. Which of the following best describes the disaccharide shown below?



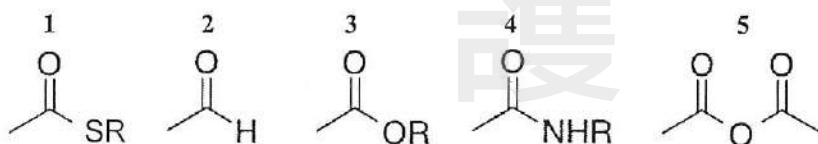
- (A) The glycosidic bond is $\beta(2 \rightarrow 4)$.
 (B) The glycosidic bond is $\alpha(1 \rightarrow 2)$.
 (C) The glycosidic bond is $\alpha(2 \rightarrow 4)$.
 (D) One of the sugar moieties is a ribose.
 (E) The disaccharide is maltose.
57. Which of the following protein modifying reagents is **correctly** defined?
 (A) 2-mercaptoethanol: readily oxidizes -SH group and forms disulfide bridges in proteins.
 (B) cyanogen bromide: the Br ion reacts with the nucleophilic sulfur atom of the target amino acid that leads to protein cleavage.
 (C) phenylisothiocyanate: reacts with free carboxyl groups in protein.
 (D) cyanogen bromide: specifically reacts with internal cysteine residues
 (E) guanidinium HCl: disrupts ionic interactions and hydrogen bonds

國立清華大學 111 學年度學士後醫學系單獨招生試題

考試科目：生物與生化

共 18 頁，第 18 頁

58. Which of the following amino acid has a strong and broad absorption signal 3400cm^{-1} in the infrared spectrum?
- (A) Tryptophan
(B) Glycine
(C) Proline
(D) Leucine
(E) Tyrosine
59. Chorismate mutase converts chorismate to prephenate. Which of the following is **NOT** relevant to the reaction catalyzed by the enzyme?
- (A) The enzyme catalyzes the reaction via a chair transition state
(B) The reaction involves a concerted two-molecule sequential reaction.
(C) The enzymatic reaction involves the stabilization of the transition state by 12 electrostatic and hydrogen bond interactions
(D) In the reaction, one carbon-oxygen bond is broken and one carbon-carbon bond is formed.
(E) Formation of a near attack conformation is facile in the chorismate mutase active site.
60. Which one is the correct ranking of the relative reactivity of the following carbonyl groups?



- (A) $1 > 2 > 4 > 5 > 3$
(B) $5 > 2 > 1 > 3 > 4$
(C) $5 > 2 > 3 > 1 > 4$
(D) $4 > 1 > 3 > 2 > 5$
(E) $1 > 2 > 3 > 4 > 5$

國立清華大學學士後醫學系考試 各科試題參考答案

科目名稱：生物與生化

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
答案	A	D	D	C	A	A	A	B	A	B	C	A	A	D	B
題號	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
答案	E	A	B	E	E	A	B	C	E	A	B	A	A	D	E
題號	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
答案	D	D	B	A	C	D	E	D	E	D	C	A	D	B	C
題號	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
答案	B	D	C	A	C	C	B	D	A	B	B	E	E	B	B

國立清華大學 111 學年度學士後醫學系招生考試試題答案疑義釋疑公告

科目	題號	釋疑答覆	釋疑結果
生物與生化	8	考量性別與表徵，(B) Sex-linked dominant 為最符合的解答。以 (A) Autosomal dominant 及 (C) Autosomal recessive 在較低的機率下，也可得出該譜系圖。	(A)、(B)、(C)均可
	11	大多數神經病理學研究報告說，幾乎 100% 的 35 歲以上 DS 患者患有 AD 的神經病理學，臨床研究發現並非所有人 DS 會隨著年齡的增長而出現癡呆的臨床症狀 "Journal of Neurology volume 264, pages 804–813 (2017)" 有病理學證據不代表有 AD 的臨床症狀，故 (E) 選項敘述略微不精確。	(C)、(E)均可
	31	本題題目不夠精確，所提供的答案選項均無法正確回答題目提供的條件。	本題沒有正確答案，以送分處理。
	41	活化僅需 1 單位 ATP 因此最終為產生 23ATP	答案仍維持 (C)
	44	N-myristoylation occurs at the N-terminal Gly residue co-translationally . Lehninger 第 8 版內容，N-myristoylation 修飾 N-Gly。此蛋白常帶有 hydrophobic transmembrane segment，不是 N-myristoyltransferase (NMT) 進行修飾時的必要條件，因為 N-myristoylation 是 co-translationally 進行，NMT 辨識的序列主要是 Gly ¹ 和緊接在後的一小段序列，但這段序列差異性還蠻高的 (Front. Immunol. 8:751. doi: 10.3389/fmmu.2017.00751)。此外，cytosolic protein 也可以被 N-myristoylation 修飾 (例如：Lck)。綜合上述，此題最有可能被 N-myristoylation 的序列是 (B)。 (A) YRPQNLC (B) GAREFDR (C) MGRCVLN (D) NILWAKG (E) SIPGNYT	答案仍維持 (B)

生 物

曾正(曾蘇賢)老師提供

試題分佈

範疇	題數	題目
基礎生化	1題	第23題
細胞學		
生物能量學 / 酵素學	1題	第4題
細胞遺傳學		
古典遺傳學	3題	第8、9、11題
分子生物學 (含遺傳工程)	2題	第13、25題
動物生理學	13題	第6、10、14、15、16、17、18、19、20、21題 第22、24、27題
生物分類學	5題	第1、2、3、7、26題
演化論	1題	第12題
生態學		
植物生理學	1題	第5題
生物行為學		

試題評析

今年是清華大學首份的學士後西醫生物學的題目公佈，其特色為：

1. 內容極為“清華大學式”的出題作風，其學校無論是轉學考、研究所的試題皆有一共同點—把考生難倒為其宗旨。
2. 題目命題最多的部份包括動物生理學之免疫學部份及生物分類學。
3. 首次出題就考了個研究所題目，來源出自於國外研究論文的總論，一般的考生大概極難拿到分數。
4. 有關COVID-19的RNA疫苗也出了備製的課外知識，一般的同學可能望題而興歎。
5. 而2021年諾貝爾生理或醫學獎的考題被老師狠狠的命中，各位同學大概沒有忘記LINE限定版考猜清清楚楚的記錄命中內容。
6. 試題簡單的部份，也設計了一些陷阱，而中等題目也故意轉彎，為了測試同學準備是否有徹底了解。
7. 整份試題來說難度稍高，本班優秀生可拿到22題(生物總題數為27題)左右，而中等生約可拿到17題左右的成績。

精選試題解析

- (A) 1. Which of the following descriptions about brown algae is **NOT** correct?
- (A) They are the smallest and least complex algae.
 - (B) They are multicellular and mostly marine.
 - (C) They contain chlorophylls and carotenoids in their plastids for photosynthesis
 - (D) Some species, such as Japanese “kombu”, are eaten as human food.
 - (E) Their cell walls contain gel-forming polysaccharides called algin.

解析

brown algae 為最大及最複雜的藻類。

[命中生物第(十二)回講義ch3 原生生物學]

- (D) 2. Which of the following descriptions about fungi is **NOT** correct?
- (A) They are a group of eukaryotic organisms that includes yeasts, molds, and mushrooms.
 - (B) They are incapable of photosynthesis.
 - (C) Fungal membranes contain a unique steroid called ergosterol, which is a drug target of athlete’s foot treatment.
 - (D) Mycorrhizal fungi form symbiotic relationships only with legumes.
 - (E) Fungal cell walls are made of chitin.

解析

與legumes 互利共生的是根瘤菌(Rhizobium)而非fungi。

[命中生物第(十三)回講義ch6 植物生理學]

- (C) 4. Which of the following descriptions about Crassulacean acid metabolism (CAM) is **NOT** correct?
- (A) The benefit of CAM to the plant is the ability to leave most leaf stomata closed during the day.
 - (B) During the night, CAM plants allow CO₂ to enter and be fixed as organic acids.
 - (C) During the day, the stomata of CAM plants close to conserve water, and the organic acids stored in the vacuoles of bundle sheath cells are released.
 - (D) Pineapple is the economically valuable crop possessing CAM.
 - (E) Cactus utilize the CAM as an adaptation for arid conditions.

解析

白天CAM關閉氣孔，而貯存mesophyll cells 的液泡有機酸被釋出。

[命中生物第(二)回講義ch5 生物能量學]

- (A) 5. Which of the following plant pigments mostly absorb red and far-red light to regulate plant responses, including seed germination and shade avoidance?
- (A) Phytochrome
 - (B) Phototropin
 - (C) Cryptochrome
 - (D) ZEITLUPE
 - (E) UVR8

解析

plant phytochrome 為紅光及紅外光的接受器(色素分子)。

[命中生物第(十三)回講義ch6 植物生理學]

- (A) 6. During the development, the ectoderm eventually gives rise to?
 (A) Nervous system (B) Muscle (C) Lungs
 (D) Connective tissue (E) Digestive tube

解析

發育時，ectoderm導致神經系統形成。

[命中生物第(七)回講義ch9 比較動物生理學unit 7 動物胚胎學]

- (A) 7. Which of the following is not a feature of insects?
 (A) Book lung (B) Malpighian tubules (C) Open circulatory system
 (D) Tracheal system (E) Exoskeleton

解析

昆蟲的呼吸器為氣管系，而非書肺。

[命中生物第(十四)回講義ch7 動物分類學]

- (A) 12. Which of following is not a mechanism altering allele frequencies over time to cause evolutionary change?
 (A) Random mating (B) Genetic drift. (C) Natural selection.
 (D) Gene flow. (E) All above cause evolutionary change.

解析

Random mating為哈-溫定律中的因子，代表著世代之間allele frequencies維持不變。

[命中生物第(十)回講義ch11 演化論]

- (A) 13. Xeroderma pigmentosum (XP) is a rare clinical disease associated with sun sensitivity and a high risk for skin malignancy in sun-exposed areas. Which of the following defective DNA repair systems may be involved?
 (A) Nucleotide excision repair, NER
 (B) Mismatch excision repair, MMR
 (C) Base excision repair, BER
 (D) Non-homologous end joining, NHEJ
 (E) Double-strand breaks repair, DSBR

解析

Xeroderma pigmentosum (XP)是因缺乏Nucleotide excision repair而導致的疾病。

[命中生物第(四)回講義ch8 分子生物學]

- (A) 17. Parkinson's disease is characterized by a range of motor symptoms and mainly caused by
 (A) the loss of dopamine-producing nerve cells.
 (B) the degeneration of the upper motor and lower motor neurons.
 (C) rapid and uncoordinated electrical firing in the brain.
 (D) autoimmune disease producing antibodies to the acetylcholine receptors on skeletal muscle fibers.
 (E) imbalances of autonomic nervous system

解析

Parkinson's disease是因中腦產生dopamine的神經細胞丟失所致。

[命中生物第(八)回講義ch9 比較動物生理學unit 9 神經系統及感覺系統]

- (B) 18. Circadian rhythms are coordinated by suprachiasmatic nucleus in the
 (A) Hippocampus (B) Hypothalamus (C) Amygdala

(D) Cerebellum (E) Cerebral cortex

解析

上視交叉核是生物時鐘的所在，位於下視丘。

[命中生物第(八)回講義ch9 比較動物生理學unit 9 神經系統及感覺系統]

(E) 19. Which of the following hormone increases during the luteal phase of the ovarian cycle?

- (A) Androgens (B) Follicle-stimulating hormone
(C) Luteinizing hormone (D) Estrogens (E) Progesterone

解析

卵巢週期的黃體相中主要上升的激素為黃體素(P4)。

[命中生物第(六)回講義ch9 比較動物生理學unit 6 內分泌系統]

(A) 21. Which of the following is a strategy for bony fish in sea water to regulate osmolarity?

- (A) Drinking sea water
(B) High concentrations of urea and trimethylamine oxide (TMAO) in body fluids
(C) Uptake ions by gill
(D) Excretion of large amounts of water in urine
(E) All of above

解析

海水硬骨魚喝海水，排除少量等張尿、鰓泌一價鹽；腎臟泌二價鹽。

[命中生物第(六)回講義ch9 比較動物生理學unit 5 排泄系統]

(B) 22. The primary function of the descending limb of the loop of Henle is

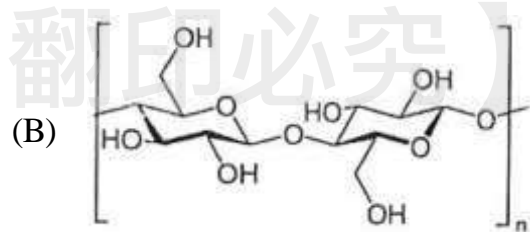
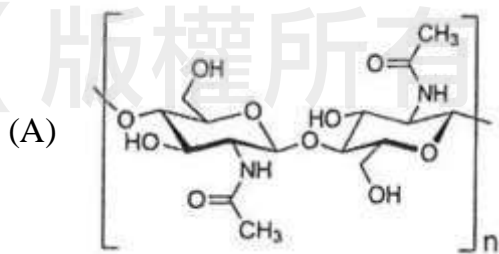
- (A) Filtration of ions (B) Reabsorption of water (C) Secretion of ions
(D) Excretion of water (E) Excretion of ions

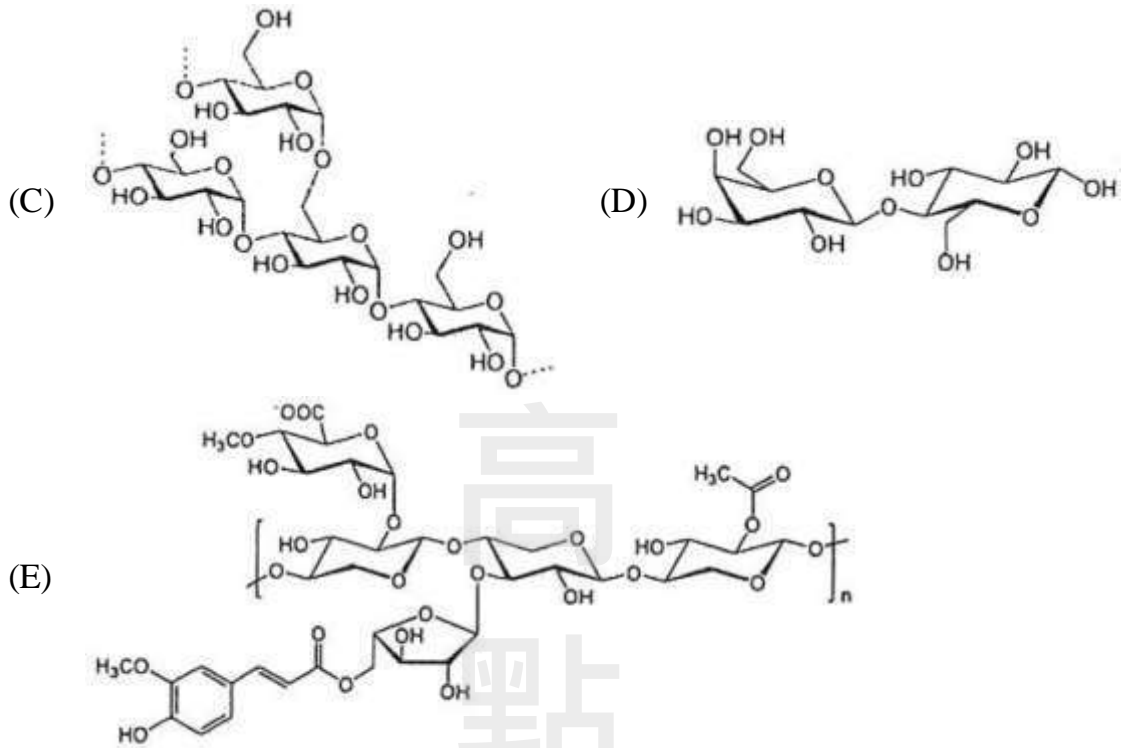
解析

腎元亨氏環下行支的主要功能為重吸收H₂O。

[命中生物第(六)回講義ch9 比較動物生理學unit 5 排泄系統]

(C) 23. Which of the following structures is stored primarily in the cells of the liver and skeletal muscle?





解析

動物肝臟及骨骼肌中貯存的多糖為glycogen。

[命中生物第(一)回講義ch3 碳與生命的多樣性]

(其他試題詳解，歡迎參考高點出版 67MU201506【生物學經典題型解析】一書)

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生化

莊老師(施政安)老師提供

精選試題解析

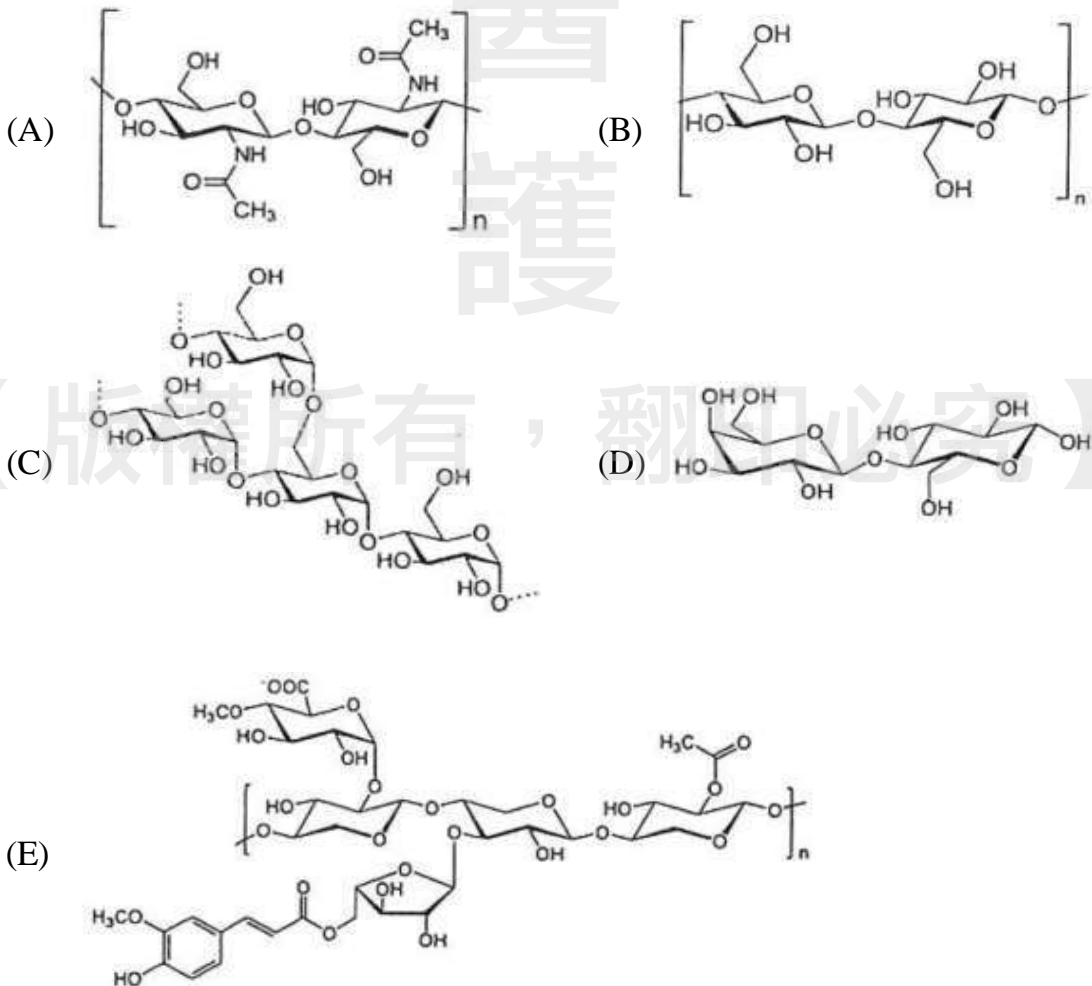
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 - (C) Base excision repair, BER
 - (D) Non-homologous end joining, NHEJ
 - (E) Double-strand breaks repair, DSBR

解析

XP diseased caused by NER (nucleotide excision repair) efficiency.

=> 故選 (A)

23. Which of the following structures is stored primarily in the cells of the liver and skeletal muscle?



解析

Glycogens present in skeletal muscle and liver.

=> 故選 (C): $\alpha(1\rightarrow4)$ and $\alpha(1\rightarrow6)$ linkages

28. Alpha-D-glucose undergoes conversion to beta-D-glucose in solution. If at 300K there is 70% conversion, what is the ΔG (J/mole) for the reaction?

ln1 = 0.00
ln2 = 0.69
ln3 = 1.10
ln4 = 1.39
ln5 = 1.61
ln6 = 1.79
ln7 = 1.95
ln8 = 2.08
ln9 = 2.20

(A) 2120

(B) 2369

(C) 2743

(D) 4864

(E) 5487

解析

$$\Delta G = RT \ln \left(\frac{[\beta]}{[\alpha]} \right)$$

$$\Rightarrow \Delta G^{\circ} = 8.315 \times 300 \ln (70\%/30\%) = 8.315 \times 300 \times 0.833 \approx 2078$$

=> 故選 (A)

30. For the same mass of glycogen, amylose, amylopectin, and cellulose, rank the initial rate of hydrolysis of these polysaccharides by alpha-1,4-glucosidase.

(A) cellulose > amylopectin > glycogen > amylose

(B) glycogen > amylose > cellulose > amylopectin

(C) amylose > cellulose > amylopectin > glycogen

(D) amylopectin > glycogen > amylose > cellulose

(E) glycogen > amylopectin > amylose > cellulose

解析

enzyme efficiency 和表面積成正比:

a. 表面積多 \rightarrow 少: glycogen \rightarrow amylopectin \rightarrow amylose

b. α -1,4-glycosidase 不能分解含 β -1,4-glycosidic bond 的 cellulose

=> 故選 (E)

31. The K_m and V_{max} of hexokinase I for glucose are $100 \mu\text{M}$ and $30 \mu\text{M}/\text{min}$ and the K_m and V_{max} of hexokinase II for glucose are 10 mM and $50 \mu\text{M}/\text{min}$, respectively. Which of the following descriptions about the kinetics of the two enzymes is most likely to be **correct**?
- (A) If the glucose concentration is $50 \mu\text{M}$, the reaction velocity of hexokinase I will be $\sim 20 \mu\text{M}/\text{min}$.
- (B) If the glucose concentration is $50 \mu\text{M}$, the reaction velocity of hexokinase I will be $\sim 25 \mu\text{M}/\text{min}$.
- (C) If the glucose concentration is 1.0 mM , the reaction velocity of hexokinase II will be $\sim 30 \mu\text{M}/\text{min}$.
- (D) If the glucose concentration is 30 mM , the reaction velocity of hexokinase II may reach $50 \mu\text{M}/\text{min}$.
- (E) Compared to hexokinase II, hexokinase I is more efficient when the glucose concentration is higher than 10 mM .

解析

A. HKI (hexokinase I) : $v = \frac{V_{max} [S]}{K_m + [S]} = \frac{30 \times 50}{100 + 50} = 10$

B. 同 A

C. HKII (hexokinase II) : $v = \frac{V_{max} [S]}{K_m + [S]} = \frac{50 \times 1}{10 + 1} \approx 4$

D. HKII (hexokinase II) : $v = \frac{V_{max} [S]}{K_m + [S]} = \frac{50 \times 30}{10 + 30} = \underline{\underline{37.5 \approx 40 \text{ 不是 } 50}}$

E. V_{max}/K_m 值: HKI > HKII, 故 enzyme efficiency: HKI > HKII

=> 故無解才對

33. Which of the following descriptions about phenylalanine hydroxylase deficiency is **not true**?
- (A) The ability of cells to produce tyrosine is reduced.
- (B) It may result in the accumulation of pyruvate in the body.
- (C) The amount of phenylpyruvate excreted in the urine is greatly increased.
- (D) The resulting disease is called phenylketonuria, which often affects intellectual development in untreated patients.
- (E) Such patients can be treated with a diet low in phenylalanine.

解析

B. Phenylalanine → Phenylpyruvate 才對

=> 故選 (B)

35. Protein acetylation is an important mode of regulation. Which of the following statements about reversible protein acetylation is **incorrect**?
- (A) Protein acetylation usually uses acetyl-CoA as the acetyl group donor.
 (B) The deacetylation reaction often involves the participation of NAD^+ as a cofactor.
 (C) The reaction typically occurs at the α -amino group of a lysine in the target protein.
 (D) Almost all enzymes in the TCA cycle can be regulated by protein acetylation
 (E) Sirtuin-3 is a mitochondrial deacetylase that activates a TCA cycle enzyme - isocitrate dehydrogenase.

解析

C. ϵ -amino group of lysine 才對
 => 故選 (C)

36. The kinetic constants for wild-type and mutant ATPase are listed in the table. Which of the following statements of this ATPase is **TRUE**?

Enzyme	K_m (μM)	k_{cat} (sec^{-1})
Wild-type	1	50
R160A	80	20
R160E	200	22
R160K	10	30
E36A	4	0.1
E36Q	3	0.3

- (A) Among the mutants, E36A has the highest catalytic efficiency.
 (B) The positive charge of residue R160 is important for ATP hydrolysis.
 (C) Residue E36 stabilizes the phosphate group.
 (D) Residue E36 is likely to be a catalytic residue.
 (E) Increase in ATP concentration can increase the catalytic efficiency of R160 mutants.

解析

k_{cat}/K_m 可以評估 enzyme efficiency

Enzyme	k_{cat}/K_m
Wild type	$50/1 = 50.0$
R160A	$20/80 = 0.25$
R160E	$22/200 = 0.11$
R160K	$30/10 = 3.0$
E36A	$0.1/4 = 0.025$
E36Q	$0.3/3 = 0.1$

=> E36A mutant 活性下降最多 故最有可能突變在 catalytic residue
 => 故選 (D)

39. Which of the following statements about the characteristics of allosteric enzymes is **correct**?
- (A) Allosteric enzymes are often monomeric.
 - (B) The effectors of allosteric enzymes are typically enzyme inhibitors.
 - (C) Reactions catalyzed by allosteric enzymes generally follow Michaelis Menten kinetics.
 - (D) Most allosteric enzymes are regulated through protein phosphorylation.
 - (E) Binding of an effector molecule on a non-catalytic site of the enzyme can result in a change in substrate binding affinity.

解析

- A. Allosteric enzyme: oligomer
- B. Allosteric effector: activator or inhibitor
- C. Allosteric enzymes can not obey the Michaelis-Menten kinetics.
- D. Allosteric enzymes effected by noncovalent binding.

=> 故選 (E)

40. According to its function and structure, the electron transport chain can be divided into four complexes. Which of the following descriptions about these complexes is **incorrect**?
- (A) Complex I oxidizes NADH and reduces coenzyme Q.
 - (B) Complex II oxidizes succinate and reduces coenzyme Q.
 - (C) Complex III transfers electrons from coenzyme Q to cytochrome c.
 - (D) Coenzyme Q is a highly hydrophilic molecule that is confined by the mitochondrial membrane.
 - (E) Complex IV obtain electron from cytochrome c.

解析

CoQ is a hydrophobic molecule.

=> 故選 (D)

41. Acetoacetic acid is one of the major components of ketone bodies. In case, 1 mole acetoacetic acid is completely oxidized in cells. How many moles of high-energy bond will be generated?
- (A) 13 (B) 18 (C) 23 (D) 26 (E) 28

解析

本題使用舊式計算法: $\text{NADH} = 3.0 \text{ ATPs}$, $\text{FADH}_2 = 2.0 \text{ ATPs}$, 所以 TCA cycle 跑一圈產生 12 ATPs ($3\text{NADH} + \text{FADH}_2 + \text{GTP} = 12 \text{ ATPs}$)

=> Acetoacetate
 ↓ Succinyl-CoA (CoA donor)
 Acetoacetyl-CoA
 ↓
 2Acetyl-CoA → 2 turns of TCA cycle

=> ATP = $2 \times 12 - \text{GTP (= succinyl-CoA)} = 24 - 1 = 23 \text{ ATPs}$

=> 故選 (C)

43. Regarding the structure and function of plasma membrane, which of the following statement is incorrect for plasma membrane?
- (A) Plasma membrane consists of three classes of amphipathic lipids: phospholipids, glycolipids, and sterols.
- (B) Plasma membranes are involved in a variety of cellular processes including cell adhesion
- (C) Glycolipids embedded in the outer lipid layer.
- (D) Phosphatidylserine is a component of the plasma membrane and is distributed dominantly in the outer plasma membrane.
- (E) Plasma membrane has large amount of proteins, usually around half of membrane volume.

解析

Phosphatidylserine presents on **inner leaflet** of plasma membrane.

=> 故選 (D)

44. Which of the following peptides would be the most likely to have an N-myristoyl anchor?
- (A) YRPQNLC (B) GAREFDR (C) MGRCVLN
(D) NILWAKG (E) SIPGNYT

解析

N-myristoyl group is anchored at **N-terminal glycine** of protein.

=> 故選 (B)

46. Which of the following is a semi-essential amino acid; that is, this amino acid is essential in infants but not in adult.
- (A) Proline (B) Histidine (C) Leucine (D) Tyrosine (E) Lysine

解析

Semi-essential amino acid: Histidine and Arginine

=> 故選 (B)

48. Phenylketonuria is an inborn error of metabolism that results in decreased metabolism of the amino acid phenylalanine. The unavailability of the following factor might result in phenylketonuria?
- (A) thiamine (B) biotin (C) tetrahydrobiopterin
(D) tetrahydrofolate (E) lipoamine

解析

Phenylalanine hydroxylase contains tetrahydrobiopterin(BH4).

=> 故選 (C)

49. Comparing the ubiquitination and sumoylation pathways, which of the following statements are **TRUE**?
- (1) Both types of protein modification can target proteins for proteasome mediated degradation
 - (2) Both types of protein modification can be used to regulate DNA repair.
 - (3) Before modification, SUMOs need to be proteolytically processed.
 - (4) Both types of modification can provide a new binding site for an interacting partner.
 - (5) For both types of modification, ligation occurs between a Gly residue on substrate proteins and a Lys residue on the modifiers.
- (A) 234 (B) 135 (C) 245 (D) 123 (E) 345

解析

1. 只有 ubiquitin 和 protein degradation 有關
 5. (target protein/lysine ϵ -NH₂) + (modifier protein /C-ter glycine-COOH)
- => 故選 (A)

51. RNA interference is a technique commonly used to modulate gene expression. Which of the following descriptions about this technology is **incorrect**?
- (A) Double-stranded RNA usually produces better interference effect than single stranded RNA does.
 - (B) The RNA delivered into the cell is first trimmed into 21-23 nucleotide siRNA by the endoribonuclease Dicer.
 - (C) siRNA binds to the target gene promoter and prevents transcription through the action of the RNA-induced silencing complex (RISC).
 - (D) RISC has RNA helicase and RNase H activities.
 - (E) RISC can cleave the mRNA bound by siRNA, so that the protein cannot be translated.

解析

- C. The siRNA frequently binds to **ORF (open reading frame)** site of mRNA.
 - D. RISC complex 只有 **RNaseH-like** activity 但無 **RNA helicase activity**
- => 故 (C) or (D) 皆可

55. Which of the following amino acid contains two chiral centers?
- (A) Proline (B) Isoleucine (C) Tyrosine (D) Phenylalanine (E) Tryptophan

解析

- 只有兩個 amino acid 有兩個 chiral center: isoleucine and threonine
- => 故選 (B)

58. Which of the following amino acid has a strong and broad absorption signal 3400cm^{-1} in the infrared spectrum?
- (A) Tryptophan (B) Glycine (C) Proline
(D) Leucine (E) Tyrosine

解析

3400cm^{-1} : -OH group

=> 故選 (E)

高
點
醫
護

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