

每題 2.5 分，請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

1. Which of the following organs are not in immune system?
  - (A) Spleen
  - (B) Thymus
  - (C) Skin
  - (D) kidney
  - (E) Lymph node
  
2. Which properties of gene-knockout mouse are true?
  - (A) Gene is introduced into genome by random insertion.
  - (B) Gene is introduced into genome by homologous recombination.
  - (C) Gene is introduced into genome by transposon.
  - (D) Gene is studied for gain of function.
  - (E) Gene is studied for loss of function.
  
3. Which of the following methods are assayed with flow cytometry?
  - (A) Intracellular staining for cytokines
  - (B) Identification of specific antigens on cell surface
  - (C) Northern blotting
  - (D) Western blotting
  - (E) DNA microarray
  
4. Which of the following statements about Toll-like receptor (TLR) are not true?
  - (A) It is only in mammal.
  - (B) It involves in cellular immunity.
  - (C) Its discovery is awarded in 2011 Nobel Prize.
  - (D) It recognizes the components of microbes.
  - (E) It activates innate immune responses.
  
5. Which of the following cell types are phagocytes?
  - (A) NK cell
  - (B) Macrophage
  - (C) Dendritic cell
  - (D) Neutrophil
  - (E) T cell
  
6. Which of the following factors can initiate Inflammatory reaction?
  - (A) UV light
  - (B) Cold exposure
  - (C) Infections
  - (D) Nitric oxide (NO)
  - (E) Arachidonic acid metabolites
  
7. Which of the following responses are mediated by cellular immunity?
  - (A) Phagocytosis
  - (B) Complement activation

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- (C) Allograft rejection
- (D) Antibody neutralization
- (E) Tumor cell killing

8. Regarding to antibody which statements are true?

- (A) It has one pair of heavy chain and light chain.
- (B) It is part of cellular immunity.
- (C) It is secreted by plasma cells.
- (D) It can block the entry of virus into host cells.
- (E) It can be classified into IgM, IgG, IgE, and IgA four isotypes.

9. Which of the following diseases can be controlled by vaccine?

- (A) Influenza
- (B) EV71 infection
- (C) Tumor
- (D) Tuberculosis
- (E) Hepatitis

10. Which of the following techniques are applied with monoclonal antibody?

- (A) ELISA
- (B) Immunoprecipitation
- (C) Southern blotting
- (D) Cancer targeting therapy
- (E) TUNEL assay for apoptosis

11. A protein is found in a transport vesicle as it transits from the Golgi to the plasma membrane. The protein has two transmembrane domains. The spacing of the transmembrane domains is shown as gray boxes in Figure 1. The C-terminal domain of this protein is cytoplasmic.

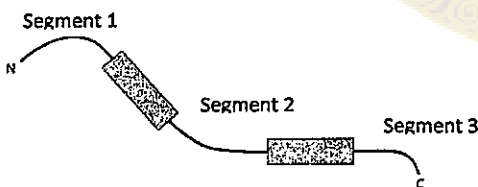


Figure 1

Which statements are correct?

- (A) The N-terminal domain of the protein is extracellular.
- (B) The N-terminal domain of the protein is cytoplasmic.
- (C) The portion of Segment 1 (the N terminus to the first transmembrane domain) is most likely to be glycosylated.
- (D) The portion of Segment 2 (between two transmembrane domains) is most likely to be glycosylated.
- (E) The portion of Segment 3 (the second transmembrane domain to the C terminus) is most likely to be glycosylated.

12. In the search for extraterrestrial life, water on other planets is definitive evidence. Which statements are correct?

- (A) All known life requires water.
- (B) C-H and O-H bonds have special properties that make life possible.
- (C) Water is a liquid with a high surface tension due to its Van der Waals attraction.
- (D) Water is a polar molecule with partial positive charges on the oxygen atoms and a partial negative charge on the hydrogen atom;
- (E) Water has the solubility and reactivity of DNA, proteins, polysaccharides, and fatty acids.

13. A hypothetical pathway involved in a series of reactions similar to glycolysis is plotted on a graph in Figure 2. The catabolic intermediates are designated A, B, C, etc.

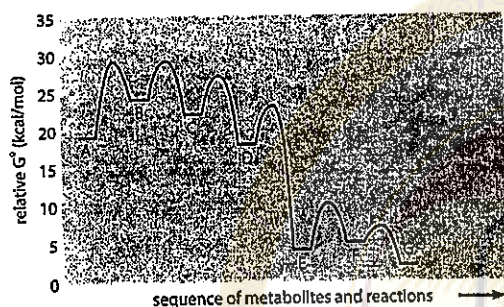


Figure 2

Which statements are correct?

- (A) Reaction A to B is most likely to occur spontaneously.
- (B) Reaction A to B has the most positive or unfavorable  $\Delta G^\circ$ .
- (C) Reaction F to G is most likely to occur without an enzyme.
- (D) ATP synthesis is most likely to produce in Reaction D to E.
- (E) ATP hydrolysis is most likely to couple to Reaction D to E.

14. A Western blot (WB) is one method of visualizing proteins. Which statements are correct?

- (A) Proteins can be extracted from either plant or animal cells.
- (B) The proteins are denatured and separated by charges and ion strength using electrophoresis through a gel;
- (C) The protein of interest is detected by binding to an antibody that is raised against the protein.
- (D) The method is useful to investigate whether Protein X interacts with Protein Y.
- (E) The larger protein migrates faster than the smaller one on a gel.

15. Apoptosis is a form of cell death. Which of the followings are key features in a cell undergoing apoptosis?

- (A) Irregular bulge in the plasma membrane of the cell
- (B) More water goes into the cell
- (C) DNA fragmentation in the nucleus
- (D) Increase in the volume of the cytoplasm
- (E) Cell shrinkage

16. In patients with autoimmune diseases, the adaptive immune system recognizes

some normal cells or proteins as though they were foreign. **Which statements are correct?**

- (A) T and B lymphocytes are the components of the the adaptive immune system.
- (B) Apoptosis of T or B lymphocytes (B cells and T cells) that recognize the body's own normal proteins can help to avoid autoimmune diseases.
- (C) Apoptosis of a cell usually triggers immune responses in autoimmune diseases.
- (D) Apoptosis of T or B lymphocytes which recognize self protein is beneficial to a host.
- (E) Apoptosis of self-reactive T or B lymphocytes is completed after the birth of the host.

17. You want to study the cell cycle in fish embryo cells, in which the cell cycle length is about 30 min. You examine the amount of M-cyclin in these cells and see that it varies over the cell cycle. A drug, called MI575 is known to block the cell cycle. The drug is added to cells and levels of M-cyclin are examined. The results are shown in Figure 3.



Figure 3

**Which statements are correct?**

- (A) M-cyclin levels in control cells decrease in DNA synthesis stage.
- (B) M-cyclin levels in control cells decrease in late mitosis.
- (C) The drug MI575 is most likely to block late mitosis in treated cells.
- (D) The abnormally high levels of M-cyclin in treated cells should keep the cells from completing mitosis.
- (E) The cell cycle is blocked because dephosphorylation of M-cyclin target is inhibited in MI575 treated cells.

18. More than 90% of mammalian genes encode proteins and fewer than 10% produce RNA as their final product. **Which statements are correct?**

- (A) Most RNA in cells is messenger RNA (mRNA).
- (B) About 80% of the total RNA by weight is ribosomal RNA (rRNA).
- (C) Many of genes are not transcribed at all in a given cell or are transcribed at very low levels.
- (D) Genes that are not transcribed are eventually deleted from the genome.
- (E) mRNA can be purified from a cell by taking advantage of its poly-A tail which hybridizes to oligo-dT (a DNA molecule with the sequence TTTTTTTT) linked cellulose beads

19. Please deduce the reading frame of this segment of cDNA in Figure 4A and **choose the correct answers from the following statements.** (You can consult the genetic code provided in Figure

4).

cDNA sequence 5'-CGAAGGATTACCAGTAATTACGTGCAGA-3'  
3'-GCTTCCTAATGGTCATTAATGCACGTCT-5'

(B)

	U	C	A	G
U	UUU Phe (F)	UCU Ser (S)	UAU Tyr (Y)	UGU Cys (C)
	UUC "	UCC "	UAC "	UGC "
	UUA Leu (L)	UCA "	UAA Stop	UGA Stop
	UUG "	UCG "	UAG Stop	UGG Trp (W)
C	CUU Leu (L)	CCU Pro (P)	CAU His (H)	CGU Arg (R)
	CUC "	CCC "	CAC "	CGC "
	CUA "	CCA "	CAA Gln (Q)	CGA "
	CUG "	CCG "	CAG "	CGG "
A	AUU Ile (I)	ACU Thr (T)	AAU Asn (N)	AGU Ser (S)
	AUC "	ACC "	AAC "	AGC "
	AUA "	ACA "	AAA Lys (K)	AGA Arg (R)
	AUG Met (M)	ACG "	AAG "	AGG "
G	GUU Val (V)	GCU Ala (A)	GAU Asp (D)	GGU Gly (G)
	GUC "	GCC "	GAC "	GGC "
	GUA "	GCA "	GAA Glu (E)	GGA "
	GUG "	GCG "	GAG "	GGG "

Figure 4

- (A) The first amino acid encoded by the cDNA can be Arg.
- (B) The first amino acid encoded by the cDNA can be Glu.
- (C) The first amino acid encoded by the cDNA can be Lys.
- (D) The last (9th) amino acid encoded by the cDNA Arg.
- (E) The last (9<sup>th</sup>) amino acid encoded by the cDNA Ala.

20. Which statements are correct?

- (A) The number of different proteins in a human cell is probably greater than the number of genes in a bacterium.
- (B) The number of genes in an organism is a good indicator of the number of different proteins found in a single cell from that organism.
- (C) The number of proteins in a cell is usually smaller than the number of genes in a mammalian cell.
- (D) One gene encodes one protein.
- (E) Alternative mRNA splicing is one of the mechanisms that give rise to the diversity of the proteins in multicellular organisms.

21. Which of the following ions have far higher concentration in the extracellular space than in the cytosol?

- (A) Sodium
- (B) Potassium
- (C) Calcium
- (D) Chloride
- (E) Proton

22. Which of the following molecules are major components of the cytoskeleton in eukaryotic cells?

- (A) Aquaporins
- (B) Rhodopsin
- (C) Actin
- (D) Lamin
- (E) Tubulins

Questions 23-24

Use codon table provided below to answer the following question

		Second Base				
		T	C	A	G	
First Base	T	Phe	Ser	Tyr	Cys	T
		Phe	Ser	Tyr	Cys	C
		Leu	Ser	Stop (Ochre)	Stop (Umber)	A
		Leu	Ser	Stop (Amber)	Trp	G
	C	Leu	Pro	His	Arg	T
		Leu	Pro	His	Arg	C
		Leu	Pro	Gln	Arg	A
		Leu	Pro	Gln	Arg	G
	A	Ile	Thr	Asn	Ser	T
		Ile	Thr	Asn	Ser	C
		Ile	Thr	Lys	Arg	A
		Met	Thr	Lys	Arg	G
	G	Val	Ala	Asp	Gly	T
		Val	Ala	Asp	Gly	C
		Val	Ala	Glu	Gly	A
		Val	Ala	Glu	Gly	G

23. What is/are the amino acid sequence(s) encoded by a hypothetical mRNA

AUG AAG UUU GGC AAG UUU GGC UAA AAC AAG UUU AAC GGC

- (A) Met Lys Phe Gly Lys Phe Gly
- (B) Met Lys Phe Gly Lys Phe Gly Asn Lys Phe Asn Gly
- (C) Met Lys Phe Gly Lys Phe Gly stop Asn Lys Phe Asn Gly
- (D) Met Lys Phe Gly Lys Phe Gly Gln Asn Lys Phe Asn Gly
- (E) Asn Lys Phe Asn Gly

24. If an insertional mutation is introduced and the mRNA becomes

AUG AAG UUU GGC AAG UUU GGC UCAA AAC AAG UUU AAC GGC

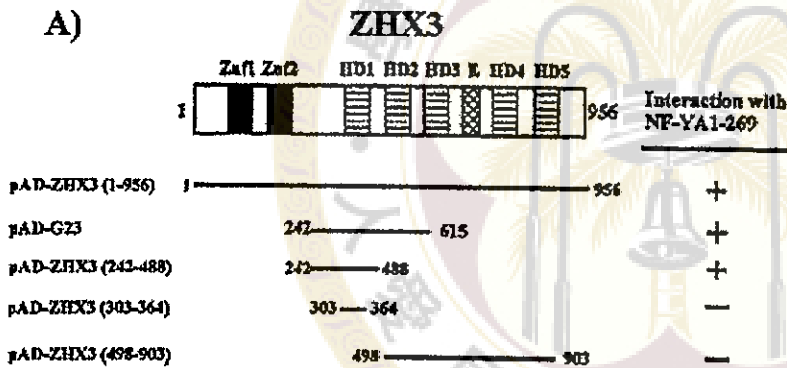
What is/are the amino acid sequence(s) encoded by the mutated mRNA

- (A) Met Lys Phe Gly Lys Phe Gly
- (B) Met Lys Phe Gly Lys Phe Gly Ser Lys Gln Val
- (C) Met Lys Phe Gly Lys Phe Gly Ser Lys Gln Val Arg
- (D) Met Lys Phe Gly Lys Phe Gly Ser Lys Gln Val Arg C
- (E) Met Lys Phe Gly Lys Phe Gly Asn Lys Phe Asn Gly

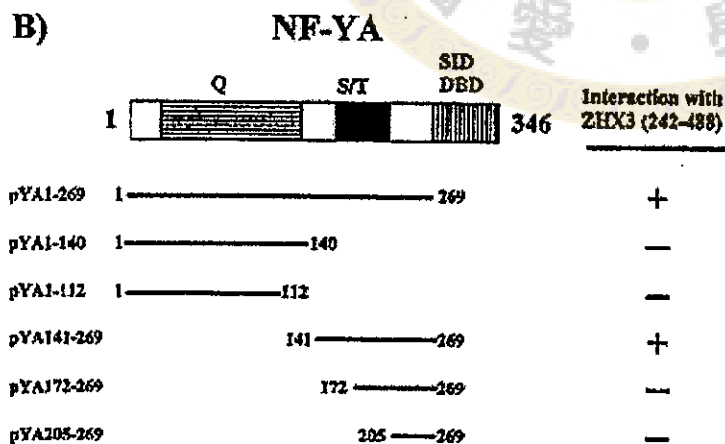
		Second Base				
		C		G		
First Base	T	Phe	Ser	Tyr	Cys	T
	C	Phe	Ser	Tyr	Cys	C
A	T	Leu	Ser	Stop (Ochre)	Stop (Umber)	A
	C	Leu	Ser	Stop (Amber)	Trp	G
G	T	Leu	Pro	His	Arg	T
	C	Leu	Pro	His	Arg	C
U	T	Leu	Pro	Gln	Arg	A
	C	Leu	Pro	Gln	Arg	G
C	T	Ile	Thr	Asn	Ser	T
	C	Ile	Thr	Asn	Ser	C
A	T	Ile	Thr	Lys	Arg	A
	C	Met	Thr	Lys	Arg	G
G	T	Val	Ala	Asp	Gly	T
	C	Val	Ala	Asp	Gly	C
U	T	Val	Ala	Glu	Gly	A
	C	Val	Ala	Glu	Gly	G

25. An experiment mapping the interaction domains between two proteins, NF-YA and ZHX3, is shown below. Where are interaction domains?

A)



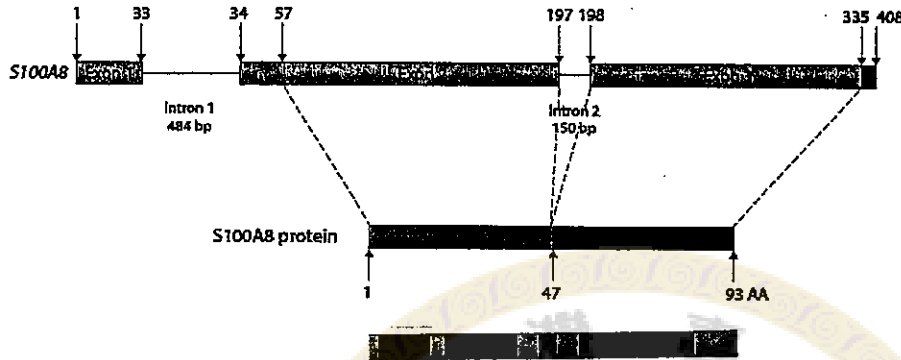
B)



- (A) pAD-ZHX3 242-303 is necessary to interact with NF-YA  
 (B) pAD-ZHX3 242-303 interacts with NF-YA  
 (C) pAD-ZHX3 242-488 is sufficient to interact with NF-YA  
 (D) NF-YA141-269 is sufficient to interact with ZHX3  
 (E) NF-YA141-172 interacts with ZHX3

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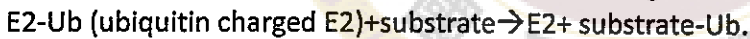
26. A schematic illustration of S100A8 genomic DNA and protein is shown below. Which of the following statement(s) is/are correct?



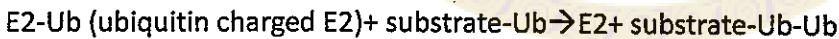
- (A) The length of S100A8 pre-mRNA is 1042 bp without polyA
- (B) The length of S100A8 mRNA is 408 bp without polyA
- (C) The length of S100A8 CDS is 282 bp including the stop codon
- (D) The length of S100A8 5'UTR is 541
- (E) The length of S100A8 3'UTR is 70, not including stop codon

**Questions 27-28**

Ubiquitin is a 76 a.a. small polypeptide that can modify another protein or ubiquitin molecule, a process called ubiquitination. Ubiquitination of a substrate involves an enzymatic cascade that eventually adds one ubiquitin moiety onto target lysine on the substrate. The last enzymatic reaction shown below is catalyzed by ubiquitin E3 ligase.

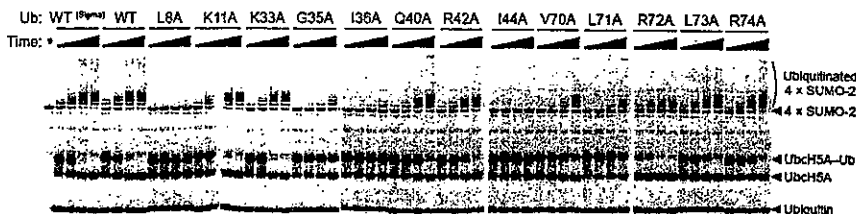


The lysine in the newly conjugated ubiquitin on the substrate can serve as a target lysine for the next run of ubiquitination as shown below.



After several runs of reactions, the substrate is polyubiquitinated.

In the following example, wild type and 13 different mutated ubiquitins are used to assay the kinetics of ubiquitination of 4xSUMO-2.



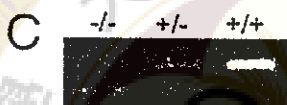
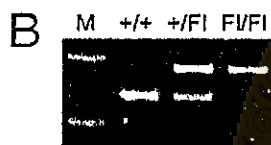
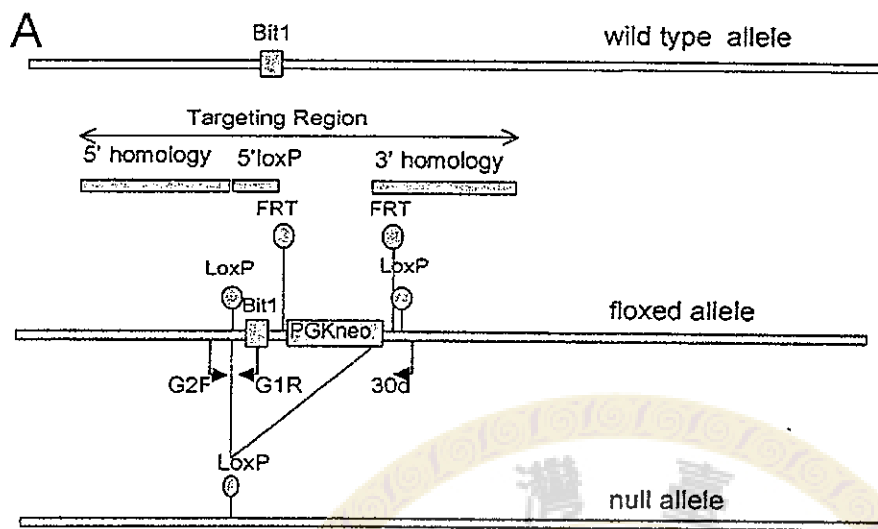


27. Which of the following conclusion(s) about the ubiquitination of 4xSUMO-2 using wild ubiquitin (the second to ninth lanes from the left) is/are correct?
- (A) As ubiquitination reaction goes further with time, more high molecular weight ubiquitinated 4xSUMO-2 molecules become evident.
  - (B) As ubiquitination reaction goes further, the levels of unmodified 4xSUMO-2 decrease with time.
  - (C) As ubiquitination reaction goes further with time, less amount of UbcH5A-Ub remains in reaction.
  - (D) As ubiquitination reaction goes further with time, more UbcH5A molecules are produced.
  - (E) The ubiquitination reaction stops when all UbcH5A-Ub molecules have been used as an ubiquitin donor. Further extension of reaction does not yield more ubiquitinated 4xSUMO-2.
28. The kinetics varies a lot among the mutated Ub used in the ubiquitination reaction. Which of the following conclusion(s) is/are correct?
- (A) The kinetics order from fast to slow is WT, G35A, I44A.
  - (B) The kinetics order from fast to slow is K11A, L8A, R42A.
  - (C) L8A and I44A mutations on Ub completely kill the ubiquitination activity.
  - (D) Ub-K11A and Ub-K33A work almost as efficiently as wild type Ub in the ubiquitination reaction.
  - (E) None of the above.

#### Questions 29-30

The schematic illustration (A) below describes the targeting strategy to generate Bit1 KO mice. The wild-type, floxed, and null alleles are shown. PCR genotyping assay shown in (B) is designed to detect the floxed allele using primers G2F and G1R. M, molecular weight standard. The PCR assay shown in (C) is to genotype MEFs from Bit1 wild-type (+/+), heterozygotes (+/-), and KO (-/-) mice using PCR primers G2F, G1R, and 30d.

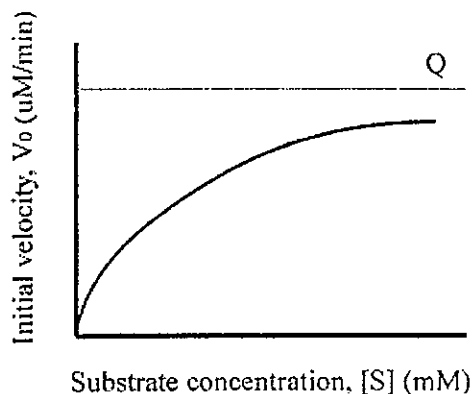
29. Which of the following conclusion(s) about wild-type, floxed, and null alleles is(are) correct?
- (A) The PCR product from floxed (Fl) allele is longer than wild type allele
  - (B) The PCR product from floxed (Fl) allele contains a PGKneo cassette, therefore it is longer than wild type allele.
  - (C) The PCR product from floxed (Fl) allele contains two LoxP sites, therefore it is longer than wild type allele.
  - (D) Using same primers (G2F and G1R), there would be a PCR product from null allele, containing one LoxP site and shorter than wild type allele
  - (E) Using same primers (G2F and G1R), there would be no PCR product from null allele.



30. Which of the following conclusion(s) about MEFs from Bit1 wild-type (+/+), heterozygotes (+/-), and KO (-/-) mice is/are correct?

- (A) When PCR primers G2F, G1R, and 30d are used to genotype wild-type (+/+), heterozygotes (+/-), and KO (-/-), the PCR product from KO (-/-) is amplified by G2F, G1R
- (B) When PCR primers G2F, G1R, and 30d are used to genotype wild-type (+/+), heterozygotes (+/-), and KO (-/-), the PCR product from KO (-/-) is amplified by G2F, 30d
- (C) When PCR primers G2F, G1R, and 30d are used to genotype wild-type (+/+), heterozygotes (+/-), and KO (-/-), the PCR product from KO (-/-) contain one FRT site
- (D) When PCR primers G2F, G1R, and 30d are used to genotype wild-type (+/+), heterozygotes (+/-), and KO (-/-), the PCR product from KO (-/-) contain no FRT site but one Loxp site.
- (E) None of the above

31. The following diagram describes the kinetic features of an enzyme with regard to the concentration of its substrate ([S]), whereas  $V_0$  is the initial reaction velocity catalyzed by the enzyme. Which of the following descriptions are CORRECT?



- (A)  $V_0$  almost linearly increases with  $[S]$  when  $[S]$  is low.
- (B)  $Q$  is the maximal reaction velocity
- (C)  $K_m$  is the substrate concentration when  $V_0$  is one-third of  $Q$
- (D) Enzymes with such features follow the Michaelis-Menton kinetics.
- (E) The curve will shift towards the left for enzymes with larger  $K_m$  values

32. Which of the following statements about carbohydrates in the biological system are CORRECT?

- (A) The abundance and variety of carbohydrates are determined by enzymes that regulate the key biogenesis steps in carbohydrate species
- (B) Proteoglycans are lipid-conjugated carbohydrates that play critical functions in the fluidity of plasma membrane
- (C) Carbohydrates greatly increase the repertoire of surface antigens expressed by pathogens, such as viruses and bacteria
- (D) Glycosylation of proteins is completed in peroxisomes and multivesicular bodies
- (E) Glycosylated parts of the plasma membrane proteins face the extracellular sides

33. Which of the following descriptions about mitochondria are CORRECT?

- (A) Mitochondria are of both paternal and maternal origins in a fertilized zygote
- (B) Association of mitochondria with the endoplasmic reticulum (ER) maintains the normal morphology of mitochondria
- (C) Caspases released from disrupted mitochondria are major effectors for programmed cell death
- (D) The majority of mitochondrial proteins are encoded by mitochondrial DNA
- (E) Mitochondria are the major source of reactive oxygen species in eukaryotic cells

34. Which of the following descriptions about lipid metabolism and synthesis are CORRECT?

- (A) Long-chain fatty acids are first metabolized to acetyl-CoAs through  $\beta$ -oxidation, which then enter the citric acid cycle to generate ATP
- (B) Long-chain fatty acids enter mitochondria through malonic acid shuttles, and they undergo  $\beta$ -oxidation in the mitochondria
- (C) Insulin promotes fatty acid oxidation, whereas glucagon promotes fatty acid synthesis
- (D) HMG-CoA reductase is the rate-limiting enzyme in cholesterol synthesis
- (E) The three major lipid species of biological membranes are phospholipids, sphingolipids and sterols.

35. Which of the following descriptions about amino acids are CORRECT?

- (A) Tryptophan, histidine and phenylalanine are hydrophobic amino acids
- (B) Tyrosine, serine and threonine are common phosphorylation sites of proteins
- (C) Lysine and asparagine carry positive charges
- (D) Glutamate and aspartate carry negative charges
- (E) The transmembrane domain of membrane surface proteins are enriched in glutamine, methionine and isoleucine

36. Which of the following statements about hormone and endocrine systems are CORRECT?

- (A) Insulin is first synthesized as a pre-propeptide and matures through cleavage to become a smaller, functional peptide
- (B) Glucocorticoids and mineralocorticoids are secreted by the adrenal medulla
- (C) The receptor for corticosteroid hormone can directly bind DNA in the cell nucleus
- (D) Dopamine, epinephrine and norepinephrine are all synthesized from the same precursor, tyrosine
- (E) An abnormally high level of thyroid-stimulating hormone (TSH) suggests excessive activity of the thyroid gland (hyperthyroidism)

37. Which of the following description about RNAs are CORRECT?

- (A) Non-coding RNAs constitute the majority of the transcripts and are mostly non-functional, representing merely as evolutionary remnants in gene expression
- (B) Messenger RNAs (mRNAs) are mainly synthesized by RNA polymerase II in eukaryotic cells
- (C) microRNAs mainly function in the transcriptional or post-transcriptional regulation of gene expression by a sequence mis-match mechanism
- (D) RNA cannot serve as carriers of genetic information. Only DNA does.
- (E) RNAs have enzymatic activity

38. Which of the following descriptions about genetics are CORRECT?

- (A) Large-scale mutagenesis screens could be easily carried out in yeast, *C. elegans* and *Drosophila*
- (B) A trans-heterozygote of the diploid animal is the combination of two different alleles of the same gene
- (C) Haplo-insufficiency causes dominant phenotypes by antagonizing the normal protein function, or so-called "dominant-negative effect"
- (D) The chance of homologous recombination is dependent on the distance between two loci on the same chromosome: the closer they are, the more likely for the recombination to occur
- (E) Epigenetic mechanisms are the same as histone regulation of gene expression

39. A plasmid has 4450 base pairs of nucleotides with a single cutting site for a restriction enzyme, HindIII, from nt 1230 to nt 1235. The HindIII site is: 5'AAGCTT3' and HindIII cuts between the two A nucleotides. A graduate student, Valina, is trying to amplify a piece of DNA, which has 800 nucleotides, by PCR from a template, and paste this DNA fragment into the HindIII site. Which of the following statements are CORRECT?

- (A) After digestion of the plasmid with HindIII and run a DNA gel electrophoresis, Valina should get two bands, 1230 and 3220 nucleotides, respectively, on the DNA gel
- (B) The cloning will work only if the 800 nucleotide DNA fragment contains HindIII sites
- (C) The culture medium for bacteria transformed with the ligation mixtures of the plasmid and the DNA fragment should not contain antibiotics
- (D) It will be better for Valina to treat the plasmid with phosphatase after HindIII digestion, because this increases the chance of cloning in the correct orientation
- (E) To amplify the 800 nucleotides DNA, Valina needs a pair of primers that contain the AAGCTT HindIII site sequence.

題號： 201

國立臺灣大學103學年度碩士班招生考試試題

科目：生命科學(A)

節次： 2

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40. Which of the following molecules could serve as second messengers?

- (A) AMP
- (B) Diacyl glycerol
- (C) Calcium
- (D) Inositol 1,4,5-triphosphate (IP3)
- (E) G proteins

