

※ 注意：第 I 大題 1-20 題請於試卷上「選擇題作答區」依序作答。

21-26 題請於試卷上「非選擇題作答區」第一頁作答，並應註明題號。

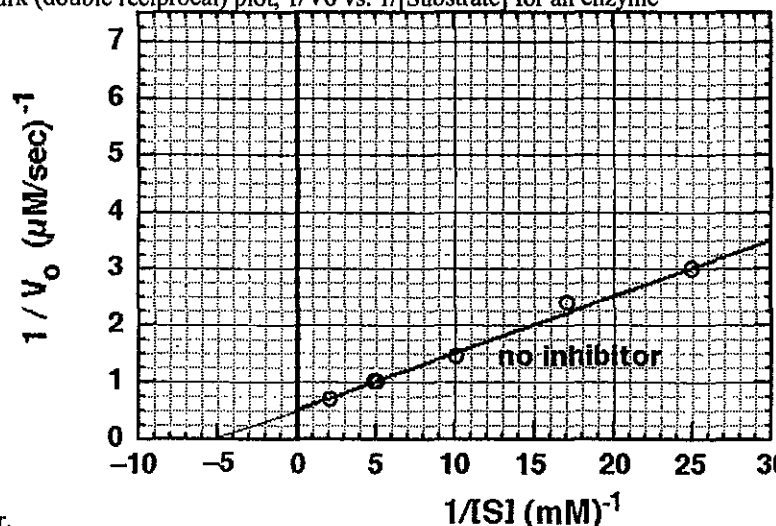
I. Multiple Choice(s) (Note: There may be more than one correct answer. 2.5% per question; 65% in total):

1. Which of the following do NOT need a primer in order to function?
(A) DNA Pol I (B) DNA Pol II (C) DNA Pol III (D) RNA Polymerase (E) Reverse transcriptase
2. Which of the following statements is/are TRUE about ALL topoisomerases?
(A) They relax DNA. (B) They underwind DNA. (C) They change the number of twists (T_w).
(D) They catalyze the breaking and resealing of phosphodiester bonds. (E) All of the above.
3. Nucleosomes (pick up all that apply)
(A) bind to RNA pol II. (B) package eukaryotic DNA. (C) are only present in prokaryotes.
(D) are composed on an octamer of histones and ~150 bp of DNA. (E) metabolize lactose.
4. Which of the following statements is/are CORRECT?
(A) The part of the bacterial RNA polymerase responsible for recognizing the promoter is the sigma subunit.
(B) The RNA primer is removed from the Okazaki fragment by exonuclease.
(C) DNA is replicated semi-conservatively.
(D) DNA ligase does join Okazaki fragments to the high molecular weight DNA chain on the lagging strand.
(E) Eukaryotic RNA polymerase I is specialized to transcribe tRNA.
5. Enhancer regions in eukaryotic DNA is/are
(A) DNA Pol I binding sites. (B) orientation independent. (C) position independent.
(D) promote transcription. (E) bind transcription factors.
6. Which of the following statements is/are CORRECT about DNA repair system?
(A) All DNA repair mechanisms in *E. coli* require DNA ligase.
(B) In *E. coli*, mismatch repair requires DNA polymerase III.
(C) Base-excision DNA repair uses DNA glycosylases to remove damaged bases.
(D) In bacteria, the SOS response starts when DNA damage is extensive. (E) All of the above.
7. Which of the following statements is/are CORRECT about the *E. coli* Lac operon?
(A) It is polycistronic. (B) The mRNA for the repressor binds to the operator. (C) It is an example of negative control.
(D) The repressor binds to the operator. (E) The presence of lactose acts as an inducer.
8. Which of these processes does NOT occur in the nucleus of eukaryotes?
(A) Polyadenylation (B) Pre-mRNA splicing (C) 5'-end capping of mRNAs (D) Translation (E) None of the above.
9. Which of the following statements is TRUE about telomerase or telomeres?
(A) Telomerase uses an RNA component to serve as a primer for synthesis of telomeres.
(B) Cell senescence (cessation of cell division) will occur if telomerase activity is restored.
(C) Somatic cells lack telomerase activity.
(D) Telomeres are needed to protect the circular chromosomes of eukaryotes.
(E) None of the above.
10. Which of the following is/are TRUE about the difference between translation in prokaryotes and eukaryotes??
(A) Only prokaryotes have an initiation factor that binds the 5' cap structure on mRNAs.
(B) Translation and transcription are coupled only in prokaryotes.
(C) A Shine-Dalgarno sequence is needed for initiation of translation of only eukaryotic mRNAs.
(D) Only eukaryotic proteins initiate with a residue of N-formylmethionine.
(E) All of the above.
11. Which of the following statements is/are CORRECT about the *E. coli trp* operon?
(A) Tryptophan acts as an effector molecule. (B) The *trp* operon is subject to catabolite repression.
(C) Tryptophan suppresses the expression of the Trp repressor protein.
(D) The *trp* operon is subject to translational repression.
(E) Trp repressor protein is activated in the presence of tryptophan.

12. Micro-RNAs (miRNAs) and small interfering RNAs (siRNAs) inhibit the expression of specific genes by? (pick up all that apply)

- (A) methylating the genes to prevent their transcription. (B) base pairing with the genes to prevent their transcription.
(C) activating DNases to destroy those genes. (D) repressing their translation. (E) targeting their mRNAs for degradation.

13. Below is a Lineweaver-Burk (double reciprocal) plot, $1/V_o$ vs. $1/[Substrate]$ for an enzyme



in the absence of any inhibitor.

Which of the following statements is/are CORRECT?

- (A) The K_M for this enzyme in the absence of inhibitor is 0.2 mM.
(B) The V_{max} for this enzyme in the absence of inhibitor is 0.2 $\mu\text{M/sec}$.
(C) The K_M for this enzyme in the absence of inhibitor is 2.0 mM.
(D) The V_{max} for this enzyme in the absence of inhibitor is 2.0 $\mu\text{M/sec}$.
(E) The K_M for this enzyme in the absence of inhibitor is -5.0 mM.

14. A polypeptide is cleaved into peptides by treatment with trypsin and cyanogen bromide, and the peptides are purified and sequenced. The sequences of the peptides (from N to C-terminus) are shown below.
(Note: Trypsin cleaves after K and R residues; cyanogen bromide cleaves after M.)

Trypsin peptides

T-1 GASMALIK
T-2 EGAAYHDFEPIDPR
T-3 DCVHSD
T-4 YLIACGPMTK

Cyanogen bromide peptides

C-1 EGAAYHDFEPIDPRGASM
C-2 TKDCVHSD
C-3 ALIKYLIACGPM

Based on sequences of the overlapping peptides generated by treatment with trypsin and cyanogen bromide (shown above), which of the peptides could represent the N-terminus of the polypeptide?

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

15. Which of the following is/are TRUE about the difference between ELISA and immunoblot assays, both of which can be used to detect protein antigens?

- (A) Only immunoblots allow for quantification in the presence of an antigen in a sample.
(B) Only ELISA assays require a purified protein antigen.
(C) Only immunoblots enable an approximation of an antigen's molecular weight.
(D) Only ELISA assays require a secondary antibody.
(E) Only ELISA assays recognize native protein antigen.

16. The dissociation constant (K_d) of the human insulin receptor for insulin is $1 \times 10^{-10} \text{ M}$. What does this mean?

- (A) It means that when the concentration of the insulin receptor is $1 \times 10^{-10} \text{ M}$, half of the available insulin receptor sites are occupied.
(B) It means that when the concentration of the insulin receptor is $1 \times 10^{-10} \text{ M}$, all of the available insulin receptor sites are occupied.
(C) It means that when the concentration of insulin is $1 \times 10^{-10} \text{ M}$, all of the available insulin receptor sites are occupied.
(D) It means that when the concentration of insulin is $1 \times 10^{-10} \text{ M}$, half of the available insulin receptor sites are occupied.
(E) None of the above.

17. Which of the following statements is/are CORRECT?
 - (A) Glucose and galactose are epimers of each other.
 - (B) Cellulose is generally not digestible by animals, whereas starch is easily digestible.
 - (C) Lectins are proteins that bind carbohydrates.
 - (D) Cellulose is a structural polysaccharide in plant cells.
 - (E) All of the above.
18. Which of the following is/are TRUE about the structure of DNA as proposed by Watson and Crick (B-form DNA)?
 - (A) The strands of DNA are parallel. (B) DNA forms a left-handed double helix.
 - (C) The complementary base pairs are held together by hydrogen bonds.
 - (D) A complete turn of the double helix occurs after every base pair.
 - (E) There are two hydrogen bonds between A-T base pairs.
19. Which of the following is TRUE about the structure of nucleotides?
 - (A) Purine nucleotides cannot base pair with pyrimidine nucleotides.
 - (B) Pyrimidine bases are larger than purine bases.
 - (C) Purine and pyrimidine bases are found in DNA and RNA.
 - (D) Thymine base is found in DNA and RNA.
 - (E) None of the above.
20. Which technique is/are normally associated with DNA fingerprinting?
 - (A) Restriction endonuclease digestion (B) DNA microarray analysis (C) Northern blotting
 - (D) Southern blotting (E) The polymerase chain reaction (PCR)
21. Which of the following descriptions is correct for fatty acids?
 - (A) Arachidonic acid is a poly-unsaturated fatty acid with four double bonds at Δ^5 , Δ^9 , Δ^{12} and Δ^{15} .
 - (B) In nearly all naturally occurring unsaturated fatty acids, the double bonds are in the trans configuration.
 - (C) Poly unsaturated fatty acids have higher melting points than fully saturated fatty acids.
 - (D) Fatty acid derivatives, such as esters and amides, are generally less soluble in water than the free fatty acids.
 - (E) The longer the fatty acyl chain and the fewer the double bonds, the lower is the solubility in water.
 - (F) All the derivatives of phosphatidic acids are negative-charged.
22. Which of the following techniques has been used for observation of protein-protein interaction?
 - (A) FRAT (fluorescence recovery after photobleaching) (B) FRET (fluorescent resonance energy transfer)
 - (C) FISH (fluorescent *in situ* hybridization) (D) AFM (atomic force microscopy)
23. How can phosphatidylcholine diffuse from the outer leaflet of the bilayers to the inner?
 - (A) By passive diffusion. (B) By catalysis. (C) By transporter. (D) By flippase. (E) By phospholipase. (F) By SNARE complex.
24. Which of the following neurotransmitters is the derivative of tyrosine?
 - (A) Dopamine (B) Norepinephrine (C) γ -amino-butyric acid (GABA) (D) Acetylcholine (E) Serotonin
25. If you can label glucose with ^{14}C at any position or combination of positions, for yeast fermenting glucose to ethanol, which form of labeled glucose would give the most radioactivity in CO_2 and the least in ethanol?
 - (A) C-1 (B) C-2 (C) C-3 (D) C-4 (E) C-5 (F) C-6.
26. Which of the following reaction(s) does(do) NOT occur in the inner membrane of mitochondria?
 - (A) The malate shuttle (B) The transport of pyruvate (C) ATP synthesis (D) Citric acid cycle.

II. Matching (2% per question; 10% in total); Link the following basic mechanisms in signal transduction to the relevant example(s) by picking up one item from Column B to fill in the blank in Column A.

※ 注意：請於試卷上「非選擇題作答區」依序作答，並應註明作答之題號。

Column A

1. Gated ion channels: _____
2. G protein-coupled receptors (GPCRs): _____
3. Receptors with no intrinsic enzyme activity: _____
4. Receptors with intrinsic enzyme activity: _____
5. Nuclear receptors: _____

Column B

- | | |
|---|---|
| A) Nicotinic acetylcholine receptor | H) NADH |
| B) Aquaporin | I) Glucose transporter GLUT1 |
| C) ABC transporter | J) NADPH |
| D) Estrogen receptor | K) TNF (tumor necrosis factor) receptor |
| E) FADH ₂ | L) Insulin receptor |
| F) FMN | M) ANF (atrial natriuretic factor) receptor |
| G) Voltage-gated Ca ²⁺ channel | N) β-adrenergic receptor |

III. Answer the following questions (25% in total):

1. The addition of oligomycin to mitochondria markedly decreases both the rate of electron transfer from NADH to O₂ and the rate of ATP formation. The subsequent addition of DNP leads to an increase in the rate of electron transfer without changing the rate of ATP formation. What does oligomycin inhibit? (5%)
2. The adenosine A2A receptor is coupled to G_s, while the adenosine A1 receptor is coupled to G_i in the same neurons. Predict the cAMP level (increase or decrease) upon adenosine treatment in the neurons after the following molecular perturbations:
 - (1) Overexpression of recombinant molecules containing the extracellular sequences of the adenosine A2A receptor joined to the cytosolic sequences of the adenosine A1 receptor. (2%)
 - (2) Overexpression of recombinant molecules containing the extracellular sequences of the adenosine A1 receptor joined to the cytosolic sequences of the adenosine A2A adenosine receptor. (2%)
 - (3) Using RNAi to silence the adenosine A1 receptor. (2%)
 - (4) Using RNAi to silence the adenosine A2A receptor. (2%)
 - (5) Using RNAi to silence the phosphodiesterase. (2%)
3. Draw the diagram to describe how G-protein coupled receptors (GPCRs) can transduce its signal to gene expression. (10%)