

1. What would be the pH and concentration of the resulting buffer solution when 3.48 g of K_2HPO_4 and 2.72 g of K_2HPO_4 are dissolved in 250 ml of deionized water? [Hint: use Henderson-Hasselbach equation to solve the problem. Phosphoric acid has $pK_{a1}=2.12$; $pK_{a2}=7.21$; $pK_{a3}=12.32$]. (10%)
2. The following events, steps, or reactions occur during *E. coli* DNA replication. For each entry in Column A, select the appropriate entry in Column B. Each entry in A may have more than one answer, and each entry in B can be used more than once. (13%)

Column A

- _____ a. Unwinds the double helix
- _____ b. Prevents reassociation of complementary bases
- _____ c. Is a RNA polymerase
- _____ d. Is a DNA polymerase
- _____ e. Is the "repair" enzyme
- _____ f. Is the major elongation enzyme
- _____ g. A 5' → 3' polymerase
- _____ h. A 3' → 5' polymerase
- _____ i. Has 5' → 3' exonuclease function
- _____ j. Has 3' → 5' exonuclease function
- _____ k. Bonds free 3'-OH end of a polynucleotide to a free 5' monophosphate end of polynucleotide
- _____ l. Bonds 3'-OH end of a polynucleotide to a free 5' nucleotide triphosphate
- _____ m. Separates daughter molecules and causes supercoiling

Column B

- A Polymerase I
- B Polymerase III
- C Helicase
- D Primase
- E Ligase
- F SSB protein
- G Gyrase
- H None of these

3. A bottle contains 1 mCi of L-phenylalanine -C¹⁴ (uniformly labeled) in 2.0 ml of solution. The specific activity of the labeled amino acid is given as 150 m Ci/mmole. Calculate (a) the concentration of L-phenylalanine in the solution and (b) the activity of the solution in terms of CPM/ml at a counting efficiency of 80%. [Hint: 1 curie = 2.22 x 10¹² DPM; CPM = counting efficiency x DPM (5%)
4. A gene makes a polypeptide 30 amino acids long containing an alternating sequence of phenylalanine and tyrosine. What are the sequences of nucleotides corresponding to this sequence in the following: (8%)
- The DNA strand which is read to produce the mRNA, assuming Phe = UUU and Try = UAU in mRNA
 - The DNA strand which is not read
 - The sequence that is meant to be the gene
 - tRNA

Directions: Each of the following questions contains five suggested answers. Choose the one best response to each question. Two points for each question.

5. Which of the following electrophoretic analytic procedures does not depend on the charge of the protein?
- (1) moving boundary electrophoresis.
 - (2) zone electrophoresis.
 - (3) polyacrylamide gel electrophoresis in sodium dodecyl sulfate.
 - (4) isoelectric focusing.
 - (5) none of the above.
6. The specific activity of an enzyme is
- (1) the amount of enzyme that produces 1 mol of product per second under standard conditions.
 - (2) the activity of an enzyme in relation to a standard preparation of the enzyme.
 - (3) the number of enzyme units per milligram of enzyme protein.
 - (4) the amount of enzyme causing transformation of 1 umol of substrate per minute under standard conditions.
 - (5) the activity of an enzyme in the presence of its preferred substrate.
7. The Michaelis-Menten constant (K_m) is
- (1) numerically equal to $V_{max}/2$.
 - (2) the equilibrium constant for the dissociation of ES to E + P.
 - (3) increased in value with increasing affinity of the enzyme for its substrate.
 - (4) the substrate concentration at $1/2 V_{max}$.
 - (5) the intercept on the $1/v$ axis of a Lineweaver-Burk transform.

8. Which of the following compounds can serve as neurotransmitters?
- (1) norepinephrine
 - (2) 5-hydroxytryptamine
 - (3) dopamine
 - (4) γ -aminobutyrate
 - (5) all of the above
9. Deoxyribonucleotides are formed by reduction of
- (1) ribonucleosides.
 - (2) ribonucleoside monophosphates.
 - (3) ribonucleoside diphosphates.
 - (4) ribonucleoside triphosphates.
 - (5) none of the above.
10. Restriction endonucleases are enzymes that
- (1) cleave the 5' terminal nucleotides from duplex DNA molecules.
 - (2) make sequence-specific cuts in both strands of duplex DNA molecules.
 - (3) promote circularization of the duplex DNA molecule by removal of the 5' terminal nucleotides.
 - (4) generate 3'-hydroxyl and 5' phosphate ends in the cut DNA strands.
 - (5) (2) and (4).
11. Enzymes increase the rates of reactions by
- (1) increasing the free energy of activation.
 - (2) increasing the free-energy change of the reaction.
 - (3) changing the equilibrium constant of the reaction.
 - (4) decreasing the energy of activation.
 - (5) decreasing the free-energy change of the reaction.
12. How the genetic traits are carried over from one generation to another of any living organism? (5%)
13. In a dividing eukaryotic cell, generally how many phases (or stages) are described in the cell cycle? (2%) Why existing different phases in eukaryotes but not in prokaryotes? (3%)
14. When you feel hungry, glucagon is released into the blood stream. What's the biochemical event can be induced inside the liver cell? (5%) One the other hand, insulin is released into the blood stream after a rich meal. How insulin makes liver cell store glucose from the blood stream? (5%)

15. Different phospholipases can hydrolyze phospholipids at different ester bonds. Please fill out each name of the enzymes in the following figure (A to D) (4%). Arachidonic acid is an important fatty acid for the synthesis of Prostaglandin E₁ and other biological effectors. Which enzyme is required for releasing arachidonic acid from the lipid? (E) (1%)

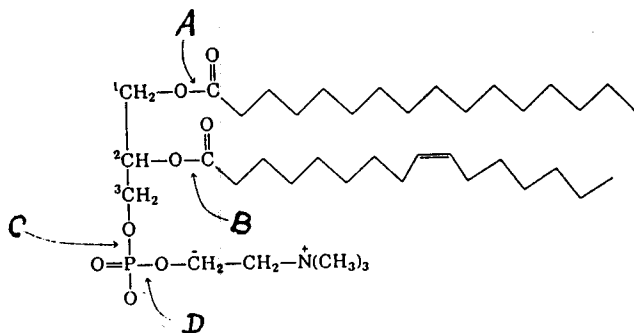
A: _____

B: _____

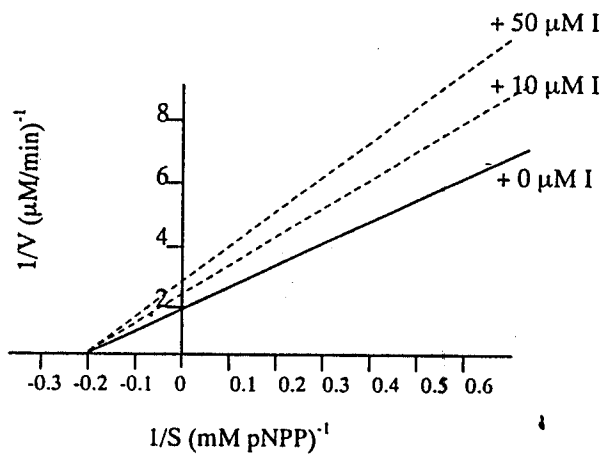
C: _____

D: _____

E: _____



16. What is the general picture of mRNA harvested from mammalian cells? (5%)
17. The following Lineweaver-Burk plot is derived from an inhibitor (I) that block the enzymatic activity of cdc25B phosphatase on the digestion of p-nitrophenyl phosphate (pNPP). Please calculate the K_m and V_{max} of this enzyme. (4%) What is the inhibition mechanism of this I compound on cdc25B phosphatase? (2%)



18. Briefly explain the following terms:
- intron and exon (2%)
 - operon (2%)
 - kinase and phosphatase (2%)
 - oncogene and proto-oncogene (2%)
 - PCR (Polymerase Chain Reaction) (2%)
 - TCA cycle (4%)