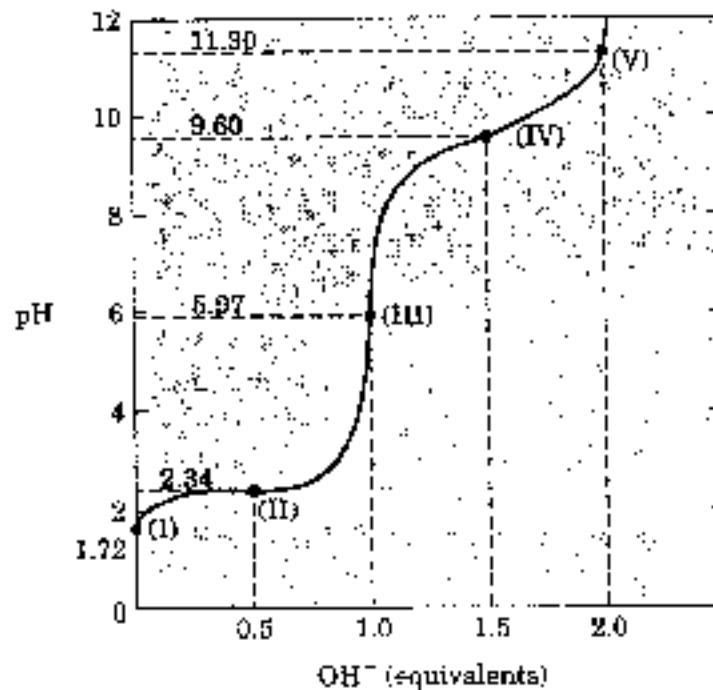## Part I.

1. The titration curve of glycine is: (6%)

a. Please show the structure of glycine as a Zwitterionic form.
b. At what points does glycine have its maximum buffering capacity?
c. At what point is the average net charge zero?
d. At what point is the average net charge of glycine -1?

2. List the precusors needed to make the leading versus lagging strands during DNA replication in E. Coli? (4%)

3. The pKa value for adenine (N-1) is 4.2. Please calculate the percentage of the group in protonated form at pH 7.2. (3%)

4. In samples of DNA isolated from two identified species of bacteria, adenine makes up 32 and 17% of the total bases, respectively. What relative proportions of adenine, guanine, thymine and cytosine would you expect to find in the two DNA samples? One of these bacteria was isolated from a hot spring (64°C). Which DNA came from this species? Why? (6%)

5. An E. Coli cell is growing in a solution with glucose as the sole carbon source. Tryptophan is suddenly added. The cell continue to grow and divide every 30 minutes. Describe how the amount of tryptophan synthase activity in the cell changes if
a. the trp mRNA is degraded showly over many hours.
b. The trp mRNA is degraded rapidly, but tryptophan synthase is stable.
c. The trp mRNA and tryptophan synthase are both degraded rapidly.
(6%)

Part II.

1. Please briefly draw an energy diagram schematically indicating the electronic states of chlorophyll and their most important modes of interconversion. (5 %)

2. Why is the oxidation of succinate to fumarate only associated with the production of two ATP's during oxidative phosphorylation, while that of malate to oxaloacetate with three ATP's? (10 %)

3. Calculate the equilibrium concentrations of reactants and products for the reaction:

Acetoacetate⁻ + NADH + H⁺ <——-—> β-hydroxybutyrate⁻ + NAD⁺
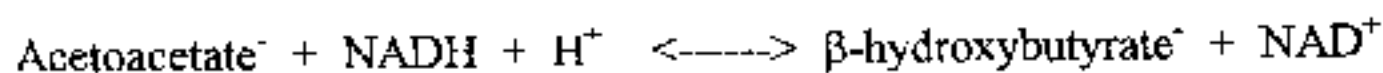
when the initial concentrations of acetoacetate⁻ and NADH are 0.01 and 0.005 M, respectively, and β-hydroxybutyrate and NAD⁺ are initially absent. Assuming the reaction has taken place at 25°C and pH 7, and the standard reduction potentials of half reactions involved are:

(1). Acetoacetate⁻ + 2 H⁺ + 2 e⁻ <——-—> β-hydroxybutyrate⁻
$E^{o'} = -0.346$ V

(2). NAD⁺ + H⁺ + 2 e⁻ <----> NADH
$E^{o'} = -0.32$ V
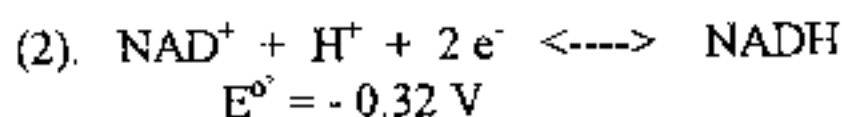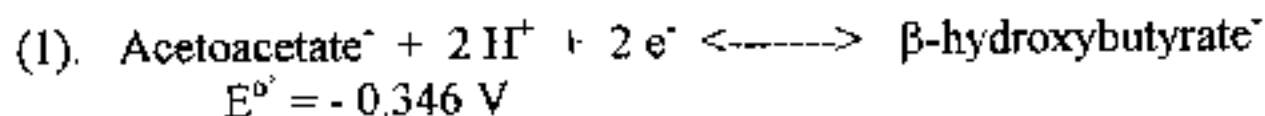
(Partial credit will be given for the derivation of calculation.) (10 %)

4. What are affinity, size exclusion, ionic chromatographies? Please indicate their general principles. (5 %)

5. How do you determine the molecular weight, the number of subunit, subunit composition, and probable subunit structure of an oligomeric protein? (10 %)

6. Please indicate schematically the reaction mechanisms of different types of enzyme inhibition. Please also show their Lineweaver-Burk plots. (10 %)

7. Please indicate the general principles for PCR (polymerase chain reaction). (5 %)

8. Please briefly describe the replication mechanism of *E. coli* chromosomes. (10 %)

9. Please briefly describe each steps in translation mechanism. (10%)