## CHEM106 Test 2 Examination You must show all equations and all work to receive any credit

1. Calculate the Nernst equilibrium potential, in mV, for the bicarbonate ion (HCO<sub>3</sub><sup>-</sup>) in a cell that has an extracellular concentration of 27 mM and an intracellular concentration of 8 mM. Draw a clearly labeled diagram showing the electric potential and concentration gradient across a bicarbonate ion channel at equilibrium. Do not account for any other ions that may be present.

- 2. For a cell with a resting membrane potential of -70 mV:
  - a. Explain why cells have this resting membrane potential; clearly outline the basis for this.
  - b. Neglect the resting membrane potential and calculate the change in Gibbs Free Energy required to move a mole of bicarbonate ions from the outside to the inside of a cell down the bicarbonate ion concentration gradient. Use the same intracellular and extracellular bicarbonate ion concentrations identified in the earlier question.
  - c. Now neglect the bicarbonate ion (HCO<sub>3</sub><sup>-</sup>) concentration gradient and calculate the change in Gibbs Free Energy required to move a mole of bicarbonate ions from the outside to the inside of a cell across the -70 mV electric resting potential.
  - d. If a bicarbonate ion channel were to open, explain what would spontaneously occur, why, and whether this would have an inhibitory or excitatory neural effect? Draw a diagram and clearly support your answer using the diagram.

3. Discuss the four classes of substances that have been historically used to treat depression and clearly outline the molecular mechanism of action for each class.

- 4. Outline the mechanism of action of oxycodone medications with each of the following receptors:
  - $\alpha$ .  $\mu$  opioid receptors
  - b. ĸ opioid receptors
  - c.  $\delta$  opioid receptors
- 5. Outline the complete mechanism of action for local anesthetics.

- 6. Draw the complete Lewis structure for each of the following molecules at physiological pH of 7.4 [except for aromatic rings, show all atoms, bonds, lone pairs, and full charges (not partial charges)].
  - a. Acetylcholine
  - b. Dopamine
  - c. Amphetamine

7. Draw the structure of an acetylcholine molecule at physiological pH of 7.4 that is situated in the active site of acetylcholinesterase. Draw a diagram and clearly show the mechanism of action that the enzyme uses to break down acetylcholine. You must show the key amino acid side chains involved to include all atoms, bonds, lone pairs for each. Clearly label the processes that occur.

8. Draw the interaction diagram of an adrenergic receptor with its ligand at the binding site; illustrate at least four separate ligand receptor interactions. Draw the complete molecular structure of both the ligand and the various side groups.

9. Understanding the signaling mechanism for GPCRs is central to modern biomedical research. Nearly half of the new medicines being developed specifically target GPCRs. This week, the international journal *Cell* published a research article entitled *"Signaling of a GPCR Heteromeric Complex Reveals a Unifying Mechanism of Action of Antipsychotic Drugs."* Outline the complete sequence of steps and the mechanisms involved in GPCRs. Use diagrams and detailed explanations to support your answer.