Name Key

Chem 452 - Fall 2012 - Quiz 1

1. Short answers:
   a. Who is credited with disproving the *Vital Force Theory* in biology by demonstrating that a biologically associated, organic molecule (urea) could be synthesized from a non-biological salt (ammonium cyanate)?

      Fredrich Wöhler

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   b. Who was the first to publish a proposed structure for DNA? (Hint: It is not Watson & Crick.)

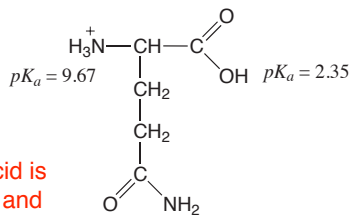
      Linus Pauling (and Robert Corey)

   c. Cite two pieces of evidence that support the theory that all current life forms evolved from a common ancestor.
      i. All living organisms share the same major macromolecules (DNA and proteins), which are made of the same building blocks (nucleotides and amino acids).

      ii. All living organisms share the genetic code for translating a nucleotide sequence into a protein sequence.

      The more closely related two organisms are to one another, the more similar the sequences are for proteins that carry out the same function in the two organisms.

2. Shown to the right is the structure for the amino acid glutamine. This amino acid has two ionizable groups, shown here in their protonated (acidic) forms.



   a. What is the *pH* of a 0.05 M solution of glutamic acid when dissolved in its fully protonated form? (Hint: Consider only the effect of the most acidic of the two ionizable groups.)

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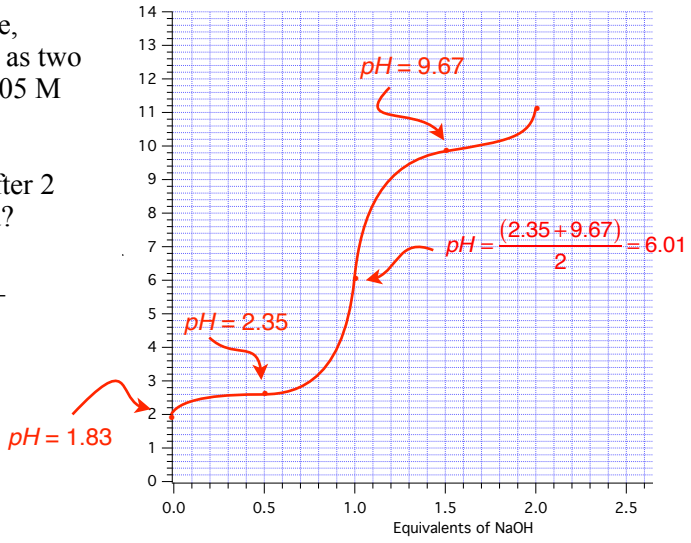
To the first approximation, the hydrogen ion concentration, $[H^+]$, for a weak acid is equal to the square root of the product of the acide dissociation constant, K_a, and the concentration C:

$$[H^+] = \sqrt{K_a \cdot C} = \sqrt{10^{-pK_a} \cdot C}$$

$$= \sqrt{10^{-2.35} \cdot 0.05\ M} = 1.49 \times 10^{-2}\ M$$

$$pH = -\log([H^+]) = -\log(1.49 \times 10^{-2}) = 1.83$$

   b. Sketch the titration curve for glutamine, starting with its fully protonated form, as two equivalents of NaOH are added to a 0.05 M solution of glutamine.



   c. What is the net charge on glutamine after 2 equivalents of NaOH have been added?

      Net charge = −1

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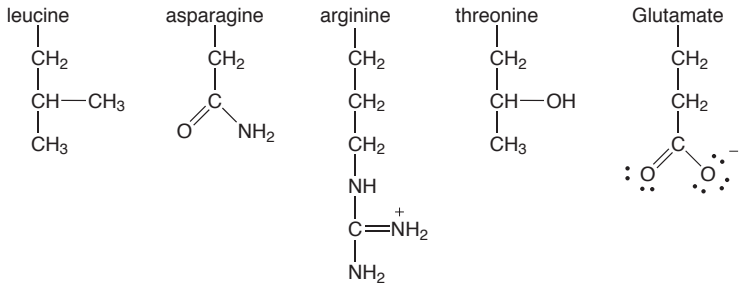
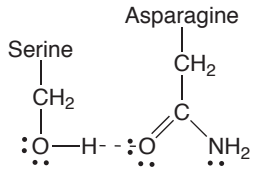
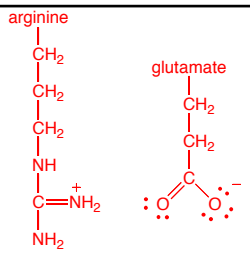
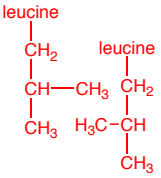
3. The side chains of the amino acids used to build proteins present a wide range of options for non-covalent interactions. Below are some examples of amino acid side chains, as they exist at *pH* 7:



a. For each non-covalent interaction listed below, use the chemical structures of the amino acid side chains shown above to illustrate each interaction. An example is shown. You may use the same amino acid twice for a given example.

Interaction	Example
Hydrogen bonding	
Charge/Charge	
Hydrophobic Interactions	
A second example of Hydrogen bonding