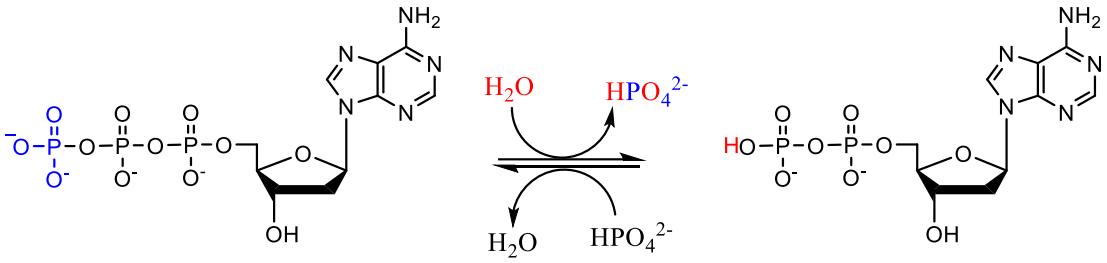
BCH4053.0002 Spring 2020
Topic: Water and Buffer Systems

More than just a solvent: Water is a direct participant in some biochemical reactions, for instance,



Propose the role of water in the reaction above:

Buffer Solutions: Biological reactions are carried out at a very narrow pH range; the pH is controlled by various buffer systems. In the human blood, for instance, the pH is maintained at a narrow range between 7.35- and 7.45and is buffered in part by carbonic acid (H_2CO_3), which is formed from dissolved carbon dioxide and water in the blood. The bicarbonate buffer system depends on the equilibrium between carbonic acid and bicarbonate (HCO_3^-), a reaction catalyzed by carbonic anhydrase.

Draw the equilibrium between carbonic acid and bicarbonate, and write out its equilibrium constant expression:

Describe how the Henderson-Hasselbalch equation may help correlate to the pH of a buffered solution:

Example: A buffered aqueous solution is prepared using H_2CO_3 with pKa values of 6.35 and 10.33. Assuming that the $[H_2CO_3]$ is 10 times larger than the $[HCO_3^-]$ in the described solution, determine the pH of the solution: (*Note*: no other ionization states of carbonic acid are present; log(10) = 1; log(0.1) = -1).

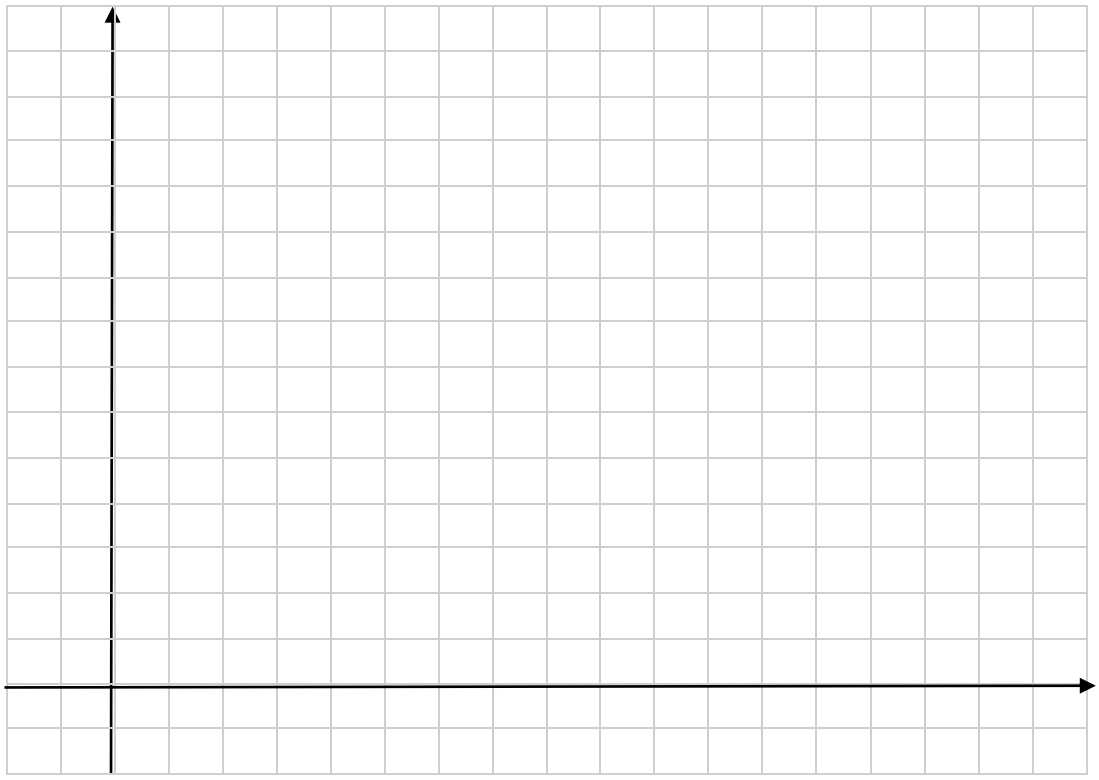
Explain if this particular solution would be more suitable to resist changes in pH upon addition of acid or base?

Aspartic Acid:
Aspartic Acid is an essential proteinogenic amino-acid with three ionizable groups: its amino group has a pK_a of 9.90, the carboxylic acid group attached to the alpha carbon has a pK_a of 1.99, while the carboxylic acid group on its side chain has a pK_a of 3.90.

Sketch out the structure of aspartic acid
and give its one and three letter abbreviation.

Draw aspartic acid in its fully protonated form and show each of its possible ionization reactions.

Sketch a titration curve for aspartic acid in an aqueous solution.



Indicate which two specifies are present at each of the half equivalence points, and the relative concentration of each.