Acid Base Online Tutorial

University of Connecticut

Acid Buffering

One of the major ways in which large changes in H+ concentration are prevented is by buffering. The body buffers which are primarily weak acids, are able to take up or release H+ so that changes in the free H+ concentration are minimized. Buffers are located in the extracellular fluid (ECF), intracellular fluid and bone.

Extracellular Buffers

The most important buffer in the ECF and the body is **HCO3-** (bicarbonate) which combines with excess H+ ions to form carbonic acid.

Take for instance an acid load of H2SO4 produced via metabolism of methionine:

H2SO4 + 2NaHCO3 → NA2SO4 + 2H2CO3 →2CO2 + 2H2O + NA2SO4.

Note in this buffering reaction that bicarbonate reacts with a strong acid to form a weaker acid(H2CO3) which then dissociates into CO2 and H2O. The CO2 produced here does not reform H2CO3 because it is then excreted by the lungs. Note that HCO3- is used up in this reaction. So that pH is not affected, the HCO3- used up in this process must be regenerated and the NA2SO4 must be excreted by the kidneys.

The CO2/HCO3- buffer system is considered very effective because of the vast quantity of bicarbonate in the body and the ability to excrete the CO2 formed via ventilation.

Other less important buffers in the ECF are plasma proteins and inorganic phosphates.

Intracellular Buffers

The primary intracellular buffers are proteins, organic and inorganic phosphates and in the RBC, **hemoglobin (HB-).** Whereas buffering by plasma HCO3- occur almost immediately, approximately **2-4 hours** is required for buffering by cell buffers due to slow cell entry.

Hemoglobin is a very important buffer in RBCs, particularly in the role of carbonic acid buffering.

It should also be noted that transcellular uptake of hydrogen ions by cells result in the passage of Na+ and K+ ions out of cells to maintain electroneutrality. This process can substantially affect potassium balance as will be discussed later.

Bone

Bone represents an important site of buffering acid load. An acid load, is associated with the uptake of excess H+ ions by bone which occurs in exchange for surface Na+ and K+ and by the dissolution of bone mineral, resulting in the release of buffer compounds, such as $NaHCO_3$, $CaHCO_3$, and $CaHPO_4$.

It has been estimated that at least 40% of the buffering of an acute acid load takes place in bone. Chronic acidosis can have very adverse effects on bone mineralization due to this process and can result in bone diseases such as rickets, osteomalacia and osteopenia.

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