Blood Acid-Base Control

The human body has certain physiological mechanisms designed at maintaining physiological conditions. For example, the body regulates the pH of blood using multiple physiological systems. This Picmonic will focus on acidemia and how the body responds to it. Acidemia is a blood pH <7.35 and results from either excess CO2 levels (respiratory acidosis) or excess hydrogen levels (metabolic acidosis). Alkalosis is the opposite, with pH >7.35 and is caused by either a lack of CO2 (respiratory alkalosis) or an excess of bicarbonate (metabolic alkalosis). The lungs and kidneys can control this balance through their regulation of CO2 levels and hydrogen/bicarbonate levels, respectively. The lungs are controlled by medullary chemoreceptors which detects blood pH and sends inputs to the diaphragm and external intercostal muscles to respond accordingly. In response to acidosis, ventilation rate increases resulting in CO2 exhalation and therefore an increase in pH. The kidneys alter acid/base status by their handling of both hydrogen and bicarbonate. In acidosis, the kidneys increase bicarbonate reabsorption into the blood, causing an increase in pH. Finally, the kidney can excrete hydrogen ions into the urine, which results in less acidic blood and therefore an elevated blood pH.



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Characteristics

In a State of Acidemia

Too many H+ in blood

When the body detects that there are high levels of protons in blood (causing blood to be excessively acidic), it reacts through multiple organ systems to restore blood back to its neutral or slightly alkaline state.

Medullary Chemoreceptors Control Ventilation Rate

Medusa Ordering lungs to Breathe harder

The medulla has chemoreceptors which measure the pH of the blood. They respond to decreased blood pH by increasing the ventilation rate of the lungs through nervous system innervation of the diaphragm and external intercostal muscles. This increased exhalation of CO2 will cause a compensatory increase in pH.

Expulsion of CO2 through Lungs Increases pH

Lung-guy exhaling CO2 through Up-arrow pH-strip

By increasing the ventilation rate, the medulla forces the expulsion of carbon dioxide through the lungs. This shifts the buffer system away from producing protons, due to LeChatlier's principle. Thus, as CO2 levels decrease, pH increases.

Bicarbonate Reabsorption from the Kidney Increases pH

Kidney eating Bi-car-bomb with Up-Arrow pH-strip

Another method of increasing blood pH is by increasing the bicarbonate reabsorption from the kidney. As bicarbonate levels in the blood increase, the blood pH increases as well.

Kidney Excretion of H+ Increases pH

Kidney excreting H+ into Up-arrow pH-urinal

The kidney can excrete excess hydrogen ions into the urine, which can directly increase the blood's pH.

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