Overview of Acid–Base Balance By James L. Lewis III, MD, Brookwood Baptist Health and Saint Vincent's Ascension Health, Birmingham Last full review/revision Jul 2021| Content last modified Sep 2022 CLICK HERE FOR THE PROFESSIONAL VERSION Control of Acid–Base Balance Types of Acid–Base Disorders An important property of blood is its degree of acidity or alkalinity. The acidity or alkalinity of any solution, including blood, is indicated on the pH scale. The pH scale, ranges from 0 (strongly acidic) to 14 (strongly basic or alkaline). A pH of 7.0, in the middle of this scale, is neutral. Blood is normally slightly basic, with a normal pH range of about 7.35 to 7.45. Usually the body maintains the pH of blood close to 7.40. A doctor evaluates a person's acid–base balance by measuring the pH and levels of carbon dioxide (an acid) and bicarbonate (a base) in the blood. Blood acidity increases when the Level of acidic compounds in the body rises (through increased intake or production, or decreased elimination) Level of basic (alkaline) compounds in the body falls (through decreased intake or production, or increased elimination) Blood alkalinity increases when the level of acid in the body decreases or when the level of base increases. Control of Acid–Base Balance The body's balance between acidity and alkalinity is referred to as acid–base balance. The blood's acid–base balance is precisely controlled because even a minor deviation from the normal range can severely affect many organs. The body uses different mechanisms to control the blood's acid–base balance. These mechanisms involve the Lungs Kidneys Buffer systems Role of the lungs One mechanism the body uses to control blood pH involves the release of carbon dioxide from the lungs. Carbon dioxide, which is mildly acidic, is a waste product of the processing (metabolism) of oxygen and nutrients (which all cells need) and, as such, is constantly produced by cells. It then passes from the cells into the blood. The blood carries carbon dioxide to the lungs, where it is exhaled. As carbon dioxide accumulates in the blood, the pH of the blood decreases (acidity increases). The brain regulates the amount of carbon dioxide that is exhaled by controlling the speed and depth of breathing (ventilation). The amount of carbon dioxide exhaled, and consequently the pH of the blood, increases as breathing becomes faster and deeper. By adjusting the speed and depth of breathing, the brain and lungs are able to regulate the blood pH minute by minute. Role of the kidneys The kidneys are able to affect blood pH by excreting excess acids or bases. The kidneys have some ability to alter the amount of acid or base that is excreted, but because the kidneys make these adjustments more slowly than the lungs do, this compensation generally takes several days. Buffer systems Yet another mechanism for controlling blood pH involves the use of chemical buffer systems, which guard against sudden shifts in acidity and alkalinity. The pH buffer systems are combinations of the body's own naturally occurring weak acids and weak bases. These weak acids and bases exist in pairs that are in balance under normal pH conditions. The pH buffer systems work chemically to minimize changes in the pH of a solution by adjusting the proportion of acid and base. The most important pH buffer system in the blood involves carbonic acid (a weak acid formed from the carbon dioxide dissolved in blood) and bicarbonate ions (the corresponding weak base). Types of Acid–Base Disorders There are two abnormalities of acid–base balance: Acidosis: The blood has too much acid (or too little base), resulting in a decrease in blood pH. Alkalosis: The blood has too much base (or too little acid), resulting in an increase in blood pH. Acidosis and alkalosis are not diseases but rather are the result of a wide variety of disorders. The presence of acidosis or alkalosis provides an

important clue to doctors that a serious problem exists. Types of acidosis and alkalosis Acidosis and alkalosis are categorized depending on their primary cause as Metabolic Respiratory Metabolic acidosis and metabolic alkalosis are caused by an imbalance in the production of acids or bases and their excretion by the kidneys. Respiratory acidosis and respiratory alkalosis are caused by changes in carbon dioxide exhalation due to lung or breathing disorders. People can have more than one acid–base disorder. Compensation for acid–base disorders Each acid–base disturbance provokes automatic compensatory mechanisms that push the blood pH back toward normal. In general, the respiratory system compensates for metabolic disturbances while metabolic mechanisms compensate for respiratory disturbances. At first, the compensatory mechanisms may restore the pH close to normal. Thus, if the blood pH has changed significantly, it means that the body's ability to compensate is failing. In such cases, doctors urgently search for and treat the underlying cause of the acid–base disturbance.