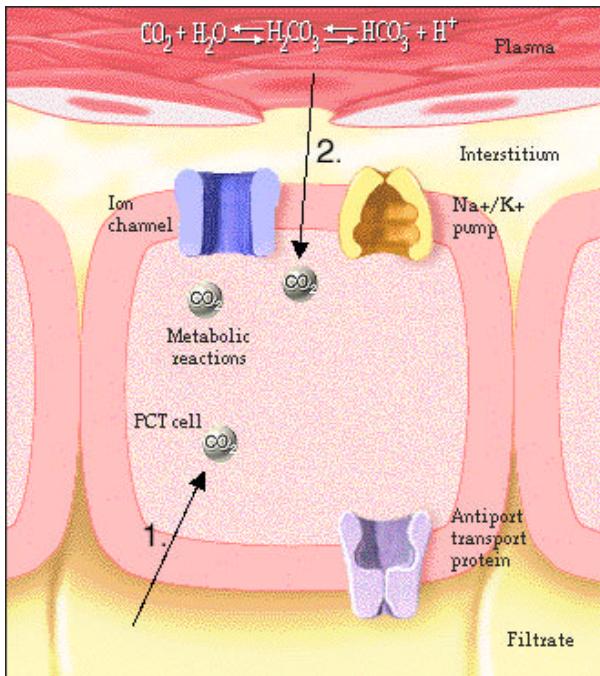
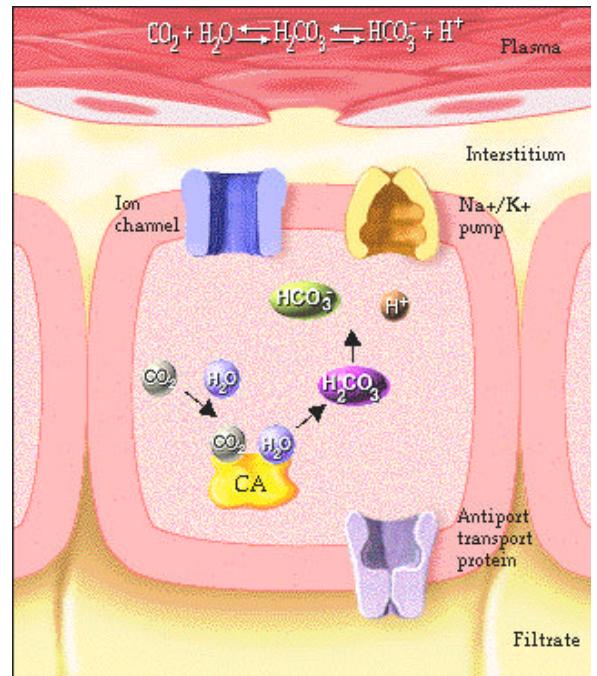


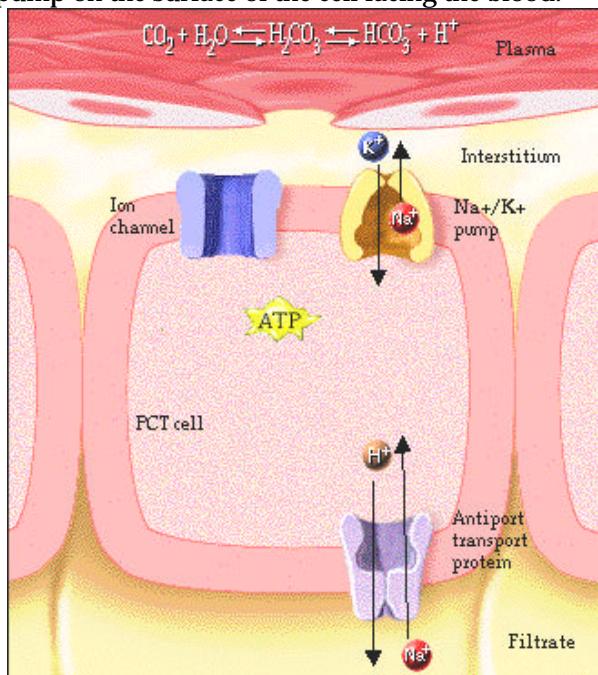
74. (1) Carbon dioxide arrives at the kidney tubule cell in the proximal convoluted tubule from the filtrate, plasma, or from metabolic reactions within the cell.



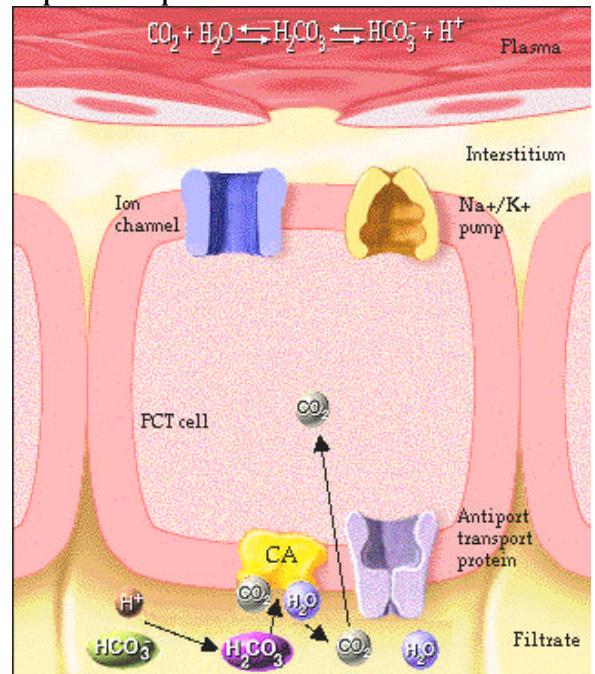
- (2) Within the proximal tubule cell, carbon dioxide reacts with water to form carbonic acid. This reaction is catalyzed by carbonic anhydrase, shown here as CA. Then the carbonic acid splits into hydrogen ions and bicarbonate.



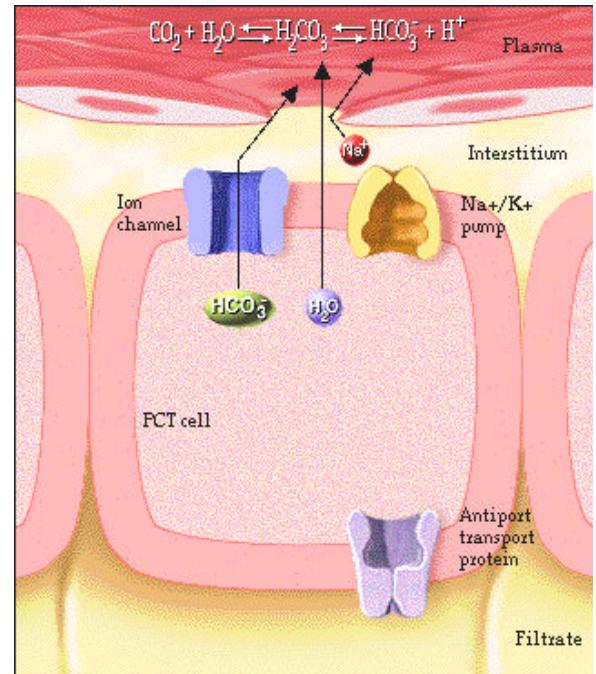
(3) The hydrogen ion moves into the filtrate in exchange for Na^+ , to maintain electrical neutrality, through a sodium ion/hydrogen ion antiport transport protein, or countertransport, which is a type of secondary active transport. The concentration of sodium ion inside the cell is kept low by the sodium/potassium pump on the surface of the cell facing the blood.



(4) In the filtrate, H^+ combines with filtrate bicarbonate to form carbonic acid. Carbonic anhydrase then breaks apart the carbonic acid into carbon dioxide and water. The carbon dioxide diffuses into the kidney tubule cell, removing bicarbonate from the filtrate. This carbon dioxide can reform bicarbonate within the cell. The process repeats.



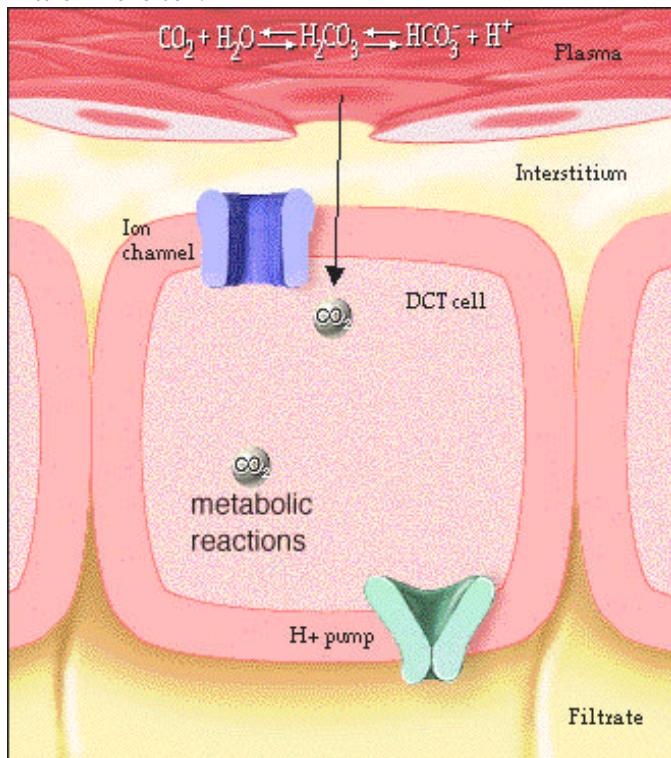
- (5) Much of the water generated also gets reabsorbed. The bicarbonate generated within the cells of the proximal convoluted tubule diffuses into the plasma. Sodium ion also moves into the plasma via the sodium/potassium pump to maintain electrical neutrality.



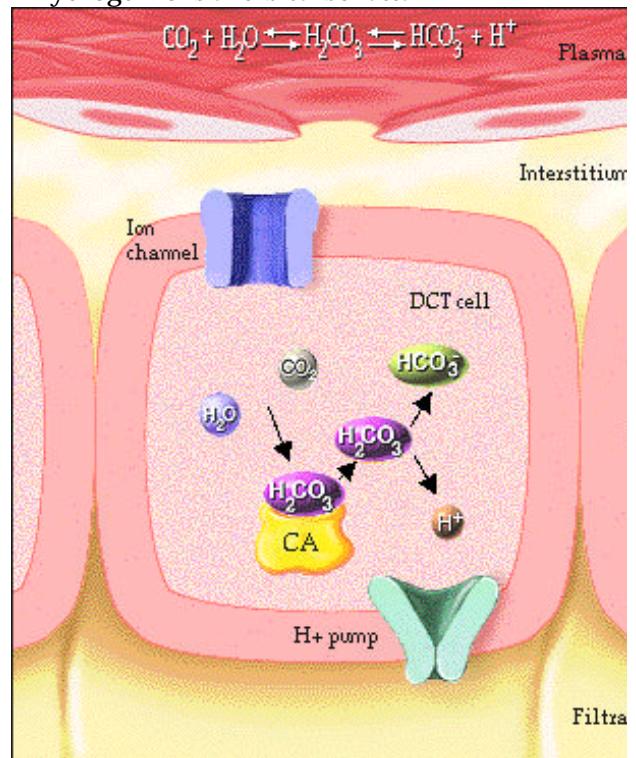
75. (1) HCO_3^- is reabsorbed into the plasma. Typically 80-90% of filtered bicarbonate is reabsorbed in the PCT. (2) You end up with more sodium ions getting reabsorbed back into the plasma.

76. Right side of page from top to bottom: Plasma, interstitium, DCT cell, filtrate Left side of page from top to bottom: Ion channel, H^+ pump

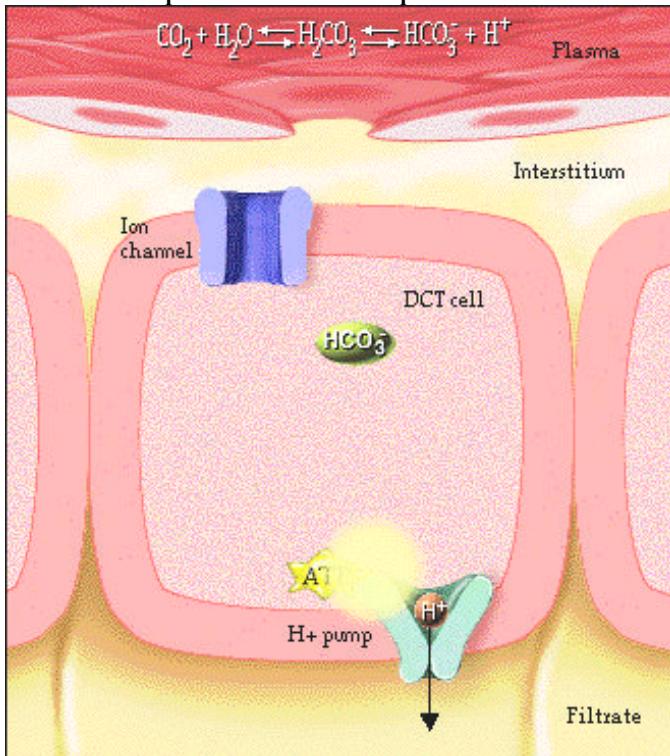
77. (1) Carbon dioxide arrives at the kidney tubule cell in the late distal convoluted tubule and cortical collecting duct from the plasma or from metabolic reactions within the cell.



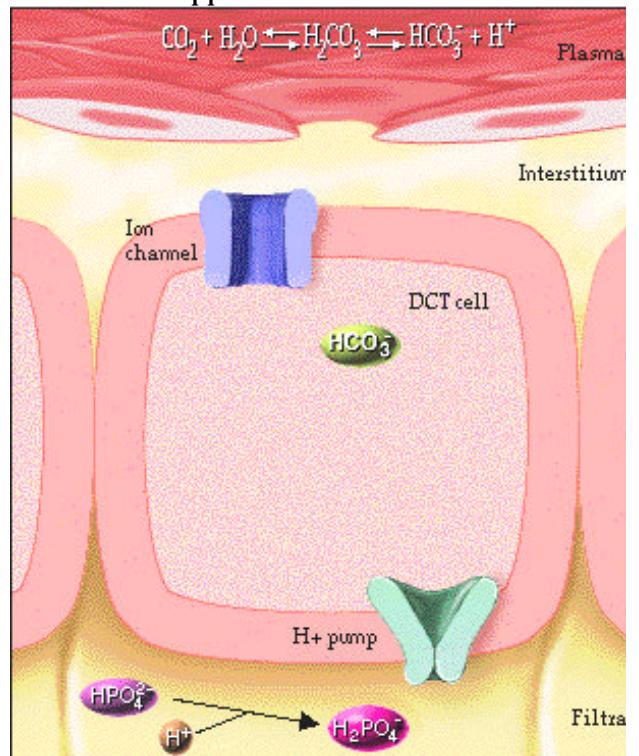
(2) In the kidney tubule cell carbon dioxide and water form carbonic acid. The reaction is catalyzed by carbonic anhydrase. Then the carbonic acid splits into hydrogen ions and bicarbonate.



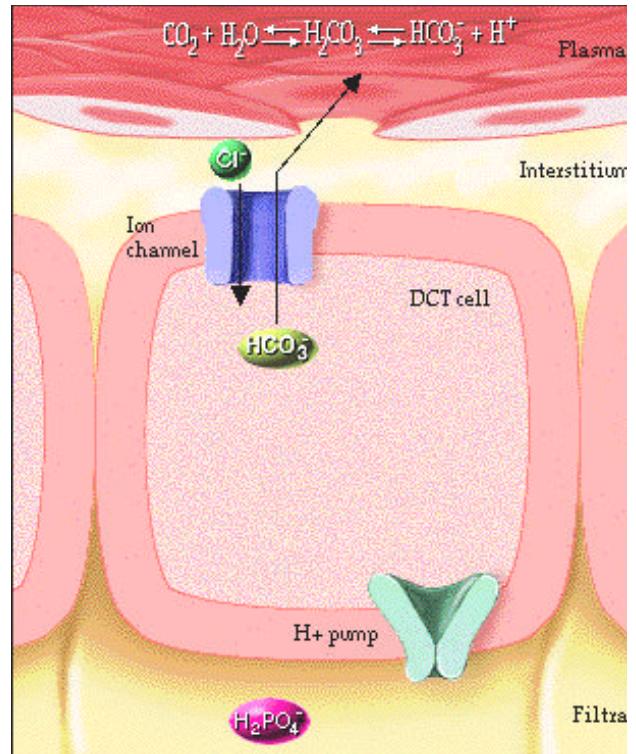
(3) The hydrogen ion goes into the filtrate via primary active transport. ATP is used up.



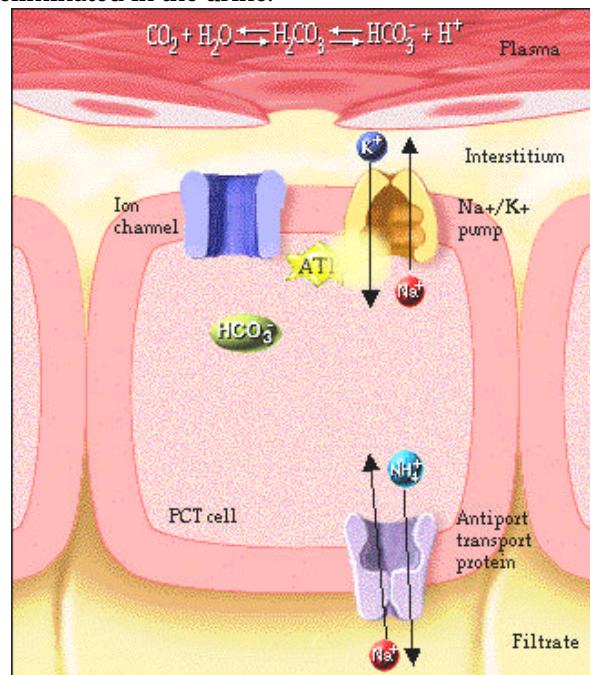
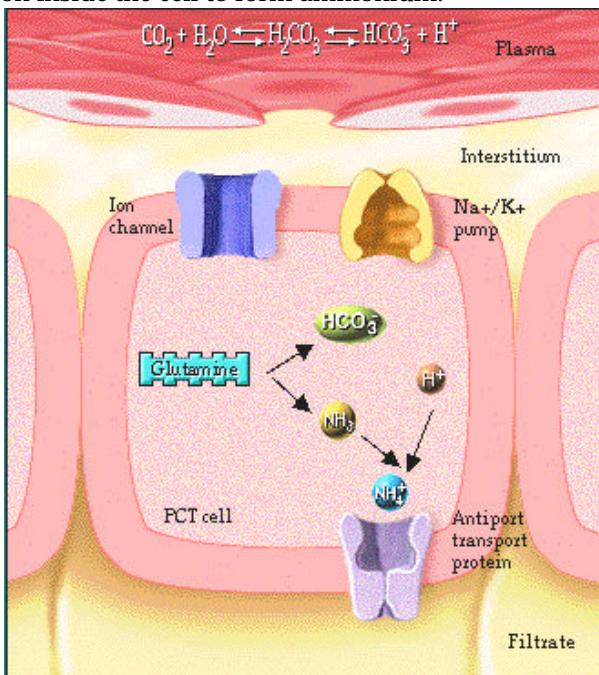
(4) Bicarbonate is scarce in the filtrate at this point because it is reabsorbed in the proximal convoluted tubule, so the hydrogen ion will combine with a buffer such as hydrogen phosphate, which is the important buffer in the urine. The resulting dihydrogen phosphate is unable to go back into the cell and is trapped in the filtrate and excreted.



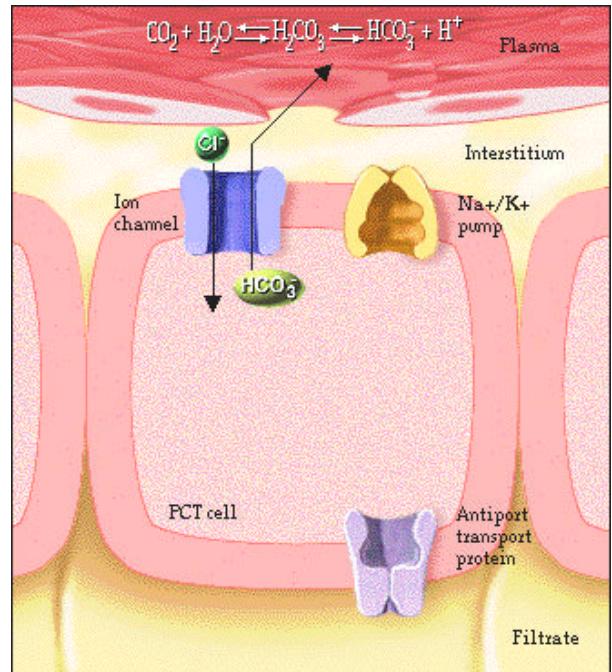
- (5) The newly formed bicarbonate moves into the plasma. Chloride ion moves into the cell at the same time to maintain electrical neutrality. The pH of the plasma increases.



78. (1) Newly generated bicarbonate is added to the plasma, increasing the pH of blood and adding new buffering power to the plasma. (2) Hydrogen ion is secreted into the filtrate, attaches to buffers, and is eliminated from the body.
79. Right side of page from top to bottom: Plasma, interstitium, Na^+/K^+ pump, antiport transport protein, filtrate Left side of page from top to bottom: Ion channel, PCT cell
80. (1) In severe acidosis, another process will occur within the cells of the proximal convoluted tubule. Glutamine is an amino acid that is metabolized in the tubule cells of the kidney. The products of its metabolism are ammonia and bicarbonate. The ammonia, which is a base combines with a hydrogen ion inside the cell to form ammonium.
- (2) The ammonium then travels from the kidney tubule cell to the filtrate in exchange for sodium via antiport transport protein, or countertransport, which is a type of secondary active transport. The sodium concentration is kept low inside the cells by sodium/potassium pump. This ammonium is eliminated in the urine.



- (3) The bicarbonate leaves the kidney tubule cell in exchange for chloride and goes into the plasma.

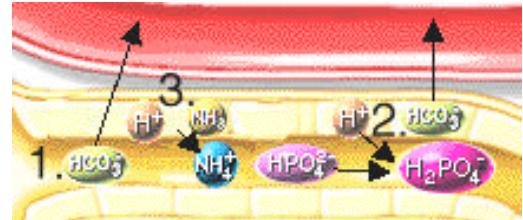


81. (1) Newly generated bicarbonate is added to the blood, increasing the pH of plasma and adding new buffering power to the plasma. (2) Hydrogen ion is eliminated from the body in the form of ammonium.

82. Clockwise from upper right: Peritubular capillary, renal tubule, glomerular capsule, glomerular capillary

(1) Conserving (reabsorption) of HCO_3^- . (2)

Generating HCO_3^- by the kidney tubule cells increases the pH of the plasma and adds new buffering power to the plasma. (3) Secreting buffered H^+ into the urine eliminates H^+ from the body and increases the pH of the plasma.



83. Chemical buffers act within seconds to correct abnormalities in pH within the body fluids. The respiratory control mechanism is slower than the buffers mechanism and may take minutes to begin. Renal mechanisms are the slowest mechanisms may take hours or days to complete.

84. The respiratory mechanism is important in compensating for metabolic acidosis or alkalosis.

85. Renal mechanisms are important in compensating for respiratory acidosis or alkalosis.

86. Carbonic acid is released as carbon dioxide and water.

87. The urinary system eliminates fixed acids from the body.

88. Metabolic alkalosis and respiratory alkalosis

89. Metabolic acidosis and respiratory acidosis

90. Chemical buffers, respiratory system, urinary system

91. Chemical buffers work quickly and immediately, but they have a limited capacity. When the buffer systems become overwhelmed, as in acidosis or alkalosis, the respiratory and urinary systems compensate.

92. Metabolic acidosis occurs when there is an excess of any body acid, except carbonic acid. It occurs when there is too much acid production in the body, or if there is loss of base.

93. Dehydration occurred from increased blood glucose and increased osmolarity.

94. Low

95. Because more H^+ is being generated in the body, the excess H^+ will combine with HCO_3^- to form CO_2 , and the reaction will shift to the left.

96. Because there is an excess amount of H^+ , the H^+ will react with HCO_3^{-1} as a result of metabolic acidosis, and the HCO_3^{-1} will decrease.

97. The respiratory system will compensate in an effort to bring the pH back toward normal.

98. Because of the increased CO_2 , the respiratory centers in the brain and large arteries are stimulated. The patient will begin to breathe faster and deeper. This response is called hyperventilation.

99. Metabolic alkalosis is caused by a relative deficit of any acid in the body, except carbonic acid. Metabolic alkalosis can occur from an excess of base in the body. Metabolic alkalosis can also occur as a result of too little acid in the body.

100. Hydrogen ion, from the hydrochloric acid in the stomach.

101. The pH will rise indicating the individual is becoming alkaloic from loss of hydrogen ion.

102. Because there is less H^+ in the body, the reaction will shift to the right and more H^+ and HCO_3^- will form.

103. As the equation shifts to the right, CO_2 decreases. The respiratory centers in the brain are inhibited hypoventilation occurs.

104. Respiratory acidosis occurs when there is an excess of carbon dioxide, and therefore an increase in carbonic acid in the body.

105. Alveolar walls disintegrate over time, producing large air spaces that remain filled with gases during expiration. Carbon dioxide becomes trapped in the alveoli and blood levels of carbon dioxide rise.

106. Because carbon dioxide crosses the blood-brain barrier more readily than many metabolic acids.

107. The build-up of carbon dioxide in the blood causes the equilibrium to shift to the right.
108. Acid levels rise and the pH decreases.
109. Kidneys retain bicarbonate and excrete H⁺.
110. Respiratory alkalosis is a deficit of carbon dioxide and occurs as a result of hyperventilation.
111. With each exhalation, more carbonic acid is eliminated from the lungs as CO₂. The reaction proceeds to the left.
112. H⁺ will decrease and the pH will increase because the H⁺ is combining with HCO₃⁻ to form more CO₂.
113. By excreting bicarbonate through the kidneys.
114. Metabolic acidosis: a,d,f,i,k,m Metabolic alkalosis: b,j,n Respiratory acidosis: g,p,o
Respiratory alkalosis: c,e,h,l

115.

Acidosis

Metabolic
Respiratory

Cause: Generation of H ⁺ or loss of base from the body. HCO_3^- falls	Cause: Loss of H ⁺ or generation of base in the body. HCO_3^- rises
Compensation: Respiratory - Hyperventilation $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$	Compensation: Respiratory - Hypoventilation $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$
Cause: Defective exchange of gases in the lungs. $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$ CO_2 rises	Cause: Hyperventilation $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$ CO_2
Compensation: Renal Urinary Reabsorption of HCO_3^-	Compensation: Renal Urinary Excretion of HCO_3^-

116. Metabolic acidosis can be caused by either a gain of acid or a loss of base from the body.

117. HCO_3^- levels fall due to loss of HCO_3^- from the body or increased acid reacting with HCO_3^-

118. Because the problem is metabolic in origin, the respiratory system compensates.

119. The increased H⁺ causes the equilibrium reaction of this reaction to shift to the left.

120. The individual hyperventilates to blow off the excess carbon dioxide which is generated.

121. Metabolic alkalosis can be caused by either a loss of acid or a gain of base in the body

122. HCO_3^- levels rise due to gain of HCO_3^- or decreased acid reacting with HCO_3^- .

123. Because the problem is metabolic in origin, the respiratory system compensates.

124. The decreased H⁺ causes the equilibrium reaction of this reaction to shift to the right.

125. The individual hypoventilates to conserve CO_2 .

126. Respiratory acidosis occurs because CO_2 is not eliminated from the body.

127. The increased CO_2 in the blood will cause the reaction to shift to the right.

128. CO_2 rises because the individual is unable to blow off this gas.

129. The renal system will compensate by generating or reabsorbing bicarbonate or excreting H⁺, but it may take hours or days for complete compensation to occur.

130.

NORMAL	ABOVE	BELOW
BLOOD pH 7.35-7.45	alkalosis	acidosis
pCO ₂ 35-45 mmHg	respiratory acidosis	respiratory alkalosis
HCO ₃ ⁻ 22-26 mEq/L	metabolic acidosis	metabolic alkalosis

131. Respiratory alkalosis occurs when too much carbon dioxide is eliminated from the body because of hyperventilation.

132. The equilibrium reaction shifts to the left as acid is used up.

133. CO_2 falls due to hyperventilation.

134. The renal system will compensate by excreting excess base.