Normal metabolic processes in an animal body result in the production of relatively large quantities of acids. These acids are transported to the excretory organs, i.e., the lungs and the kidneys, without causing marked alterations in blood pH. This sensitive control of blood pH in the normal range of **7.3 to 7.5** is accomplished by the combined effects of the blood buffer system, the respiratory system, and the renal system. The body responds quickly to alterations in blood pH. Correction in these alterations occurs in steps, with buffer systems providing the immediate response to any pH alteration, followed quickly by the respiratory response. Later, the kidney mechanism is initiated and sustains the corrective activity for a longer time span.

ACID-BASE DISTURBANCES

Respiratory Acidosis - carbonic acid excess (hypoventilation)

Causes

a. Pneumonia

b. Emphysema

c. Pulmonary edema

d. Paralysis of respiratory muscles

e. Morphine poisoning

f. Occlusion of breathing passages

h. In closed gas anesthesia when oxygen is adequate, but carbon dioxide removal is insufficient.

Laboratory findings

a. Uncompensated

1) Urine pH - more acid

2) Blood pH - below 7.35

3) Plasma bicarbonate - normal

4) Elevated pCO_2

b. Partially Compensated

1) Elevated pCO_2

2) Plasma bicarbonate - increased

3) Plasma chloride - low; increased excretion of chloride by kidney to make more sodium available for bicarbonate.

4) Blood pH - decreased

5) Urine pH - acid

Body compensatory action

1) If the primary cause is not in the respiratory center (e.g., CNS problem), the center will cause an increased pulmonary rate with a resultant decrease in pCO_2.

2) The renal compensatory mechanism will conserve bicarbonate ions and excrete hydrogen ions and nonbicarbonate anions to produce more acid urine. There is also increased reabsorption of bicarbonate.

Respiratory Alkalosis - carbonic acid deficit (hyperventilation)

Causes - increased rate and depth of breathing

a. Fever

b. Oxygen lack

c. Respiratory center stimulation (encephalitis, drugs such as salicylates)

d. Hysteria and anxiety

Laboratory Findings

a. Uncompensated

1) Urine pH - more alkaline

2) Blood pH - over 7.45

3) Plasma bicarbonate - normal

4) Decreased pCO_2

b. Partially Compensated

1) Decreased pCO2

2) Plasma bicarbonate - decreased

3) Plasma chloride - normal to high

4) Blood pH - increased, but lower than uncompensated.

5) Urine pH - alkaline

Body compensatory action

1. The compensatory mechanisms are principally renal. Renal control is manifested by a decrease in ammonia formation, a decrease in bicarbonate reabsorption, retention of hydrogen ions (exchanged for sodium) and an increase in excretion of bicarbonate instead of chloride.
2. The respiratory response is depression of the respiratory center which causes carbon dioxide retention and a concomitant increase in carbonic acid.

Metabolic Acidosis - bicarbonate deficit

Causes

a. Extreme diarrhea

b. Renal insufficiency

c. Ketosis in which large amounts of ketonic acids are produced and accumulate in the tissues (diabetes mellitus, starvation).

d. Lactic acid

e. Excessive loss of saliva.

Laboratory Findings

a. Uncompensated

1) Urine pH - more acid

2) Blood pH - below 7.35

3) Plasma bicarbonate - decreased

4) Normal pCO_2

b. Partially Compensated

1) Decreased pCO_2

2) Plasma bicarbonate - decreased

3) Blood pH - decreased, but higher than uncompensated

4) Urine pH - acid

Body compensatory action

1) The respiratory compensatory mechanism decreases pCO_2 by increased respiratory rate.

2) The renal compensatory mechanism will conserve bicarbonate ions and excrete hydrogen ions and nonbicarbonate anions to produce more acid urine. There is also increased reabsorption of bicarbonate.

Metabolic Alkalosis - bicarbonate excess

Causes

Accumulation of bicarbonate in extracellular fluid as a result of excessive acid loss.

a. Vomiting

b. Sequestration of abomasal juices in ruminants with high GI tract obstructions

c. Hyperadrenocorticism

d. Alkaline therapy

Laboratory Findings

a. Uncompensated

1) Urine pH - more alkaline

2) Blood pH - over 7.45

3) Plasma bicarbonate - increased

4) Normal pCO_2

5) Plasma chloride - low

6) Plasma potassium - may be low

b. Partially Compensated

1) Increased pCO_2

2) Plasma bicarbonate - increased

3) Plasma chloride - low

4) Plasma potassium - may be low

5) Blood pH - increased, but lower than uncompensated

6) Urine pH - alkaline

Body compensatory action

1) The respiratory response is a decrease in respiration in order to increase pCO_2.

2) The compensatory renal mechanism is decreased sodium-hydrogen exchange, decreased ammonia formation, and increased excretion of bicarbonate.