Biochemistry of Gastro-intestinal disturbances

A. Vomition

It is a coordinated reflex act that results in rapid expulsion of gastric contents through the mouth.

Causes: the loss of large quantities of water and H^+ and Cl^-. The loss of water causes the dehydration and loss of H^+ ions causes metabolic alkalosis and loss of Cl^-ions hypochloremia.

The chronic vomiting causes the hypokelemia (K^+ loss).

K^+ loss is due to

- Increased secretion of K^+ due to alkalosis through urine.
- Gastric juice contains significant amount of K^+ ions.

The K^+ deficiency interferes with the renal ability to conserve H^+ ions.

B. Ischemic reperfusion injury

It is caused by

- Strangulating luminal obstruction in horses
- Gastric dialatation volvulus in dogs.

In this condition, the oxygenation of tissues is compromised leading to decrease in ATP production and anaerobic glycolysis resulting in increased lactic acid production. This stimulates the release of calcium from endoplasmic reticulum causing elevation of intracellular Ca^{2+} ions that in turn causes the release of degrading enzymes from lysozomes. These degrading enzymes causes the autolytic destruction of cell organelles ultimately leading to cell death.

When reperfusion of the affected organ occurs, leading to increase in blood supply to the affected organ, there is abrupt increase in oxygen. Abrupt increase in oxygen, produces lot of **oxygen free radicals**. Normally these free radicals are removed by free radical scavengers but due to prolonged lack of proper blood supply, there is deficiency of free radical scavengers. As a result these **oxygen free radicals** causes significant injury to the tissues.

C. Acute diarrhea

The term diarrhoea is generally descri8bed as passage of abnormally fluid feces with increased fluid faeces with the increased frequency, increased volume or both. Three factor that act independently or in combination to produce diarrhea are

- Hypermotility of intestinal tract.
- Decreased intestinal assimilation of nutrients that is due to a) decreased inntraluminal hydrolysis of nutrients, b) bile salt deficiency, c) villus atrophy and d) intestinal lymphoma.
- Increased intestinal secretion of water and electrolyte.

Acute diarrhoea causes loss of water and electrolyte in watery stool. The electrolyte composition of stool in such cases is similar to that of fluid found in intestinal lumen, which in turn is similar to plasma. This causes dehydration resulting in hemoconcentration that ultimately leads to hypo-volumic shock.

The acidosis occurs during the diarrhea due to

- Decreased excretion of H^+ resulting from decreased renal perfusion.
- Increased production of organic acid.

Hyperkalemia occurs during diarrhea due to

- Increased movement of cellular K^+ ions to ECF.
- Decreased renal K^+ excretion.

In the terminal stage hypoglycaemia occurs before death due to increased anaerobic glycolysis and decreased gluconeogenisis due to hypovolumic shock.

Mechanism of action of enterotoxin induced by enterotoxin

Produced by *Vibrio cholera*. It is high molecular weight, heat labile toxin called CT (Cholera Toxin). This toxin is activated by adenyl cyclise that converts ATP to cAMP. The cAMP in turn activate protein kinase. Protein kinase activates a cascade of reaction that cause the increased secretion of water and electrolytes by intestine mucosa.

D. Intestinal malabsorption

Two mechanism that are responsible for the **Intestinal malabsorption**.

- Defective intraluminal digestion associated with pancreatic insufficiency.
- Defects in mucosal transport.

Causes:

1. Chronic intestinal inflammatory disease.
2. Granulomatous disease (Johne's disease, intestine parasitism).
3. Lymphoma.

The most commonly seen sign is statorrhea in dogs (presence of excessive amounts of fats in feces).

E. Gastric Helicobacteriosis

It is caused by *Helicobacteria pylori*→ chronic gastritis, atrophic gastritis, peptic ulcers and gastric adenocarcinoma in humans.

Helicobacteria affecting animals are:

Helicobacteria mustelae in ferrets→ gastritis and gastric ulcers.
Helicobacteria acinonychis in cheetas→ severe gastritis.
Helicobacteria heilmani in pigs→ gastric ulcers.

F. Increased intestinal permeability

Many of the intestinal macromolecules are toxic and immunogenic to the animal body. These macromolecules are not absorbed through intestine. But during certain condition, there is **Increased intestinal permeability** that causes the absorption of these macromolecules causing toxic and immune mediated injury.

Causes: Small intestinal bacterial overgrowth due to antibacterial treatment causing one bacteria to overgrow.

G. Protein losing enteropathy

Loss of albumin, IgG and other plasma protein in GI tract causing hypoproteinemia (hypo-albuminemia).

Causes: 1. Ulceration.
2. Mucosal injury.

H. Disturbances in rumen function

a. Acute rumen indigestion (Rumen overload, lactic acidosis)

Acute rumen indigestion occurs in sheep or cattle consuming high roughage diet when they suddenly consume large amount of readily fermentable carbohydrate such as grain or apples. *Streptococcus bovis* is the rumen micro-organism chiefly responsible for rapid rumen fermentation and production of large quantities of lactic acid. Two forms of lactate is formed viz. L-lactate and D-lactate. The L-lactate is absorbed and metabolized by liver and other tissues. The D-lactate is not utilized and contributes significantly to the acid load. When too much of lactic acid is produced in rumen, the metabolic acidosis occurs causing the lowering of Blood pH and bicarbonate concentration. The pH of the urine falls to 5.0. Elevation of lactic acid in rumen causes increase in osmolarity in rumen fluid. This results in draining of fluid from plasma causing hemoconcentration that results in hypovolumic shock. When the rumen pH falls to dangerous level causes the rumen atony.

b. Acute rumen tympany (Bloat)

The gas produced during rumen fermentation (such as CO_2 and methane) are continually removed by eructation. The interference in the process of eructation produces a condition called dry bloat.

The **froathy blot** results from froath in rumen content where the CO_2 and methane remains trapped. This occurs due to pectin and pectin methyl esterase in feed. pectin methyl esterase act on pectin producing pectic acid and galactouronic acid. These two compounds increases viscosity of the rumen fluid leading to formation of highly stable form. Other causes of froathy blot are 1. Presence of slim producing bacteria in feeds that increases the viscosity of rumen fluid. 2. Enzyme ribulose diphosphate carboxylase present in legume.

Treatment:

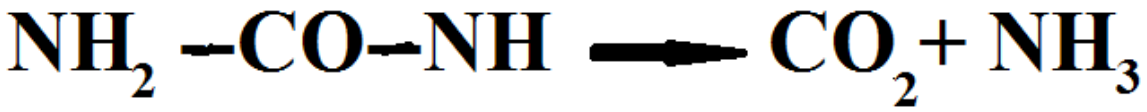
- Decreasing or prevention of foam formation by certain non-ionic detergents that break up or prevent formation of froth in rumen.

Prophylaxis:

- Sodium alkyl sulfonate: it inhibits the pectin mehyl esterase.

c. Urea poisoning

Ruminants can utilize NPN for synthesis of protein.



The free NH_3 generated is incorporated into amino acids and protein by rumen microbes. The bacterial protein is digested and absorbed in abomasums and small intestine. When the diet have more than 3% urea, the excess ammonia produced is not incorporated into protein but exerts encephalotoxic effects.

This can be corrected by oral administration of acetic acid.