1) Which of the following is an Enteric Nervous system (ENS) plexus?

  A. Membranous
  B. Myasthenic
  C. Lamina propria
* D. Myenteric
  E. Subdermal

  The two main ENS plexuses are the myenteric plexus (located between the two layers of smooth muscle of the tunica muscularis), and the submucosal or Meissner's plexus (located in the submucosal layer).

2) The control of the GI system is:

  A. Entirely regulated by the ANS
  B. Entirely regulated by the CNS
  C. Completely disconnected from higher centers
* D. Predominantly self-regulated

  The ENS can almost be thought of as having a "mind of its own" - it is mostly self-contained. Much of the GI is regulated by ENS reflexes, however there is some input from the ANS, and some sensory information does ascend to the CNS (pain, fullness, nausea).

3) Select the ENS excitatory neurotransmitters from the following list. (Multiple answers)

  A. motilin
* B. tachykinins
* C. somatostatin
  D. nitric oxide
  E. vasoactive intestinal polypeptide

  Acetylcholine, tachykinins, and motilin are the main excitatory neurotransmitters of the ENS while somatostatin and nitric oxide are the main inhibitory neurotransmitters.

4) Select the species that has an esophagus composed entirely of skeletal muscle. (Multiple answers)

* A. Dogs
  B. Cats
  C. Horses
  D. Crocodiles
* E. Cattle
* F. Goats
  G. Pigs

  Dogs and ruminants have skeletal muscle along the whole length of their esophagus.

5) Movement of the stomach and the intestines is largely coordinated and propagated by all of the following, except :

  A. Local circuits
  B. Gap junctions between smooth muscle cells
* C. Cranial nerve V & VII
  D. Intrinsic rhythmic depolarizations from pacemaker cells

  Cranial nerves V (trigeminal), VII (facial), IX (glossopharyngeal) and XII (hypoglossal) are involved with swallowing, but their influence does not extend beyond the esophagus.

6) Which of the following concerning slow waves of the GI tract is incorrect?

  A. They are produced in the ICC (Interstitial cells of Cajal)
* B. They cause contraction of smooth muscle
  C. They can be produced in the stomach, duodenum and the colon
  D. They move from oral to aboral segments

  Slow waves, by themselves, do NOT cause contraction in smooth muscle although they do depolarize smooth muscle. Slow waves along with excitatory neurotransmitters cause the membrane to depolarize sufficiently, thus passing the threshold potential and resulting in a smooth muscle contraction. The membrane potential can be made more negative and distanced from the threshold potential (thus preventing muscle contraction) via the action of inhibitory neurotransmitters.

7) Anti-peristalsis (retrograde) movement of ingesta:

  A. Is initiated by pacemakers in the stomach of ruminants so they can chew their cud
  B. Is defined as a mass movement that occurs at regular intervals to clear the contents of a whole gut segment
* C. Occurs in the colon to increase time for water absorption
  D. Never occurs in the GI, since movement is from oral segments to aboral segments
  E. Occurs in the small intestine to increase time for digestion of food

  There are pacemakers in the colon that promote anti-peristaltic waves, which increase the travel time of ingesta, therefore is very important for water reabsorption.

8) How does water move across the intestinal wall (multiple answers)?

* A. Transcellular pathway
  B. Co-transport (usually anti-port)
  C. Through primary active transport
* D. Paracellular pathway
  E. Co-transport (usually symport)
  F. Exocytosis

  All water flow in the intestine is passive through transcellular and paracellular (between cells) pathways. When the osmolarity of the lumen is more than in the enterocytes and the blood, water moves into the lumen. When the osmolarity of the lumen is less than in the enterocytes and the blood, water moves out of the lumen.

9) What factors do NOT drive water to move from the intestinal lumen into enterocytes?

* A. When large molecules in the lumen are broken up (digested)
  B. The higher oncotic pressure of the nearby capillaries
  C. Passive diffusion
* D. Active transport
  E. When nutrients are absorbed by enterocytes

  All water flow in the intestine is passive. When the osmolarity of the lumen is more than in the enterocytes and the blood, water moves into the lumen. When the osmolarity of the lumen is less than in the enterocytes and the blood, water moves out of the lumen. When large molecules in the lumen are broken down into smaller pieces, the osmolarity of the lumen increases, promoting the entry of water into the lumen.

10) Antiports are a type of primary active transport.

* A. False
  B. True

  Primary active transport depends on an ATP pump. Most of the enzymes that perform this type of transport are transmembrane ATPases. A primary ATPase universal to all cellular life is the sodium-potassium pump, which helps maintain the cell potential. Antiports and symports are two types of secondary active transports. They are passive, but dependent on the concentration gradient generated by a primary active transport.

11) Which of the following statements about nutrient absorption is true?

  A. Absorption primarily depends on passive diffusion.
  B. Nutrients such as glucose are primarily absorbed through the paracellular pathway because it is easier for large molecules to travel in the spaces between cells.
* C. Nutrients must be broken down into simple molecules for absorption to occur.
  D. Absorption primarily depends on secondary active transport.

  Nutrients such as glucose are too big to travel through the paracellular pathway, and thus primarily travel through the transcellular pathway. Nutrients must be broken down into simple molecules to be able to be absorbed by the enterocytes. Absorption of nutrients primarily depends on active transport, although some does occur passively.

12) Which of the following statements concerning blood flow to the GI is false?

* A. The tips of intestinal villi are usually very well perfused because approximately 75% of blood flow to the GI is to the mucosa.
  B. If blood flow to the stomach is decreased, stomach ulcers may occur.
  C. If blood flow to the small intestine is decreased drastically, villi blunting (sloughing) can occur.
  D. Prostaglandins can both increase and decrease local blood flow.

  The tips of intestinal villi are usually hypoxic because of poor perfusion. This is due to the countercurrent exchange that occurs in the villi. Oxygenated vessels run alongside deoxygenated vessels, increasing the chance that oxygen could diffuse to venous circulation before reaching the tip of the villi. This makes the villi quite susceptible to hypoxic damage.

13) Which of the following is NOT a function of saliva?

  A. Antibacterial properties
* B. Digestive enzymes for protein digestion
  C. Lubrication
  D. Grooming

  The only digestive enzymes found in saliva are amylases to digest starches (seen in pigs and humans) and lipases to digest lipids in neonates. Other functions of saliva are to act as a buffer for rumen contents and thermoregulation.

14) Which of the following is a FALSE statement regarding saliva secretion?

* A. CNS stimulation has no effect on saliva secretion
  B. Saliva secretion is inhibited by sympathetic stimulation
  C. Atropine decreases saliva secretion
  D. Acetylcholine increases salivation

  The CNS can cause an increase in saliva production due to hunger and nausea. Acetylcholine (parasymathetic stimulation) increases salivation while sympathetic stimulation (epinephrine and norepinephrine) decrease salivation. Atropine is often given prior to surgery to limit saliva production so that its chances of aspirating (into the lungs) is reduced.

15) Swallowing involves a voluntary phase and an involuntary phase. Which cranial nerve (yeah, back to neuro) is not involved with the involuntary phase?

* A. VI
  B. VII
  C. X
  D. V

  Cranial nerve VI is the abducent nerve. It controls the lateral rectus extraocular muscle (IV-dorsal oblique; III-all others). Cranial nerve V in the trigeminal which has branches that enervate the oral cavity and muscles of mastication. VII is the Facial nerve which enervates the palate and the cranial 2/3 of the tongue. X is the Vagus and it has some enervation to the larynx and pharynx. Cranial nerves IX and XII are also involved with swallowing.

16) The esophagus is surrounded by muscles which create peristaltic waves. Which of the following statements is FALSE regarding these muscles?

  A. The esophagus in dogs is skeletal muscle all the way down and controlled by the CNS
  B. The esophagus in cats has skeletal muscle only in the proximal portion
  C. The distal esophagus in horses is smooth muscle
* D. The esophagus in dogs is skeletal muscle all the way down and controlled by the ENS

  The esophagus in dogs is skeletal muscle all the way down, controlled by the CNS via the vagus nerve. Ruminants also have skeletal muscle along the entire length of their esophagus. All other animals have skeletal muscle in the proximal part and smooth muscle in the distal part.

17) Which of the following is NOT a function of the simple stomach?

  A. Creation of a acidic environment
  B. Control release of chyme to the small intestine
  C. Store food
  D. Digestion of protein
  E. Mechanical breakdown of food
* F. Water absorption

  Water is absorbed in portions of the small intestine and colon, not the stomach. The stomach stores food and slowly releases it into the duodenum. The stomach also mixes food to break it into smaller pieces. Pepsin is a digestive protease released (in its inactive form, pepsinogen) by the chief cells in the stomach that functions to degrade food proteins into peptides. Parietal cells release HCl that creates an acidic environment which allows pepsinogen to unfold into pepsin. Pepsin will digest up to 20% of ingested proteins.

18) Chyme is released from the stomach into the small intestine. Which of the following is NOT an effect of chyme entering the duodenum?

  A. ENS interneurons are stimulated which inhibit emptying of the stomach
  B. Afferent nerves are stimulated which decrease vagal input and increase sympathetic input
  C. Enteroendocrine cells in the duodenum secrete cholecystokinin and somatostatin
* D. The secretion of gut hormones is stimulated which increases stomach motility

  The gut hormones that are secreted in response to food entering the duodenum decrease the motility of the stomach and inhibit the emptying of the stomach. The hormones secreted are cholecystokinin and somatostatin and they are secreted by enteroendocrine cells.

19) Vomiting and regurgitation are different actions. Which of the following is not a difference between the two?

  A. Vomited food is acidic while regurgitated food is often neutral.
* B. Vomiting involves contraction of the stomach while regurgitation does not.
  C. Regurgitation is passive while vomiting is an active process
  D. Vomiting involves partially digested food, regurgitation had undigested food.

  Vomiting involves no actual contraction of the stomach. The contractions involve the abdominal muscles. Regurgitation is used by a number of species to feed their young.

  A. It involves a H+/K+/ATPase pump
  B. Cl- is actively secreted
* C. Occurs in chief cells
  D. Occurs in parietal cells

  Chief cells are responsible for the secretion of pepsinogens/zymogens. Chief cells and parietal cells (also called oxyntic cells) are both found in parietal glands along with mucus cells and enteroendocrine cells. Parietal cells produce gastric acid (hydrochloric acid) in response to histamine (via H2 receptors), acetylcholine (M3 receptors) and gastrin (gastrin receptors). The enzyme hydrogen potassium ATPase (H+/K+ ATPase) is unique to the parietal cells and transports the H+ against a concentration gradient of about 3 million to 1. The process of HCl creation is as follows : <p>(1) Hydrogen ions are formed from the dissociation of water molecules. The enzyme carbonic anhydrase converts one molecule of carbon dioxide and one molecule of water to a bicarbonate ion (HCO3-) and a hydrogen ion (H+). <p>(2) The bicarbonate ion (HCO3-) is exchanged for a chloride ion (Cl-) on the basal side of the cell and the bicarbonate diffuses into the blood. <p>(3) Potassium (K+) and chloride (Cl-) ions diffuse into the ca

21) Which of the following statements is false regarding the control of HCl secretion?

  A. Chyme in the duodenum inhibits HCl release
  B. Gastrin stimulates HCl release
* C. Histamine H2 receptors inhibit HCl release
  D. HCl release is stimulated by CNS stimulation

  Histamine H2 receptors stimulate HCl release. That is why an H2 antagonist is used to treat/prevent stomach ulcers. CNS stimulation causes Ach release from the vagus which stimulates parietal cells to release HCl and G cells to secret gastrin which also stimulates parietal cells to secrete HCl. The process of HCl creation is as follows : <p>(1) Hydrogen ions are formed from the dissociation of water molecules. The enzyme carbonic anhydrase converts one molecule of carbon dioxide and one molecule of water to a bicarbonate ion (HCO3-) and a hydrogen ion (H+). <p>(2) The bicarbonate ion (HCO3-) is exchanged for a chloride ion (Cl-) on the basal side of the cell and the bicarbonate diffuses into the blood. <p>(3) Potassium (K+) and chloride (Cl-) ions diffuse into the canaliculi. <p>(4) Hydrogen ions are pumped out of the cell into the canaliculi in exchange for potassium ions, via the H+/K+ ATPase.

22) The liver secretes bile, which is used for (multiple answers)

  A. Digestion of protein
  B. Aiding proliferation of mucus secreting cells in the duodenum
  C. Elimination of urea
* D. Lipid digestion
* E. Waste elimination from the liver

  Bile contains the following : bile salts, HCO3 and other electrolytes, phospholipids, cholestrol and lipid-soluble waste (drugs, toxins, bilirubin). The detergent action of bile salts allows for the emulsification of lipid droplets.

23) Hepatocytes are cells that line the sinusoids of the liver

* A. False
  B. True

  Endothelial cells line the sinusoids whereas hepatocytes are the specialized cells of the liver. Canaliculi, which transport bile to tbe bile duct, are formed by hepatocyte surfaces (the biliary pole), so hepatocytes do line canaliculi.

24) The 4 main classes of secretions from the pancreas include…

* A. Amylases, lipases, zymogens, and nucleases/ribonucleases
  B. Zymogens, bile salts, peroxidases, and lipases
  C. Amylases, lipases, mucus, bile acids
  D. Amylases, zymogens, mucus, bile acids

  Acinar cells of the pancreas produce 10 different types of enzymes that digest carbohydrates, lipids and proteins in an alkaline environment. Centroacinar and duct cells secrete HCO3 and H2O to buffer HCL in chyme. In dogs, intrinsic factor (B12 absorption) is also secreted.

25) Pancreatic cells have receptors for…

  A. Cholecystokinin, epinephrine, and secretin
* B. Gastrin, acetylcholine, cholecystokinin, and secretin
  C. Epinephrine, Norepinephrine and Acetylcholine
  D. Acetylcholine, amylase, thyroid hormone, Gastrin

   Pancreas exocrine secretion is stimulated by (1) Hormones (Gastrin, CCK, Secretin) (2) Low pH in duodenum (3) Peptides and fats in duodenum. <p>Inhibition occurs by (1) High pH (2) Chyme digestion & absorption.

26) Secretion of bicarbonate and mucus from duodenal glands is stimulated by…

  A. Physical or chemical stimulation of mucosa
  B. Vagal stimulation
  C. GI hormones (especially secretin)
* D. All of the above

27) The following are hormones created by cells in the duodenum

* A. Secretin, Cholecystokinin, Enterokinase
  B. Acetylcholine, amylase, thyroid hormone, Gastrin
  C. Amylases, lipases, zymogens, and nucleases/ribonucleases
  D. Cholecystokinin, epinephrine, and secretin
  E. Epinephrine, Norepinephrine and Acetylcholine

  Secretin stimulates pancreatic secretion, reduces gastric motility, inhibits HCL production and relaxes sphincter of Oddi (bile comes in). <p>Cholecystokinin (CCK) stimulates pancreatic secretion, reduces gastric motility, relaxes sphincter of Oddi (bile comes in) and stimulates contraction of the gall bladder. <p>Duodenal enterokinase converts trypsinogen to trypsin as the first step in pancreatic zymogen activation.

28) Intrinsic (hormonal and ENS) mechanisms are the major control mechanisms of exocrine pancreas secretion

  A. False
* B. True

  Gastrin secreted by stomach causes increased pancreatic enzyme secretion. <p>Lowered pH in the duodenum causes increased secretin secretion, which significantly increases bicarbonate secretion to raise pH in the lumen. <p>Peptides and fat in the duodenum cause CCK secretion which significantly increases pancreatic enzyme secretion to digest them.

29) Carbohydrates are mainly of plant cell origin and include the following types…

  A. Fiber, Starch, Amylase
  B. Starch, granulated sugars, pectins
* C. Fiber, starch, sugars
  D. Starch, cellulose, lignin

30) Simple Sugars (monosaccharides) are absorbed intact by (multiple answers)

  A. Facilitated diffusion only
  B. Active transport
* C. SGLT1 and GLUT5
* D. Sodium co-transport and facilitated diffusion
  E. Simple diffusion through paracellular spaces

  SGLT1 AND GLUT5 allow transport of simple sugars from the lumen of the gut into enterocytes. SGLT1 uses sodium co-transport to retrieve glucose and galactose while GLUT5 uses facilitated diffusion for the absorption of fructose.<p>In the proximal SI, glucose concentration may be high enough to be transported into the enterocyte by simple diffusion.

31) Glucose/Sodium transport in the crypts of villi is very efficient and results in absorption of 2 sodium for every glucose or galactose molecule

  A. True
* B. False

  Glucose/Sodium co-transport does not happen in the crypts, which are intestinal glands. Instead, as the expression of SGLT1, GLUT5, GLUT2 is highest at apex of villi (most mature enterocytes), most absorption takes place there.

32) Digestion of proteins begins in the stomach where gastric enzymes are most active in a low pH

  A. False
* B. True

  Digestion of protein begins in the stomach where pepsin and chymosin are activated by the low pH (caused by HCL secretion from parietal cells). Protein is broken down into peptides only (not amino-acids).

33) Proteins are normally absorbed into an adult's enterocytes in the following forms

  A. Tri-peptides, di-peptides, protein granulations
  B. Proteins can only be taken up in their original form or else they are useless to the animal
  C. Amino acids, tri-peptides, whole proteins
* D. Amino Acids, tri-peptides, di-peptides

  No large proteins can be absorbed in a healthy gut! Di-peptides and tri-peptides need to be digested by cytoplasmic peptidases into amino acids within enterocytes before they can be passed into the bloodstream.

34) Some of the factors that influence emulsification of fats in the body are (multiple answers)

* A. Detergent action of bile acids and phospholipids
* B. Temperature
* C. Physical mixing action
  D. Hormonal action
  E. Action by lipases

  Lipid digestion and absorption occurs in the following steps : <p> 1.Emulsification – reduces lipid droplets until small enough to remain in suspension. <p>Step 2 : Hydrolysis – through combined action of lipase and co-lipase. <p>Step 3 : Micelle formation - Monoglyceride and fatty acids bundled with other lipids to form micelles. <p>Step 4 : Diffusion across glycocalyx - only lipid components of micelles (not micelles themselves) diffuse through glycocalyx mucus to apical membrane. <p>Step 5 : Absorption – Simple diffusion or FATP transporter (Fatty acid transporter protein) – when FA concentration is low. <p>Step 6 : Triglyceride resynthesis in enterocyte.

35) Combined action of lipase AND co-lipase bound to bile acid and phopsholipid-coated lipid droplets digests triglycerides. However, at high enough temperatures lipase can work on its own because less bile acids are needed to emulsify fats

* A. False
  B. True

  Lipase ALWAYS needs co-lipase to break down the emulsified fats. <p><p>Lipid digestion and absorption occurs in the following steps : <p>1.Emulsification – reduces lipid droplets until small enough to remain in suspension. <p>Step 2 : Hydrolysis – through combined action of lipase and co-lipase. <p>Step 3 : Micelle formation - Monoglycerides and fatty acids bundled with other lipids to form micelles. <p>Step 4 : Diffusion across glycocalyx - only lipid components of micelles (not micelles themselves) diffuse through glycocalyx mucus to apical membrane. <p>Step 5 : Absorption – Simple diffusion or FATP transporter (Fatty acid transporter protein) – when FA concentration is low. <p>Step 6 : Triglyceride resynthesis in enterocyte.

36) Absorption of lipids occurs by…

  A. Simple diffusion
  B. Transporter FATP
  C. Sodium co-transporter
* D. A and B only
  E. All of the above

  Absorption of lipid occurs by 2 mechanisms.<p>Fatty Acids - simple diffusion, when FA concentration high OR FATP transporter (Fatty acid transporter protein) when FA concentration is low. <p>Other lipids (monoglycerides, cholesterol, vitamins) are always through simple diffusion.<p>Note that enterocytes package fatty acids along with cholestrol into chylomicrons prior to endocytosing them into lacteals.

37) What is the structure (classification) of the pancreas?

  A. Compound Alveolar.
  B. Simple acinar.
  C. Compound acinar.
  D. Simple tubular.
* E. Compound tubuloacinar.

  The pancreas is an encapsulated, lobulated, compound tubuloacinar gland. The main secretory units are tubuloacinar. The tubular portion is more prominent in ruminants.

38) The tubuloacinar secretory unit is continuous with a short intercalated duct. This duct begins with flattened cells (only the nucleus of which can be seen) that extend into the lumen of the acinus. These cells are known as?

  A. Bipolar-pseudoparenchymal-exocholic-metaacinar cells.
* B. Centroacinar cells.
  C. Pre-ductile cells.
  D. Tubuloacinar cells
  E. Centroadenomeric cells.

  The Centroacinar cells are flattened cells that extend into the lumen of the acinus. These cells along those of the intercalated duct secrete bicarbonate and water when stimulated by the polypeptide, secretin.

39) The intralobular ducts of the pancreas are striated?

* A. False.
  B. True.

  Unlike those of the parotid salivary gland, the intralobular ducts of the pancreas are not striated.

40) The function of the thick/dense connective tissue separating the tubuloacini of the pancreas is:

  A. Prevent spread of zymogen to adjacent acini.
  B. Cushion lobes of pancreas against shock.
  C. Insulate the tubuloacini.
  D. All of the above.
* E. None of the above.

  There is very little connective between acini (see notes). You have to expect at least one of these, n'est-ce pas?

41) Which of the following is NOT an exocrine product of the pancreas?

  A. Bicarbonate.
  B. Amylase.
  C. Lipase.
* D. Glucagon.
  E. Trypsin.

  Acinar cells of the pancreas secrete 10 different types of enzymes that digest carbohydrates, lipids and proteins in alkaline environment. Glucagon is not one of them; instead, along with insulin and somatostatin, it is an endocrine product of the pancreas. <p>Centroacinar and duct cells secrete HCO3 and H2O to buffer HCL in chyme. In dogs, they also secrete intrinsic factor that helps in B12 absorption.

42) Which cells can be found in the cardiac region of the stomach?

  A. Mucous secreting cells.
  B. Parietal (oxyntic).
  C. Endocrine (Argentaffin).
* D. Both A and C
  E. Both B and C

  The cardiac region is the "non-glandular" region. Both Mucous and Endocrine cells are present; however, cells that are not present in this region include Parietal and Chief cells.

43) How is it possible to distinguish between the fundic and pyloric regions of the stomach?

* A. The fundic region has shallow gastric pits and extensive simple branched tubular gastric glands while the pyloric region has very deep gastric pits and shallow simple branched tubular glands.
  B. The pyloric region secretes HCl and zymogens but the fundic region does not.
  C. The fundic region secretes HCl and zymogens but the pyloric region does not.
  D. The pyloric region is closest to the esophagus while the fundus region is between the pyloric and cardiac region.
  E. The fundic region does not contain mucous neck cells while the pyloric region does contain mucous neck cells.

  The fundic region is characterized by shallow pits and deep gastric glands while the pyloric region has the opposite structure, deep pits and shallow glands. All the other possible answers are B.S.

44) Which of the following promote secretion of Gastric Acid in the stomach (note, all three must be correct for the answer to be correct)?

  A. Secretin, Gastric inhibitory peptide, low pH.
  B. Gastrin, low pH, Motilin.
  C. Histamine, Gastrin, Secretin.
* D. Acetylcholine, Gastrin, Histamine.
  E. Insulin, Secretin and Somatostatin

  All three promote the secretion of HCl from parietal cells. HCl secretion is ihibited by low pH, secretin, gastric inhibitory peptide and exogenous drugs such as H2 blockers and proton pump inhibitors.

45) All of the following are epithelial cells of the mucosa of the small intestine, EXCEPT :

  A. Enterochromaffin cells
  B. Enterocytes
* C. Mucous neck cells
  D. Undifferentiated stem cells
  E. Paneth cells

  Mucous neck cells do not exist in the duodenum, but in the gastric pits of the stomach.

46) Which of the following statements are true?

  A. Villi are longest in the duodenum and become shorter distally and disappear in the large intestine.
  B. Paneth cells may be found in the small intestine where they release anti-bacterial substance called lysozyme.
  C. Peyer’s patches are located in the colon and nowhere else.
  D. Both 1 and 3.
* E. Both 1 and 2.

  Peyer’s patches are located in the entirety of the small intestine as well as the ileo-cecal junction of dog, cat and ruminants and near the blind end of the cecum of the horse. Paneth cells provide host defense against microbes in the small intestine. They are functionally similar to neutrophils. When exposed to bacteria or bacterial antigens, Paneth cells secrete a number of antimicrobial molecules into the lumen of the crypt, thereby contributing to maintenance of the gastrointestinal barrier.

47) What are the role of protozoa in the microflora ecosystem of the rumen?

  A. Digestion of protein
* B. Slow down fermentation of starches and proteins
  C. Digestion of plant cell walls
  D. Volatile fatty acid absorption
  E. Volatile fatty acid production

  Protozoa (40-60% of microbial mass) mainly prey on bacteria and other protozoa via phagocytosis (which is why they slow down fermentation), though some varieties can also use carbohydrates, especially structural carbohydrates, as a food source. Their overall importance to ruminal fermentation is unclear.<p>Microbes in the reticulorumen include bacteria, protozoa and fungi. Bacteria, along with protozoa, are the predominant microbes and by mass account for 40-60% of total microbial matter in the rumen.

48) Between a high fiber diet and a high starch diet, what is the difference in production of VFA?

* A. The ratio of Acetate to Propionate is lower in a high starch diet
  B. There is no difference as bacteria do not distinguish between the two diets
  C. Acetate is the greatest proportion of VFA produced in high-starch but not high-fibre
  D. Butyrate production is much higher in a high fiber diet

49) Which of the following is not a factor that facilitates the transport of VFA from lumen to bloodstream?

* A. Gap Junctions
  B. Tight junctions
  C. Intercellular bridges
  D. Intercellular (basolateral) spaces
  E. All of the above facilitate transport of VFA from lumen to bloodstream

  Gap junctions interfere with the concentration gradient and disrupt the efficient transport provided by tight junctions, intercellular bridges, and basolateral spaces.

50) Which of these is the primary reason that sodium is not diffused back into the rumen at high concentrations within the epithelial cells?

  A. HCO3 couples to the Na, preventing its diffusion back out to the lumen
* B. Tight junctions prevent backflow into the rumen
  C. The Na /K ATPase pump maintains the balance of any lost Na+ ions
  D. The neutral pH of the rumen prevents ion flow back into the lumen
  E. It is transported out too quickly, so turnover is high

  Tight junctions, in addition to being useful for the transport of VFA’s, also do not allow the flow of Na ions back into the lumen

51) Which of the following conditions is most desirable in a ruminant for the efficient production of VFA’s?

  A. high carbohydrate to protein feed
  B. high numbers of fungi
* C. rapid multiplication of bacteria
  D. high protein to carbohydrate feed
  E. rapid turnover of VFA

  In a balanced diet, the production of VFA is high. There also is a rapid turnover of microbes as they are washed into the abomasum. Only rapid multiplication of bacteria will allow for a continued optimal production level of VFA’s.

52) Why is eructation important?

  A. It prevents the clogging of the reticulum with particles that are too large
  B. It prevents distension of the caudoventral blind sac
* C. It allows gases to escape via the cardia and prevent bloat
  D. It inhibits primary ruminal contractions to increase transit time
  E. It promotes the presentation of foodstuff for remastication and refermentation

  The correct answer is C. Eructation is the expelling of gas through the cardia and subsequent inhalation and expiration of the large amounts of ammonia and CO2 that are produced (30-50 L per hour!). <p>A is incorrect, as primary (not secondary, or eructation) contractions are concerned with particle break-up. <p>B is incorrect, as gas would not distend the caudoventral blind sac, as this blind sac is the ventral sac and usually filled with the rumen mat. (Note that excess unexpelled gas could distend the caudoDORSAL blind sac, as it is rarely full of anything other than gas.) <p>D is incorrect, as secondary ruminal contractions are usually interdependent on primary ruminal contractions (they occour after about 50% of primary's) not the other way around. <p>E is incorrect, as this is a function of reticulorumenal motility, not eructation.

53) Which of these is not a simultaneous action during regurgitation (as part of rumination)?

  A. Contraction of reticulum prior to primary contraction
  B. Relaxation of cardia
  C. Closure of glottis
  D. Inspiratory movement
* E. All of the above are simultaneous actions of rumination

  Rumination is the apparently voluntary regurgitation, chewing, and reswallowing of food. All of the above are important parts of regurgitation of a food bolus.

54) Which of the following statements regarding control of reticuloruminal motility is correct?

  A. Moderate stretch decreases motility
* B. The central nervous system is solely responsible for reticuloruminal motility
  C. Marked stretch increases motility
  D. Large rumen mats decrease motility
  E. Greater osmolarity leads to increased motility

  The afferent and motor sections of the vagus are responsible for reticuloruminal motility. All other answers are the opposite of what actually happens (moderate stretch increases motility, etc.)

55) What is the relationship between fiber and absorption of nutrients in equids?

  A. Sinusoidal
  B. No relationship
  C. Logarithmic
  D. Direct
* E. Inverse

  The higher the fiber in the diet, the lower the absorption of nutrients. A low fiber diet like corn, for example, shows improved absorption when compared to a diet high in hay.

56) Which of the following GI organs could be classified as ‘consistently’ secreting digestive products (enzymes or acid) in a horse? (single answer)

  A. Stomach
  B. Pancreas
  C. Gall bladder
  D. Esophagus
* E. A and B

  The stomach continuously secretes HCL in the horse, while the pancreas is continually secreting enzymes and HCO3 (albeit in low concentrations). Remember that horses don’t have gall bladders.

57) How is the fermentation in a horse like the fermentation in a foregut ruminant?

* A. In both systems, VFA’s are taken up with the aid of hydronium (H+)
  B. Both the rumen and the colon can take up a proportionally large amount of water
  C. H+ and Na+ are cotransported into the lumen in the colon and rumen respectively
  D. Proteins manufactured by microbial flora are used by the horse and cow, respectively.
  E. Gap junctions allow for the speedy transport of VFA’s in both the colon and rumen epithelium

  A is incorrect, as the Na /H pump is an antiport, not a co-transporter. <p>B is incorrect, as little water flow occours across the rumen (partly the reason why when ruminants masticate, they squeeze the water out of the bolus). <p>C is incorrect, as it is tight junctions that allow for efficient transport in the rumen. <p>E is incorrect, as in horses, the microbial-manufactured protein is lost.

58) Which of the following is not a pacemaker in the large intestine of the horse?

  A. Right ventral colon
  B. Cecum
  C. All of the above are pacemakers in the LI of the horse.
* D. Left dorsal colon
  E. Pelvic flexure

  The pacemakers for retention time and peristaltic movement are in the cecum, right ventral colon, and pelvic flexure.

59) Which of the following statements is FALSE?

* A. An up-regulation of ferritin would promote iron toxicity
  B. Excess iron can be highly toxic, particularly in the ferric form
  C. Phosphorus is usually abundant in the diet and readily absorbed
  D. Although calcium is a vital mineral, it is not terribly well absorbed
  E. Herbivores do not need vitamin B12 (cobalamin) in their diet as they are able to synthesize their own

  Ferritin is the storage molecule for iron found in enterocytes. An upregulation of this molecule would promote the storage of iron in the non-toxic form inside the enterocytes. An upregulation of transferrin (the blood-bound carrier protein for iron), however, could help promote iron toxicity.

60) You are presented with a patient who has been losing weight and is quite lethargic. After performing some biochemical tests, you find that the animal has low amylase, lipase, and TLI with respect to the reference intervals. You suspect exocrine pancreatic insufficiency (EPI) as a differential diagnosis. All of the following may be found in a patient with EPI except:

A. Vitamin A deficiency
B. Excess fat in the feces (stetorrhea)
C. Diarrhea
* D. Hyperglycemia due to a lack of insulin

Exocrine pancreatic insufficiency affects only the acinar cells of the pancreas, not the Islets of Langerhans that produce hormones (insulin, glucagon and somatostatin). Excess fat will be found in the feces due to a lack of pancreatic lipase, diarrhea may be observed due to the increased luminal osmolarity (due to undigested/unabsorbed macromolecules and vitamin A may be deficient as it requires luminal digestion to be absorbed.

61) An effective method to treat copper toxicosis in animals is to give the animal a large amount of zinc.

A. False
* B. True

Copper and Zinc are absorbed by specific divalent carrier proteins and compete with one another for absorption. Administering an excess amount of zinc (which is less toxic than copper) will stimulate an upregulation of metallothionein in the enterocytes promoting more binding/sequestering of the toxic copper within the cells as opposed to the general circulation. Extra: copper binds more readily to metallothianein, so the excess zinc would not saturate the metallothianein before the copper had a chance to bind.

62) All of the following are absorbed by a Na+/substrate symport except:

A. galactose
B. amino acids
C. vitamin C
* D. lipids
E. glucose

Absorption of lipid occurs by 2 mechanisms.<p>Fatty Acids - simple diffusion, when FA concentration high OR FATP transporter (Fatty acid transporter protein) when FA concentration is low. <p>Other lipids (monoglycerides, cholesterol, vitamins) are always through simple diffusion.<p>Note that enterocytes package fatty acids along with cholestrol into chylomicrons prior to endocytosing them into lacteals.

63) Which of the following statements regarding diarrhea is TRUE?

  A. Activation of the RAAS system by the body only worsens the symptoms of diarrhea
* B. Some toxins loosen tight junctions allowing nutrients and electrolytes to leak back into the lumen
  C. Since intestinal villi are moderately hypoxic, ingesting antioxidants can often alleviate symptoms of diarrhea
  D. Secretory diarrhea results in excess water in the lumen due to the loss of membrane-bound enzymes
  E. An increase in frequency of defecation is not considered diarrhea

  As nutrients and electrolytes leak back into the lumen, the lumen's osmotic pressure increases, thus drawing water into it, promoting diarrhea.

64) The rectosphincteric reflex:

  A. stimulated anitperistalsis to increase transit time
  B. is a sympathetic reflex that promotes defecation
  C. is not a true reflex, as defecation is a voluntary act
* D. stimulates the relaxation of the internal rectal sphincter
  E. is synonamous with the vomiting reflex

  The rectosphincteric reflex stimulates the relaxation of the internal rectal sphincter and stimulates colonic peristalsis (ENS and parasympathetic).The CNS controls the external sphincter (skeletal muscle) and is ultimately responsible for defecation, but not by a reflexive pathway.

65) A diet that is lacking lipid-soluble vitamins will hinder the absorption of Calcium.

* A. True
  B. False

  The main mechanism of Ca2+ absorption is vitamin D dependent, and vitamin D is a lipid-soluble vitamin like A, E and K.

66) Bicarbonate reabsorption in the distal GI is promoted by:

* A. coupled sodium chloride transport
  B. a chloride/bicarbonate symport
  C. bicarbonate dissolves in the water that follows potassium diffusion out of the lumen
  D. the chloride bicarbonate exchanger
  E. bile acids dissociate bicarbonate into its individual ions that can readily diffuse out of the lumen

  The coupled sodium chloride transporter brings a chloride ion and sodium ion into the cell in exchange for bicarbonate and a hydrogen ion respectively. The proton and bicarbonate react in the lumen to form CO2 and H2O, both of which can readily diffuse out of the lumen. The Na+/H+ antiport provides the protons in the lumen as the lumen is no longer acidic.

67) The slow waves that originate from the ICC cells in the colon are identical to the slow waves that originate in the small intestine.

  A. True
* B. False

  The slow waves in the colon are less frequent than the slow waves in the small intestine (small intestine : about 15 waves/minute; colon : about 2-3 waves/minute)

68) All of the following occur to a great extent in the colon except:

  A. K+ absorption
  B. HCO3- absorption
  C. Na+/Cl- coupled transport
  D. Cl-/HCO3- exchanger
* E. Na+ co-transport

  Na+ co-transport is the primary means to absorb nutrients, occuring predominantly in the nutrient-rich proximal small intestine.

69) A large segment of large intestine was removed. Which of the following would NOT be true in this case?

  A. you may find less urobilinogen in the urine
  B. your body would not be able to reabsorb potassium as well
* C. during the surgery, branches of the celiac, cranial mesenteric, and caudal mesenteric artery may have to be ligated
  D. the segment you removed would show ample goblet cells but a lack of villi under the microscope
  E. the section of colon removed may test positive for vitamin K

  The celiac artery provides blood supply as far as the proximal duodenum, and thus would not have to be ligated in a large intestine surgery. Urobilinogen may be decreased in the urine because there is less gut length for bacteria to reduce conjugated bilirubin to urobilinogen.

70) Liver damage would result in all of the following except:

  A. impair the absorption of vitamin E
  B. impaired lipid digestion
* C. excess sterocobilinogen in the feces
  D. elevated unconjugated bilirubin in the blood
  E. elevated ALT and SDH levels in a large animal

  You would expect less sterocobilinogen in the feces as the liver is less able to conjugate and thus excrete bilirubin into the gut.

71) All of the following would impair vitamin A absorption except:

  A. extrahepatic cholestasis
  B. a stenotic sphincter of Oddi
* C. a mutation that prevents enterokinase expression
  D. pancreatic insufficiency
  E. a lack of co-lipase, but a compensatory overproduction of lipase

  Enterokinase activates tripsonogen in the duodenum promoting protein digestion. Since vitamin A is a lipid-soluble vitamin, enterokinase activity does not affect vitamin A digestion. All other answers impair lipid digestion in some way, therefore impairing vitamin A digestion/absorption (remember, vitamin A must be digested before it can be absorbed).

72) Which of the following does not lead to a significant change in luminal pH of the GI tract?

  A. the proton / potassium pump in parietal/oxyntic cells
  B. taking an H2 antagonist such as Tagamet
  C. the chloride / bicarbonate exchanger in enterocytes
* D. activity of the sodium / chloride transporter in enterocytes
  E. taking AlkaSeltzer (sodium bicarbonate) after a meal

  The sodium / chloride transporter moves an equivalent charge and acid/base equivalent across the membrane to remain isoelectric and at the same pH. H2 antagonists promote HCl release in the stomach, and AlkaSeltzer will buffer any acidic environment. The chloride/bic exchanger tends to cause an increase in H+ ions in the enterocyte.