

## Nutrition and Metabolism - Digestion

1. What major digestive enzyme is secreted in the saliva?  
The main enzyme in saliva is salivary amylase, which hydrolyzes  $\alpha$  1-4 bonds in starch. Salivary amylase has some but not much effect because of the short time of food in the mouth; lingual lipase (infants digest buttermilk).
2. What cells secrete pepsinogen and where are these cells located?  
Chief (peptic or zymogenic) cells, located in the oxyntic glands found in the body of the stomach.
3. What cells secrete HCl and where are these cells located?  
Parietal (oxyntic) cells, located in the oxyntic glands found in the body of the stomach.
4. What stimulates the release of gastrin?  
Gastrin release occurs in response to vagal stimulation, ingestion of specific substances or nutrients, gastric distention, hydrochloric acid in contact with gastric mucosa, as well as local and circulating hormones (i.e., ingested foods, hormones, and neurotransmitters). Foods such as coffee and alcohol, as well as nutrients such as calcium, amino acids, and peptides, present in the GI tract lumen stimulate gastrin release. Epinephrine in the blood and gastrin-releasing peptide, released by some nerves, also stimulate gastrin release.
5. What are the SPECIFIC functions of gastrin?  
Gastrin stimulates the release of hydrochloric acid, but it also stimulates gastric and intestinal motility and pepsinogen release. Gastrin stimulates the cellular growth of (has trophic action on) the stomach, and both small and large intestine.
6. Is there some sort of feedback mechanism that controls how much gastrin is secreted?  
Yes, when the lumen pH gets too acidic, a feedback mechanism reduces acid secretion by inhibiting gastrin release. Somatostatin inhibits gastrin release from the G-cells (as well as inhibiting HCL secretion at the parietal cell.)
7. Name an enzyme that digests protein in the stomach.  
Pepsin is the principal proteolytic enzyme in the stomach.
8. Name an enzyme that digests lipids in the stomach.  
Lingual lipase, produced by lingual serous glands in the mouth, hydrolyzes dietary triacylglycerols in the stomach and small intestine.
9. What word ending is associated with enzymes?  
-ase
10. Is there major digestion of carbohydrate in the stomach?

No. In the mouth, the enzyme salivary amylase (ptyalin), which operates at a neutral or slightly alkaline pH, starts the digestive action on starch, hydrolyzing it into smaller molecules. The activity of amylase is halted by contact with hydrochloric acid. If the digestible carbohydrate were to remain in the stomach long enough, the acid hydrolysis would eventually reduce much of it to the monosaccharides. However, the stomach usually empties itself before significant digestion can take place, and carbohydrate digestion occurs almost entirely in the proximal small intestine.

11. What regulates how much “food” passes into the small intestine?  
Approximately 1 to 5 ml (< 1 tsp.) of chyme enters the duodenum about twice per minute. Contraction of the pylorus and proximal duodenum is thought to be coordinated with contraction of the antrum. Gastric emptying is also partially affected by the macronutrient composition of the food. Carbohydrate and protein appear to empty at approximately the same rate from the stomach; fat, however, slows gastric emptying into the duodenum. Salts and monosaccharides inhibit gastric emptying, as do many free amino acids like tryptophan and phenylalanine. Complex carbohydrates, especially soluble fiber, decrease (slow down) the rate of gastric emptying. Neural gastrointestinal reflexes, along with the release of regulatory peptides such as secretin by the duodenal bulb, also influence gastric emptying, which following a meal usually takes between 2 and 6 hours.
12. What causes the release of cholecystokinin (CCK)?  
CCK is released in response to the presence of lipids (fat) in chyme.
13. What does CCK do?  
CCK stimulates secretion of pancreatic juices and enzymes in response to fat. It causes contraction of the gallbladder (i.e., causes the gallbladder to squirt bile into the small intestine) and slows stomach emptying.
14. What causes the release of secretin?  
Secretin is secreted into the blood by S-cells of the proximal small intestine in response to the release of acid chyme into the duodenum. (Secretin's major action is to increase the pH of the small intestine by stimulating secretion of water and bicarbonate (pancreatic juice) by the pancreas. It also inhibits gastric acid secretion and gastric emptying.)
15. Where do pancreatic secretions enter the intestine?  
Pancreatic secretions (fluid, electrolytes, bicarbonate, and enzymes) are released into the duodenum.
16. Pancreatic secretions contain two distinctly different types of material. What are they?
  1. Enzymes: are responsible for the digestion of approximately half of all ingested carbohydrates, half of all proteins, and almost all of ingested fat.

2. Bicarbonate: in pancreatic juice released into the duodenum is important for neutralizing the acid chyme passing into the duodenum from the stomach and for maximizing enzyme activity within the duodenum.

17. Where does bile enter the intestine?

Bile flows into the duodenum from the gallbladder.

18. Describe the pH differences as “food” passes from the mouth to the stomach to the small intestine.

The pH of saliva in the mouth is about 7. Gastric juices lower the pH to 2 in the stomach. Secretin increases intestinal pH by releasing bicarbonate. Intestinal juice, pancreatic juice, and bile are pH 8.

19. Give an example of a “brush border” enzyme.

Isomaltase (active against  $\alpha$  1-6 bonds).

Aminopeptidases, tripeptidases, dipeptidases.

20. How does surface area affect digestion? Think of a food example that illustrates your point.

The anatomic advantage of the villi-microvilli structure is that it presents an enormous surface area to the intestinal contents, thereby facilitating absorption. It has been estimated that the absorptive capacity of the human intestine amounts to about 5,400 g/day for glucose and 4,800 g/day for fructose -- a capability that would never be challenged in a normal diet.

21. Give an example of how a neural stimulus can affect digestion.

The nervous system of the gastrointestinal tract, the enteric system, provides neural regulation of the gastrointestinal tract by a combination of neural plexuses and reflexes. The myenteric plexus controls peristaltic activity and/or gastrointestinal motility. It is innervated by parasympathetic and sympathetic nervous systems, and it greatly influences gastrointestinal motility. The submucosal plexus controls mainly gastrointestinal secretions and local blood flow. Gastrin release is stimulated, in part, by vagal stimulation (neurotransmitters). Epinephrine in the blood also stimulates gastrin release. Also, simply the thought, sight, or smell of food can make the mouth “water”, or release saliva, in anticipation of food.

22. What nutrients is an infant well prepared to digest?

Lingual lipase, which hydrolyzes dietary triacylglycerols in the stomach and small intestine, is mostly of importance to infants. They are well prepared to digest milk, especially breast milk.

23. Why is salivary amylase relatively inactive in the stomach?

The high concentration of hydrochloric acid in the gastric juice results in its low pH, about 2, which inactivates salivary amylase.

24. What is another source of amylase?

The pancreas secretes pancreatic  $\alpha$  amylase.

25. What effect does physical processing have on digestion? Why?

The pacemaker, located between the fundus and body of the stomach, determines the frequency of the contractions that occur. As the food moves into the antrum, the rate of contractions increases so that in the distal portion of the stomach, food is liquefied into chyme. The migrating motility complex functions to sweep gastrointestinal contents and prevent bacterial overgrowth in the intestine. Contractions within the stomach promote physical disintegration of solid foods into a liquid form. Chyme, in the small intestine, is mixed and moved through the small intestine by various contractions under nervous system influence. Sleeve contractions (longitudinal) mix the intestinal contents with the digestive juices. Standing contractions (segmentation) of circular muscles, produces bidirectional flow of the intestinal contents, and serves to mix and churn the chyme with digestive secretions in the small intestine. Peristaltic waves, or progressive contractions, move the chyme distally along the intestinal mucosa toward the ileocecal valve.

26. Where does digestion of protein begin? What are the sources of enzymes that digest protein?

Digestion of protein begins in the stomach, where pepsin functions as a protease - that is, an enzyme that hydrolyzes proteins. Hydrochloric acid converts or activates the zymogen pepsinogen to form pepsin. Most protein digestion takes place in the duodenum, however. The pancreatic proteolytic enzymes pancreatic trypsin, chymotrypsin, and carboxypolypeptidase break down intact protein and continue the breakdown started in the stomach until small polypeptides and amino acids are formed. Proteolytic peptidases located on the brush border also act on polypeptides, changing them to amino acids, dipeptides, and tripeptides. The final phase of protein digestion takes place in the brush border, where dipeptides and tripeptides are hydrolyzed to their constituent amino acids by peptide hydrolases.

27. How is the acid chyme neutralized in the small intestine? What are the effects if the chyme is not effectively neutralized?

Chyme, moving from the stomach into the duodenum, initially has a pH of about 2 because of its gastric acid content. Chyme is neutralized in the duodenum by secretions from the pancreas and Brunner's glands. If the chyme is not effectively neutralized, the duodenum is not protected from the gastric acidity.

28. Where does digestion of most lipid begin? What enzyme is responsible?

Enzymes necessary for lipid digestion are produced by the pancreas and secreted into the small intestine. Pancreatic lipase, the major fat-digesting enzyme, hydrolyzes triacylglycerols.

29. Name two substances absorbed from the stomach.

Water, some fat-soluble drugs (aspirin), and alcohol.

30. Where are enterocytes found?

The villi of the small intestine are fingerlike projections lined by hundreds of cells (enterocytes, also called absorptive epithelial cells).

31. How frequently are cells in the small intestine renewed (replaced)?

Intestinal cell turnover is rapid, approximately every 3 to 5 days.

32. Where in the gastrointestinal tract are most nutrients absorbed?

Most in duodenum and jejunum.

33. If disease or drugs increase intestinal motility, what is the potential effect on absorption?

Digestion and absorption of nutrients within the small intestine are rapid, with most of the carbohydrate, protein, and fat being absorbed within 30 minutes after chyme has reached the small intestine. About 90-95% of the water and sodium entering the colon each day is absorbed. Increased intestinal motility could adversely impact the ability of the intestinal tract to adequately perform its job of absorbing nutrients and water.

34. What is recirculation of compounds such as bile salts between the small intestine and the liver

called?

The circulation of bile is termed entero-hepatic circulation. The pool of bile is thought to recycle at least twice per meal.

35. Where are bile salts secreted into the intestine? Where are they reabsorbed? Where are they

excreted?

Bile flow into the duodenum is regulated by the intraduodenal segment of the common hepatic bile duct and the sphincter of Oddi, located at the junction of the common hepatic bile duct and the duodenum. More than 90% of the bile acids and salts secreted into the duodenum are reabsorbed by active transport in the ileum. Small amounts of the bile may be passively reabsorbed in the jejunum and the colon. Bile that is absorbed in the ileum enters the portal vein and is transported attached to plasma protein albumin in the blood back to the liver. New bile acids are typically synthesized in amounts about equal to those that are lost (excreted) in the feces.

36. What type of nutrients pass into the portal blood?

Carbohydrate absorption goes to portal circulation -- to the liver.

37. What type of nutrients pass into lacteals for transport by the lymphatic system?

38. What difference does the route of absorption make in the destination of nutrients or drugs?
39. What are the principle nutrients absorbed in the large intestine?  
The proximal colonic epithelia absorb sodium, chloride, and water.
40. What effect does fiber in the ileum have on enterohepatic recirculation?  
Bile acids bound to fiber cannot be reabsorbed and recirculated. Fiber-bound bile acids are typically sent into the large intestine for either fecal excretion or colonic microflora degradation.
41. The immediate risk of severe diarrhea is loss of which nutrients?  
Excessive loss of fluid and electrolytes, especially sodium and potassium.
42. How much energy is provided by a gram of carbohydrate?  
4 kcal/g.
43. What % of energy is provided by carbohydrate in the usual American diet?  
48%
44. Is free glucose commonly found in food?  
No. There's almost no free glucose. There is some free glucose and fructose in honey, certain fruits, and the carbohydrates added to processed foods.
45. What tissues depend on glucose for fuel?  
The brain and other tissues of the Central Nervous System, and Red Blood Cells are particularly dependent on glucose as a nutrient.
46. What word ending designates a carbohydrate?  
-ose,
47. What is the storage form of carbohydrate in plants?  
Starch, the energy storage product of the cell, is found within the cell walls.
48. What is the storage form of carbohydrate in animals?  
The major form of stored carbohydrate in animal tissues is glycogen, which is localized primarily in liver and skeletal muscle.
49. Is meat a good source of glycogen? Why or why not?  
No. Slaughtered animals have no glycogen by the time the meat is packaged.
50. What are the components of each of the common dietary disaccharides?  
Sucrose: glucose + fructose  
Lactose: glucose + galactose  
Maltose: glucose + glucose
51. Into what compound in the body is 2-deoxy-D-ribose incorporated?

Deoxyribonucleic acid (DNA).

52. Where is lactose synthesized? Where is it digested?

Lactose is made almost exclusively in the mammary glands. The  $\beta$  linkage in lactose is hydrolyzed by lactase in the intestinal cell.

53. What are the public health implications of an inability to digest lactose?

Lactose intolerance eliminates the whole dairy food group as a possible nutrient source. Lactose intolerance increases with age and its distribution varies with ethnic background. It is low in Caucasians and high in Native Americans, Asians, and Black populations.

54. How are the symptoms of lactase deficiency related to osmotic pressure and to the actions of colonic bacteria?

Lactose that is not hydrolyzed into galactose and glucose remains in the gut and acts osmotically to draw water into the intestines. Colonic bacteria ferment the undigested lactose, generating short-chain fatty acids, carbon dioxide, and hydrogen gas. Consumption of quantities greater than 12 g (the amount typically found in 240 mL of milk) may result in bloating, flatulence, cramps, and diarrhea.

55. In the "usual U.S. diet", how much of the digestible carbohydrate is starch and how much is sucrose?

Roughly half of dietary carbohydrate is in the form of polysaccharides such as starches and dextrans, derived largely from cereal grains and vegetables. The remaining half is supplied as simple sugars, the most important of which include sucrose, lactose, and, to a lesser extent, maltose, glucose, and fructose. Sucrose, consisting of a glucose and a fructose residue, furnishes approximately one-third of total dietary carbohydrate in an average diet.

56. How many grams of carbohydrate in the "usual U.S. diet"?

48% of 2000 kcal = 960 kcal from carbohydrate.

$960 \text{ kcal} / 4 \text{ kcal/g} = 240 \text{ g.}$  of carbohydrate in the "usual U.S. diet".

57. Which carbohydrate is sweeter? Sucrose or fructose?

Fructose is the sweetest of the sugars.

58. Are amino acids transported via the portal blood or the lymphatic system?

Amino acids are transported across the cell membrane into the surrounding fluid where they enter the capillaries on their way to the liver.

59. What lipids make up the cell membrane?

Membrane lipids consist primarily of phospholipids. Phosphoglycerides and phosphingolipids (phosphate-containing sphingolipids) comprise most of the membrane phospholipids. Of the phosphoglycerides, phosphatidylcholine and

phosphatidylethanolamine are particularly abundant in higher animals. Another important membrane lipid is cholesterol.

60. What effects does lack of bile acids have on lipid digestion and absorption?

Bile salts are necessary to decrease the surface tension of the fat, thus permitting emulsification of the fat and enabling digestion (hydrolysis) of the triacylglycerol molecules to occur by pancreatic and intestinal lipases. Once hydrolyzed, bile acids and salts help in the absorption of these end products of lipid digestion. Bile acids and salts, along with phospholipids, help in the absorption of lipids by forming small, spherical, cylindrical, or disklike shaped complexes called micelles that permit solubility in the watery digestive fluids and transportation to the intestinal brush border for absorption. Without bile acids, digestion and absorption of lipids (fat) would not be possible.

61. Are bile acids still secreted if the gall bladder is removed?

Bile acids are still secreted, but cannot be stored and released in response to the presence of fat. Rather, the bile drips continuously into the duodenum.

62. What is a micelle?

A micelle is a small (<10 nm) spherical, cylindrical, or disklike shaped complex that can contain as many as 40 bile salt molecules. The hydrophobic steroid portion of bile salts and acids, which is mostly fat soluble, position themselves together and surround the monoacylglycerols and fatty acids that formed following the action of lipases. Polar portions of the bile salts, bile acids, and phospholipids project outward from the lipid core of the micelle, thus permitting solubility in the watery digestive fluids and transportation to the intestinal brush border for absorption.

63. What effect does chain length of a fatty acid have on the route of absorption?

Some substances such as water and small lipid molecules cross membranes freely by diffusion. Other compounds cannot cross cell membranes without a specific carrier, such as in facilitated diffusion and active transport. Some large molecules are moved into the cell via pinocytosis, engulfment by the cell membrane.

64. What are the principle components of the plasma membrane?

Membrane lipids

- phospholipids
- cholesterol
- hydrophobic)

Membrane proteins -- pumps, receptors and enzymes

Protects cellular components

Allows exposure to the environment

Contains some carbohydrate

*Membranes are sheetlike structures composed primarily of lipids and proteins held together by noncovalent interactions. Membrane lipids consist primarily of*

*phospholipids, which have both a hydrophobic and hydrophilic moiety. In water, they form lipid bilayers which retard the passage of many water-soluble compounds into and out of the cell. Membrane proteins serve as pumps, gates, receptors, energy transducers, and enzymes. The plasma membrane has a greater carbohydrate content owing to the presence of glycolipids and glycoproteins. The plasma membrane has a higher content of cholesterol which enhances the mechanical stability of the membrane and regulates its fluidity.*

65. What are the key metabolic pathways in the cytoplasmic matrix?

- Glycolysis
- Pentose phosphate pathway
- Glycogenesis
- Glycogenolysis
- Fatty acid synthesis
- Production of nonessential, unsaturated fatty acids

66. What are the key metabolic reactions that occur in mitochondria?

Oxidative phosphorylation - production of most of ATP (via electron transport chain).

- Electron transport chain is exothermic.
- Release energy from food/couple to form ATP.
- Includes Krebs cycle and fatty acid oxidation.
- All cells except RBC have mitochondria.

67. What organ secretes the majority of the digestive enzymes?

The pancreas is the major source of most digestive enzymes. Enzymes from the pancreas digest 50% of all carbohydrates - alpha-amylase, 50% of all proteins - proteases, and 90% of all fat - pancreatic lipase. Endocrine secretions include insulin and glucagon. It also secretes bicarbonate.

68. Where is the pyloric sphincter and what is its role?

The pyloric sphincter at the distal end of the stomach controls the release of chyme (partially digested food existing as a thick semiliquid mucky mass) from the stomach into the duodenum.

69. Is the net energy transformation for the Krebs cycle endothermic or exothermic? What does this mean?

The net energy transformation for the Krebs cycle is exothermic. That means it is energy releasing. The high energy output of the Krebs cycle is attributed to mitochondrial electron transport, with oxidative phosphorylation being the source of ATP formation.

70. What is oxidative phosphorylation? What is produced?

A process by which a molecule of inorganic phosphate is condensed with ADP to form ATP.

Oxidation of fuel molecules utilizes  $O_2$ .  
Energy yield can be measured by oxygen consumption.

71. Approximately what % of energy from food is trapped as ATP?  
We're about 40% efficient in converting food to ATP. The other 60% goes to maintaining body heat.
72. What hormones regulate the circulating level of carbohydrate in the blood? What is the name of the primary circulating carbohydrate?  
Insulin and glucagon. Glucose.
73. When in relation to meals does glycogenesis occur?  
When you just ate. An increase in glucose leads to the synthesis of glycogen (glycogenesis) for storage of the extra glucose.
74. When would glycogenolysis occur?  
When you haven't just eaten. A decrease in blood glucose is a stimulus to glycogenolysis.
75. Where in the cell is most of the energy produced?  
The mitochondria are responsible for most of the metabolic energy produced in cells.
76. What are the end products of the Krebs' cycle and how are they utilized/removed by the body?  
Over 90% of energy released from food occurs here.  
Oxidative phosphorylation.  
Pyruvate transferred to mitochondria -- yields acetyl CoA and  $CO_2$  (released by exhalation).  
Acetyl CoA - from fatty acids, glucose, amino acids.  
The oxidation of 1 mol of acetyl CoA in the Krebs cycle yields a total of 12 ATPs. 12 ATPs x 2 mol of acetyl CoA per mole of glucose = 24 ATPs. Plus 6 ATPs from intramitochondrial pyruvate dehydrogenase reaction = 38 ATPs..
77. What does gluconeogenesis mean?  
Glucose synthesis from noncarbohydrate sources. (i.e., generation of new glucose.)
78. What is a normal fasting serum glucose level?  
70-105 mg/dL fasting..
79. What is glycogen loading?  
Consuming carbohydrates over a period of several days prior to an athletic event in an attempt to store up glycogen which is a limiting factor for exercise at intensities requiring 70-85%  $VO_{2max}$ .

80. What effect does dietary fiber have on water in the stool? What effect does this have on constipation?

The gastrointestinal effects of the ingestion of fibers that can hold water and create viscous solutions within the GI tract include:

delayed (slowed) emptying of food from the stomach,  
reduced mixing of gastrointestinal contents with digestive enzymes,  
reduced enzyme function,  
increased nutrient diffusion rate and thus delayed nutrient absorption, and  
altered small intestine transit time.

Fibers that are nonfermentable, especially cellulose and lignin, and fibers that are more slowly fermentable, such as some hemicelluloses, have been shown to be helpful in overcoming constipation, particularly constipation associated with symptomatic diverticular disease and/or irritable bowel syndrome.

81. What effect do free sugars have on stool water?

Free sugars would alter osmolarity, leading to a high osmotic pressure and an influx of water into the cells from the surroundings (the stool water).

82. Name some specific chemical compounds produced by carbohydrate fermentation in the colon.

The principal metabolites of fermentable fibers (including any starch that has passed into the cecum and been degraded by bacteria) are lactate and short-chain fatty acids (SCFAs). The short chain fatty acids include primarily acetic, butyric, and propionic acids. Other products of fiber fermentation are hydrogen, carbon dioxide, and methane gases that are excreted as flatus or are expired by the lungs.

83. What difference does it make if glucose is joined by alpha-1-4 linkages or beta-1-4 linkages?

The key enzyme in the digestion of dietary polysaccharides is  $\alpha$ -amylase, a glycosidase that specifically hydrolyzes  $\alpha$ -1,4 glycosidic linkages. Resistant to the action of the enzyme, therefore, are the  $\beta$ -1,4 bonds of cellulose.

84. Give an example of a digestible polysaccharide and of a non-digestible polysaccharide?

Starch is a digestible polysaccharide.

Cellulose and lignin are indigestible polysaccharides.

85. What causes the sensation of "heartburn"?

On swallowing, the LES pressure drops. This drop in LES pressure relaxes the sphincter so that food may pass from the esophagus into the stomach. Closure of the LES sphincter is important because it prevents gastroesophageal reflux, the movement of chyme from the stomach back into the esophagus. The gastric acid in the chyme when present in the esophagus is an irritant to the esophageal mucosa. The individual experiencing reflux feels a burning sensation in the midchest region, a condition referred to as heartburn.

86. Think about nutrients in a meal? For each of these, where would most digestion and absorption occur?

<u>Nutrient</u>	<u>Digestion</u>	<u>Absorption</u>
Protein	Stomach, Small Intestine	Small Intestine
Carbohydrate	Small Intestine	Small Intestine
Lipid	Small Intestine	Small Intestine

87. What types of foods provide fiber?

Dietary fiber is derived from plant cells. The consumption of plant foods provides fiber in the diet. Cereal bran such as wheat bran provides primarily hemicellulose as well as lignin. Psyllium provides primarily mucilages but also some nonpolysaccharides. Consumption of fruits and vegetables provides almost equal quantities of cellulose and pectin.

88. What makes a carbohydrate “a fiber” for humans?

Probably the most widely accepted definition for dietary fiber is "plant polysaccharides and lignin which are resistant to hydrolysis by the digestive enzymes of man."

89. What are the health benefits of insoluble fiber?

Insoluble fibers decrease (speed up) intestinal transit time and increase fecal bulk. A shortened fecal transit time decreases the time during which toxins can be synthesized and in which they are in contact with the colon. Insoluble fibers such as lignin that resist degradation bind carcinogens, thereby minimizing the chances of interactions with colonic mucosal cells.

90. What are the health benefits of soluble (viscous) fiber?

Generally, soluble fibers delay gastric emptying, increase transit time (slower movement) through the intestine. This effect creates a feeling of postprandial (after eating) satiety (fullness) as well as slows down the digestion process. Wheat bran is one of the most effective fiber laxatives because it can absorb three times its weight of water, thereby producing a bulky stool. Fibers that increase fecal bulk decrease the intraluminal concentrations of carcinogens and thereby reduce the likelihood of interactions with colonic mucosal cells.

91. What are the effects of fiber on stomach emptying? What type of fiber is involved?

When fibers form viscous gels or hydrate within the stomach (i.e. soluble fiber), the release of the chyme from the stomach into the duodenum (proximal small intestine) is delayed (slowed). Thus, nutrients remain in the stomach longer with these fibers than would occur in the absence of the ingested fiber. This effect creates a feeling of postprandial (after eating) satiety (fullness) as well as slows down the digestion process, because carbohydrates and lipids that remain in the stomach undergo no digestion in the stomach and must move into the small intestine for further digestion to occur.

92. What are the effects of fiber on fermentation in the colon? What types of products are produced from fermentation in the colon?

Many of the microflora in the large intestine are capable of degrading (fermenting) fiber, especially pectins, gums, mucilages, and algal polysaccharides. The principal metabolites of fermentable fibers are lactate and short-chain fatty acids (SCFAs). The short chain fatty acids include primarily acetic, butyric and propionic acids, as well as hydrogen, carbon dioxide, and methane gases that are excreted as flatus or are expired by the lungs. Some general effects of short-chain fatty acids generated from fiber fermentation by intestinal microbes include increased water and sodium absorption in the colon, mucosal cell proliferation, provision of energy, and acidification of luminal environment.

93. Why does fiber have an effect on satiety?

Nutrients remain in the stomach longer due to delayed gastric emptying; this effect creates a feeling of postprandial satiety.

94. What are fiber effects on absorption of nutrients? Give an example where this is beneficial

and an example where it is detrimental.

Generally, soluble fibers delay gastric emptying, increase transit time through the intestine, and decrease nutrient (e.g., glucose) absorption. This could be of benefit to someone with diabetes mellitus. In contrast, insoluble fibers decrease intestinal transit time and increase fecal bulk. Soluble fibers may affect lipid absorption by adsorbing fatty acids, cholesterol, and/or bile acids within the digestive tract. Thus fiber-bound lipids (i.e. cholesterol) are not absorbed in the small intestine and pass into the large intestine where they will be excreted in the feces or degraded by intestinal bacteria. Adsorption of bile acids to fibers prevents the use of the bile acids for micelle formation. Bile acids bound to fiber cannot be reabsorbed and recirculated.

95. What are ways that fiber can have an effect on serum cholesterol?

Soluble fibers may affect lipid absorption by adsorbing fatty acids, cholesterol, and/or bile acids within the digestive tract. Thus fiber-bound lipids (i.e. cholesterol) are not absorbed in the small intestine and pass into the large intestine where they will be excreted in the feces or degraded by intestinal bacteria.

96. What types of fiber are most protective against colon cancer? Why?

Insoluble fibers such as lignin that resist degradation bind carcinogens, thereby minimizing the chances of interactions with colonic mucosal cells.

97. What would be a recommendation for fiber intake for an adult consuming foods providing 2000 kcal/day?

The recommended intake of fiber for the general population ranges from 20 to 40 g/day. Another recommendation is 10 to 13 g dietary fiber intake per 1000 kcal. So, for a 2000 kcal/day diet, that would be 20 to 26 g/day.

