Chapter 4 Human Digestion and Absorption

Lecture Outline

4.1 Organization of the Human Body

A. Cells

1. Smallest functional unit of the human body
2. Grow, absorb nutrients, use energy, conduct metabolic and physiological functions, excrete wastes
3. Cellular processes and reactions require energy from carbohydrates, proteins, and fats; energy transformed into adenosine triphosphate (ATP) for the body to use
4. Cells also need water, building materials and chemical regulators

B. Tissues: groups of similar cells working together to perform a specific task

1. Epithelial tissue: covers surfaces inside and outside body
2. Connective tissue: supports and protects body
3. Muscle tissue: permits movement
4. Nervous tissue: transmits nerve impulses

C. Organs: structures that perform specific functions; comprised of tissues

D. Organ systems: several organs working together to perform a specific function (see Table 4-1)

1. Digestive
2. Nervous
3. Cardiovascular
4. Endocrine
5. Lymphatic and Immune
6. Urinary
7. Integumentary
8. Skeletal
9. Muscular
10. Respiratory
11. Reproductive

4.2 Digestive System Overview

A. General

1. Digestion: mechanical and chemical processes of breaking down foods into smaller components
2. Absorption: uptake of nutrients from the GI tract into the blood or lymph
3. GI tract is barrier to entry of harmful microorganisms into the body and produces immune components
4. Houses healthy bacteria called microbiota; make up the microbiome

B. Overview of GI Tract Digestion and Absorption Functions (Table 4–2)

1. Mouth and salivary glands
   a. Chew food
   b. Detect taste molecules
   c. Moisten food with saliva
   d. Start digestion of starch with amylase enzyme
2. Esophagus
   a. Move food to stomach (peristalsis)
3. Stomach

a. Secretes gastric juice containing acid and enzymes
b. Mixes food with gastric juice, converting it to liquid chyme
c. Starts digestion of protein with pepsin enzyme
d. Kills microorganisms with acid
e. Secretes intrinsic factor, a protein needed for vitamin B-12 absorption
f. Slowly releases chyme to the small intestine

4. Liver: produces bile to aid fat digestion and absorption
5. Gallbladder: store, concentrate, and release bile into small intestine
6. Pancreas: secretes pancreatic juice containing digestive enzymes and bicarbonate into the small intestine
7. Small intestine
   a. Mixes chyme with bile and pancreatic juice to complete digestion
   b. Absorbs nutrients and other compounds in foods
   c. Transports remaining residue to large intestine
8. Large intestine
   a. Absorbs water and electrolytes
   b. Forms and stores feces
   c. Houses most of the gut microbiota
9. Rectum: holds feces and expels via anus

C. Anatomy of the GI Tract (Alimentary Canal)
1. General
   a. Long, hollow, muscular tube that extends ~15 feet from mouth to anus
   b. Nutrients pass through walls of the GI tract
      i. Mucosa: innermost layer, lined with epithelial cells and glands, not smooth and has tiny, fingerlike structures that project into the lumen
      ii. Submucosa: second layer, consists of loose connective tissue, glands, blood vessels, and nerves
      iii. Muscle: inner layer of circular smooth muscle and outer layer of longitudinal muscle fibers (stomach has third layer that runs diagonally); functions to move food forward
      iv. Serosa: outermost, protective layer; secretes fluid that cushions GI tract and reduces friction
   c. Sphincters: ring-like muscle that opens and closes like valves to control the flow of GI contents (figure 4–4)
      i. Lower esophageal sphincter: prevents backflow of stomach contents into the esophagus
      ii. Pyloric sphincter: controls flow of stomach contents into the small intestine
      iii. Hepatopancreatic sphincter: controls flow of bile and pancreatic juice from common bile duct and pancreatic ducts into small intestine
      iv. Ileocecal valve: prevents contents of large intestine from reentering small intestine
      v. Anal sphincters: controls defecation until person desires to do so

D. GI Motility: Mixing and Propulsion
1. Peristalsis: coordinated wave of contraction and relaxation that moves the contents through the intestinal tract toward the anus
2. Segmentation: back-and-forth action in the small intestine that breaks apart contents of the small intestine into smaller pieces and mixes with digestive juices

E. Digestive Enzymes and Other Secretions
1. Digestive enzymes are protein molecules that speed up digestion.
2. Catalyze chemical reactions known as hydrolysis reactions:
   a. Water breaks apart molecules too large to pass through the G I tract wall
   b. Yields simple molecules that are small enough to be absorbed

3. The salivary glands and stomach produce small amounts of digestive enzymes, while most are synthesized by pancreas and small intestine
4. Pancreas adjusts enzyme production based on macronutrient content of diet
5. Inadequate enzyme production results in incomplete digestion and limited absorption
6. If food is incompletely digested, bacteria in large intestine convert it to gases and acids
7. Produced in the:
   a. Salivary glands
   b. Stomach
   c. Pancreas
   d. Small intestine
8. Digestive enzymes aid in the hydrolysis of carbohydrates, proteins, and fats

F. Important Secretions of the Digestive System (Table 4–3)
1. Saliva: secreted in mouth
   a. Begins starch digestion
   b. Facilitates swallowing by lubrication
2. Mucus: thick fluid secreted in mouth, stomach, small and large intestine
   a. Protects GI tract cells
   b. Lubricates food
3. Enzymes (amylases, lipases, and proteases): secreted in mouth, stomach, small intestine, and pancreas
   a. Break down carbohydrates, fats, and protein
4. Acid (HCl): secreted by stomach
   a. Protein digestion
   b. Destruction of microorganisms
   c. Increases solubility of minerals
5. Bile: produced by liver, stored in gallbladder
   a. Emulsifies fat to aid fat digestion
6. Bicarbonate: secreted by pancreas and small intestine
   a. Neutralizes stomach acid when it reaches small intestine
7. Hormones: secreted by stomach, small intestine, and pancreas
   a. Regulate digestion and absorption

4.3 Moving through the GI Tract: Mouth and Esophagus

A. General
1. Food preparation begins the process of digestion
2. Teeth tear and grind food into smaller pieces to increase surface area for exposure to saliva (see Figure 4-7)
3. Tongue mixes food with saliva, creating a bolus
4. Saliva: dilute, watery fluid containing
   a. Mucus (lubrication)
   b. Lysozyme (kills bacteria)
   c. Amylase (digest starch)

B. Taste and Smell
1. Taste-forming compounds in food dissolve in saliva
2. Taste buds on tongue and soft palate detect taste compounds in food
3. 5 basic taste sensations
   a. Salty
   b. Sour

c. Sweet
d. Bitter
e. Umami

4. Olfactory cells in the nose enhance the sense of taste

C. Swallowing (see Figure 4-8)

1. Moves food from mouth to esophagus
2. Epiglottis: flap at top of esophagus that prevents food from entering the trachea by covering the larynx
3. Esophageal muscle contractions push bolus toward stomach

4.4 Moving through the GI Tract: Stomach

A. Bolus moves past lower esophageal sphincter (a.k.a. cardiac sphincter), which prevents reflux of stomach contents into the esophagus (LES malfunction leads to heartburn)

B. Stomach

1. Holding and mixing tank
2. Little digestion occurs in stomach
3. Some absorption can occur
   a. Water
   b. Few forms of fat
   c. 20% of alcohol
4. Secretes gastric juice to aid in digestive process and we released when we see, smell, taste, or think about food
5. Secretions:
   a. Hydrochloric acid (HCl) from parietal cells inactivates proteins, destroys pathogens, dissolves minerals, converts pepsinogen to pepsin (active protein-digesting enzyme)
   b. Pepsinogen (inactive protein-digesting enzyme) from chief cells
   c. Gastric lipase from chief cells
   d. Gastrin (hormone) controls release of HCl and pepsinogen; secretion is highest at the beginning of a meal and declines as meal progresses
   e. Mucus from mucous cells on gastric mucosa lubricates and protects stomach cells from digestion by HCl and pepsin, production relies on prostaglandins
      i. Heavy use of nonsteroidal anti-inflammatory drugs can damage stomach wall because they inhibit prostaglandin production
   f. Glucose-dependent insulinotropic peptide (hormone) helps slow release of chyme into the small intestine
   g. Intrinsic factor is required for absorption of vitamin B-12
6. Contractions of 3 muscle layers mix food with gastric secretions to transform solid food into chyme
7. Pyloric sphincter between stomach and duodenum controls flow of chyme into small intestine

4.5 Moving through the GI Tract: Small Intestine and Accessory Organs

A. General (see Figure 4-12)

1. The small intestine is the major site of digestion and absorption.
2. Divided into 3 sections:
   a. Duodenum
   b. Jejunum
   c. Ileum
3. Interior of small intestine has circular folds and fingerlike projections called villi and microvilli
4. Circular folds cause chyme to move slowly through a spiral path

a. Helps mix the chyme with digestive juices and bring nutrients into contact with villi
b. Aided by segmentation

5. Villi are lined with enterocytes which secrete enzymes and absorb nutrients
   a. Other cells secrete mucus and hormones
6. Enterocytes have a brush border lined with microvilli
   a. Covered with digestive enzyme-containing glycocalyx
7. Digestion in the small intestine also depends on secretions from the:
   a. Pancreas
   b. Liver
   c. Gallbladder

B. Liver, Gallbladder, and Pancreas (accessory organs; see Figure 4-15)

1. Common bile duct and pancreatic duct empty into the duodenum at the hepatopancreatic sphincter
2. Liver secretes bile
   a. Cholesterol-containing yellow-green fluid
   b. Emulsifies fat into micelles
   c. Reabsorbed in ileum and returned to the liver (enterohepatic circulation)
      i. Small amount of bile is not reabsorbed and is excreted into the feces
3. Gallbladder stores and concentrates bile
4. Pancreas produces pancreatic juices
   a. Sodium bicarbonate ($NAHCO_3$) neutralizes acidic chyme
   b. Pancreatic amylase digests starch
   c. Pancreatic lipase digests fat
   d. Proteases digest protein

C. Gastrointestinal Hormones: A Key to Orchestrating Digestion (see Table 4-4)

1. Gastrin (stomach and duodenum): triggers release of HCl and pepsinogen, stimulates gastric and intestinal motility
2. Cholecystokinin (small intestine): stimulates release of pancreatic enzymes and bile
3. Secretin (small intestine): stimulates release of pancreatic bicarbonate
4. Motilin (small intestine): regulates motility of the GI tract
5. Glucose-dependent insulintropic peptide (GIP) (small intestine): inhibits gastric acid secretion; stimulates insulin release
6. Peptide YY (ileum and large intestine): inhibits gastric and pancreatic secretions
7. Somatostatin (stomach, small intestine, and pancreas): inhibits release of GI hormones, slows gastric emptying, GI motility, and blood flow

D. Absorption in the Small Intestine

1. Sites of absorption (see Figure 4-16)
   a. Stomach
      i. Alcohol (20% of total)
      ii. Water (minor amount)
   b. Small intestine
      i. Calcium, magnesium, iron, other minerals
      ii. Glucose
      iii. Amino acids
      iv. Fats
      v. Vitamins

vi. Water (70 - 90% of total)
vii. Alcohol (80% of total)
viii. Bile acids

c. Large intestine
i. Sodium
ii. Potassium
iii. Some fatty acids
iv. Vitamin K and biotin
v. Gases
vi. Water (10 - 30% of total)

2. Nutrients move from lumen into absorptive cells by 4 types of absorption:
a. Passive diffusion: concentration of nutrient is higher in lumen than in absorptive cells, nutrient moves into absorptive cells by diffusion
b. Facilitated diffusion: nutrients move down concentration gradient, but require carrier proteins to move into absorptive cells (e.g., fructose)
c. Active absorption: allows for concentration of nutrients on either side of the cell membrane and requires energy for absorption (e.g., amino acids, glucose)
d. Endocytosis
i. Phagocytosis: absorptive cells engulf compounds, form vesicle
ii. Pinocytosis: absorptive cells engulf liquids, form vesicle
iii. e.g., immune substances from breast milk

E. Global Perspective: Diarrhea in Infants and Children
1. In developing countries, diarrhea is the leading killer of children
2. Caused by pathogenic microorganisms found in water, food, and human and animal waste
a. Rotavirus
i. Replicates rapidly in the epithelial cells of intestinal mucosae
ii. Toxins cause the epithelial cells to slough off faster than they can be replaced
iii. Fluids and electrolytes are excreted rapidly, leading to dehydration
iv. One-third of deaths due to diarrhea are caused by rotavirus
3. Malnutrition increases risk
a. Intestinal mucosa becomes thin, damaged, and leaky, allowing pathogens to invade more easily
b. Immune function declines
c. Repeated bouts of diarrhea can make malnutrition worse
4. Prevention and treatment
a. Oral rehydration therapy
b. Supplemental zinc
c. Rotavirus vaccine

4.6 Moving Nutrients around the Body: Circulatory Systems

A. Cardiovascular System (see Figure 4-18)
1. Transports water-soluble nutrients
a. Proteins
b. Carbohydrates
c. B-vitamins
d. Vitamin C
e. Short-chain fatty acids

f. Medium-chain fatty acids

2. Components
   a. Heart
   b. Blood vessels (arteries, capillaries, veins)
   c. Blood
3. Flow of cardiovascular system
   a. Right side of the heart accepts oxygen-depleted venous blood
   b. Blood is pumped out of the right side of the heart to the lungs
   c. Blood picks up oxygen and releases carbon dioxide at the lungs
   d. Left side of the heart receives oxygen-rich blood from the lungs
   e. Oxygenated blood from the left side of the heart to the body cells
   f. Blood reaches small intestine, supplies oxygen and nutrients, picks up nutrients from digestion of food
   g. Nutrient-rich venous blood leaves the small intestine and travels via the portal vein to the liver
   h. At the kidney, waste products, nutrient excesses, and water are removed into urine
4. Water soluble nutrients are absorbed directly into the capillary beds in the villi, transported to the liver via the hepatic portal vein system, and the liver will then:
   a. Metabolize nutrients
   b. Store nutrients
   c. Send nutrients into circulation

B. Lymphatic System
1. Provides an alternative route to the bloodstream for large molecules
   a. Most fats
   b. Fat soluble vitamins: A, D, E, K
2. Lacteals in villi transport nutrients to thoracic duct
   a. Leads into the left subclavian vei

4.7 Moving through the GI Tract: Large Intestine

A. General
1. Small intestine empties into large intestine through ileocecal valve
   a. About 5% of nutrients escape absorption in the small intestine to enter the large intestine
2. 3 main parts:
   a. Colon: cecum and ascending, transverse, descending, and sigmoid colons
   b. Rectum
   c. Anus
3. Sections of large intestine (see Figure 4-19)
   a. Cecum
   b. Ascending colon
   c. Transverse colon
   d. Descending colon
   e. Sigmoid colon
   f. Rectum
   g. Anus
4. 3 main functions
   a. Houses gut microbiota: keeps GI tract healthy
   b. Absorbs water and electrolytes (sodium and potassium)
   c. Forms and expels feces

B. Gut Microbiota
1. The ileocecal valve prevents bacteria in the large intestine from migrating into the small intestine.
2. Many of the bacteria are beneficial
3. Antibiotic treatment, radiation therapy, surgery, and some diseases reduce the number of bacteria
   a. Disrupts the normal balance of beneficial and pathogenic bacteria
   b. Dysbiosis
4. Beneficial bacteria can:
   a. Synthesize vitamin K and biotin
   b. Aid lactose digestion
   c. Produce gas
   d. Ferment some fibers and starches
      i. Fermentation creates short-chain fatty acids that can be absorbed and used as an energy source in the colon
5. Probiotics and Prebiotics
   a. Consuming probiotics and prebiotics helps achieve a healthy balance of intestinal bacteria.
   b. Probiotics
      i. Live microorganisms that provide health benefits
      ii. Found in fermented foods (yogurt, kefir, miso) and supplements
      iii. Thought to help prevent diarrhea and food allergies, treat diarrhea, irritable bowel syndrome, and inflammatory bowel disease
   c. Prebiotics
      i. Non-digestible food ingredients that promote the growth of beneficial bacteria in the large intestine
      ii. Examples include inulin (found in chicory, wheat, onions, garlic, asparagus, bananas) and resistant starch (found in unprocessed whole grains, seeds, legumes, unripe fruit and cooked and chilled pasta, potatoes and rice)
6. Absorption of Water and Electrolytes
   a. Small intestine absorbs about 90%, large intestine absorbs remaining, and 1% remains in excreted feces
   b. Large intestine is the major site of sodium and potassium absorption
7. Elimination of Feces
   a. Semisolid mass is formed in large intestine that remains there until peristaltic waves and mass movements push it into rectum
   b. Feces in rectum causes stimulation for defecation
      i. Relaxation of internal and external sphincters must occur
      ii. External anal sphincter is under voluntary control
   c. Composition: 75% water, 25% solids (indigestible plant fibers, connective tissue from animal foods, bacteria from large intestine)

4.8 When Digestive Processes Go Awry

A. Heartburn and Gastroesophageal Reflux Disease
1. Occurs when stomach acid backs up into the esophagus
2. Experiencing heartburn 2x/week may signal gastroesophageal reflux disease (GERD)
3. Symptoms of GERD may include:
   a. Heartburn
   b. Hoarseness
   c. Coughing
   d. Gagging
   e. Nausea

4. Severe effects of GERD may include:
   a. Weight loss
   b. Ulceration
   c. Bleeding
   d. Anemia
   e. Risk of adenocarcinoma of the esophagus
5. Potential causes of GERD
   a. Hiatal hernia
   b. Alcohol use
   c. Overweight
   d. Smoking
   e. Pregnancy
   f. Come foods (citrus fruits, chocolate, caffeinated drinks, fatty and fried foods, garlic, onions, spicy foods, tomato-based foods)
6. Treatment for GERD (lifestyle modification and medications)
   a. Small meals
   b. Avoidance of foods that cause reflux
   c. Delay of laying down after eating
   d. Weight loss
   e. Smoking cessation
   f. Limiting alcohol intake
   g. Medications
      i. Antacids
      ii. H2 blockers
      iii. Proton pump inhibitors
      iv. Prokinetic drugs
      v. Surgery to strengthen LES
7. Recommendations to Prevent Heartburn from Occurring or Recurring
   a. Follow ulcer prevention recommendations.
   b. Wait about 2 hours after a meal before lying down.
   c. Don't overeat. Eat smaller meals that are low in fat.
   d. Elevate the head of the bed at least 6 inches.

B. Ulcers
1. Small erosion in top layer of cells in stomach or duodenum
2. Main causes
   a. *Helicobacter pylori* infection weakens mucus coating that protects the stomach and duodenum
   b. Heavy use of NSAID medications (aspirin, ibuprofen) use suppresses prostaglandin synthesis, weakening mucous barrier
3. Symptoms
   a. Gnawing or burning pain in the stomach region
   b. Nausea/vomiting
   c. Loss of appetite
   d. Weight loss
4. Complications
   a. Bleeding
   b. Perforation

5. Treatment
   a. Antibiotic treatment for *H. pylori* infection
   b. Proton pump inhibitor to suppress acid production
   c. Stopping smoking
   d. Avoiding foods that increase ulcer symptoms
6. Recommendations to Prevent Ulcers from Occurring or Recurring
   a. Stop smoking if you smoke.
   b. Avoid large doses of aspirin, ibuprofen, and other N S A I D compounds unless a physician advises otherwise. For people who must use these medications, the FDA has approved taking an N S A I D along with a medication that reduces gastric damage.
   c. Limit intake of coffee, tea, and alcohol (especially wine), if this helps.
   d. Limit consumption of pepper, chili powder, and other strong spices, if this helps.
   e. Eat nutritious meals on a regular schedule; include enough fiber (see Chapter 5 for sources of fiber).
   f. Chew foods well.
   g. Lose weight if you are currently overweight.

C. Nonalcoholic Fatty Liver Disease (NAFLD)
1. An increasingly common chronic liver disorder that occurs when liver cells store excess fat, which may cause liver swelling, inflammation, and scarring
   a. Excess alcohol intake also can cause these changes
   b. Individuals with NAFLD do not abuse alcohol
2. When inflammation or scarring is present, the condition is known as nonalcoholic steatohepatitis (NASH).
3. NAFLD and NASH can be hard to diagnose because many individuals have no symptoms.
4. Symptoms (when present):
   a. Fatigue
   b. Nausea
   c. Poor appetite
   d. Weight loss
   e. Jaundice
   f. Diffuse pain under the right rib cage (where the liver is located)
5. Most cases are diagnosed when abnormal liver blood tests are discovered as a part of regular medical care
6. Occurs in adults and children
7. Abnormal amounts of fat in the liver
8. Higher in those with obesity, diabetes, or insulin resistance (liver stores fat instead of metabolizing it)
9. Treatment for NAFLD and NASH includes lifestyle changes:
   a. Gradual weight loss
   b. Reduction in calorie intake
   c. Avoiding all alcohol
   d. Eating a nutritious diet

D. Gallstones
1. Cholesterol and bile pigments in bile form crystal-like particles
2. Related to slow gallbladder motility and bile composition (too little bile, too little phospholipids, too much cholesterol)
3. Prevention of gallstones
   a. Maintenance of healthy weight
   b. Avoiding rapid weight loss

c. Choosing plant instead of animal protein
d. Eating high-fiber diet
e. Using unsaturated fats
f. Regular physical activity

4. Factors that increase risk for gallstones
   a. Overweight and obesity
   b. Prolonged fasting
   c. Rapid weight loss (more than 3 lb. per week) and weight loss surgery
   d. High calorie, low fiber diet
   e. Other diseases: type 2 diabetes, inflammatory bowel disease, cystic fibrosis
   f. Sedentary lifestyle
   g. Some medications, especially estrogen replacement therapy and birth control pills
   h. Female gender
   i. Pregnancy
   j. Age over 60 years
   k. Family history of gallstones
   l. Ethnicity – especially Native American and Mexican-American
5. Symptoms (if present):
   a. Intermittent pain in right upper abdomen
   b. Pain between shoulder blades or near right shoulder
   c. Nausea
   d. Vomiting
   e. Gas
   f. Bloating
6. Treatment of gallstones
   a. Surgical removal of gallbladder

E. Food Intolerances
1. Symptoms vary widely
2. Common causes
   a. Inability to digest certain food components due to deficiencies in digestive enzymes
   b. Sensitivities to food components
   c. Synthetic compounds added to foods
   d. Residues of medications and other chemicals used in the production of food
   e. Toxic contaminants

F. Intestinal Gas (flatulence)
1. Flatulence is a mixture of gases
   a. Sulfur is responsible for the unpleasant odor
2. Large quantities of gas can cause bloating and pain
3. Created from the fermentation of undigested carbohydrates by bacteria in the large intestine
4. Treatment (Enzyme Preparations)
   a. Beano
   b. Lactase

G. Constipation
1. Difficult or infrequent bowel movements caused by slow movement of fecal material through the large intestine

2. Stool Types 1 and 2 of the Bristol Stool Scale represent constipation
3. Increases with age because of slowed gastric motility
4. Causes
   a. Ignoring normal urge to defecate
   b. Diabetes mellitus
   c. Irritable bowel syndrome
   d. Depression
   e. Pregnancy
   f. Medications such as antacids, antidepressants, calcium and iron supplements
   g. Low fiber diets
5. Treatment
   a. High fiber diet
   b. Drink more fluids
   c. Develop more regular bowel habits
   d. Relaxation
   e. Daily exercise
   f. Medications, if serious:
      i. Bulk-forming laxatives
      ii. Osmotic laxatives
      iii. Stimulant laxatives
      iv. Stool softeners
      v. Lubricant laxatives (not recommended)

H. Diarrhea
1. Loose, watery stools occurring more than 3 times per day
2. Stool Types 6 and 7 of the Bristol Stool Scale represent diarrhea
3. Causes
   a. Bacterial infections
   b. Viral infections
   c. Parasites
   d. Food intolerances
   e. Medications
   f. Megadoses of vitamin C
   g. Intestinal diseases
   h. Irritable bowel syndrome
4. Treatment
   a. Fluid and electrolyte replacement

I. Irritable Bowel Syndrome
1. More common among women
2. Symptoms
   a. Irregular bowel function
   b. Abdominal pain
   c. Abdominal distension, often worse after eating
3. Treatment
   a. Avoid food triggers
   b. Consuming low-fat and small, frequent meals

c. Peppermint oil

J. Inflammatory Bowel Disease
1. Cause is unknown, but an overactive inflammatory response to antigens in G I tract is suspected
2. Strong genetic association
3. Ulcerative colitis
   a. Inflammation and ulceration of the innermost layer of the large intestine
4. Crohn's disease
   a. Inflammation and ulceration in all layers and in any part of the G I tract
5. Symptoms
   a. Rectal bleeding
   b. Diarrhea
   c. Abdominal pain
   d. Weight loss
   e. Fever
6. Treatment
   a. Medications
   b. Surgery

K. Hemorrhoids (piles)
1. Swollen veins of rectum and anus
2. Caused by pressure on the blood vessels due to:
   a. Obesity
   b. Prolonged sitting
   c. Violent coughing or sneezing
   d. Pregnancy
   e. Constipation
3. Symptoms
   a. Pain
   b. Itching
   c. Bleeding
4. Treatment
   a. Warm, soft compresses
   b. Sitting in a tub of warm water
   c. Increased fiber intake
   d. Exercise
   e. Over-the-counter remedies
   f. Removal

4.9 Expert Perspective from the Field: Gluten-related Disorders: Celiac Disease and Non-celiac Gluten Sensitivity

A. Celiac Disease
1. Autoimmune response to the gluten protein (found in wheat, rye, barley, spelt, triticale)
   a. Gluten proteins damage intestinal cells, causing villi to flatten, resulting in inability to absorb nutrients and malnutrition
   b. Affects 1 in 133 people
2. Symptoms
   a. Intestinal gas

b. Bloating
c. Diarrhea
d. Constipation
e. Abdominal pain
f. Weight loss or gain
g. Anemia
h. Early bone disease
i. Fatigue
j. Slow growth in children
k. Ataxia (impaired coordination) and other neurological conditions
l. Dermatitis herpetiformis
m. Infertility

3. Treatment
   a. Drug therapies are under research
   b. Gluten-free diet (limits grain choices)
      i. May include corn, rice, buckwheat and quinoa
      ii. Food labels now identify gluten in products
      iii. Blood tests and intestinal biopsies can diagnose celiac disease
   c. Long-term complications
      i. Increased risk of GI tract cancers
      ii. Malnutrition

B. Non-celiac gluten sensitivity
   1. Symptoms are similar to celiac disease, but the small intestine is not damaged
   2. Not well understood
   3. No official diagnostic test
   4. May be caused by another condition (wheat allergy, celiac disease, inflammatory bowel disease)