Answers to Questions for Comprehension

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Q1. The four categories of macromolecules are carbohydrates, lipids, proteins, and nucleic acids.

Q2. The process that builds macromolecules is called dehydration synthesis. To form a covalent bond between two sub-unit molecules, an –OH (hydroxyl) group is removed from one sub-unit and a hydrogen atom is removed from the other sub-unit. This chemical reaction is known as **dehydration synthesis** because removing the –OH group and H atom during the synthesis of a new biological molecule essentially removes a molecule of water (H_2O).

Q3. Cells disassemble macromolecules into their component sub-units by performing a chemical reaction that is basically the reverse of dehydration synthesis. In this reaction, called **hydrolysis**, a molecule of water is added instead of removed. During a hydrolysis reaction, a hydrogen atom from water is attached to one sub-unit and the hydroxyl group is bonded to another sub-unit, effectively breaking a covalent bond in a macromolecule.

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Q4. Accept any two of the following: The two main types of carbohydrates are simple sugars and polysaccharides.

Simple sugars are composed of one sugar (monosaccharide) molecule or two sugar (disaccharide) molecules. Glucose is a common example of a monosaccharide and maltose is an example of a dissaccharide.

Polysaccharides are long chains (polymers) of glucose molecules bonded together.

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Q5. The sub-units of a fat are 3 fatty acids and glycerol.

Q6. A saturated fatty acid does not have double covalent bonds between its carbon atoms, so it contains all the hydrogen atoms it can bond with. An unsaturated fatty acid has double bonds between some of its carbon atoms, leaving room for additional hydrogen atoms. Unsaturated fatty acids cause the resulting fat to be liquid at room temperature. Saturated fatty acids usually cause the resulting fat to be solid at room temperature.

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Q7. Amino acids are the sub-units of a protein molecule.

Q8. Proteins are more structurally and functionally diverse because of the following factors.

(a) There are 20 different amino acid groups, which provide a large number of possible combinations.

(b) A strand of amino acids must undergo additional changes before it becomes a protein. Different amino acids along the strand attract and repel each other, and this causes the strand to coil and twist as the amino acids are drawn toward, or pushed away from each other. The end result is a highly complex three-dimensional structure. The final shape of a protein's three-dimensional structure determines the properties, and therefore the functions, of the protein.

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Q9. An **enzyme** is a protein molecule that acts as a catalyst to increase the rate of a reaction. In the cell, an enzyme brings particular molecules together and causes them to react with one another.

Q10. Each enzyme in the body has a precise three-dimensional shape that is specific to the kind of reactant molecule with which it can combine. The enzyme physically fits with a specific **substrate**—its reactant molecule. The enzyme is specific because it has a particular shape that can combine only with specific parts of its substrate molecule. When the substrate combines with its enzyme, its bonds become less stable and, thus, it is more likely to be altered and to form new bonds.

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Q11. Enzyme activity is affected by any change in condition that alters the enzyme's three-dimensional shape. When the temperature becomes too low, the bonds that determine enzyme shape are not flexible enough to enable substrate molecules to fit properly. At higher temperatures, the bonds are too weak to maintain the enzyme's shape. It becomes **denatured**, meaning that its molecular shape and structure (and, thus, its properties) are permanently changed. Therefore, enzymes function best within an optimum temperature range. This range is fairly narrow for most human enzymes.

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Q12. The organs that make up the human digestive tract are the mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus.

Q13. The accessory organs are the salivary glands, liver, gall bladder, and pancreas.

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Q14. The mechanical (physical) digestion of food begins in the mouth because you use your teeth to chew your food. Water and mucus in saliva aid the teeth as they tear and grind food into smaller pieces, increasing the surface area available for the chemical digestion of any starch that has been ingested.

Chemical digestion starts in the mouth, when an enzyme in saliva, called salivary amylase, begins to break down starch into simpler sugars (disaccharides).

Q15. The bolus moves through the esophagus partly by gravity but mainly through a wave-like series of muscular contractions and relaxations called **peristalsis**. As peristalsis continues, food is propelled through the esophagus toward the stomach, where the next stage of digestion occurs.

Q16. Entry to the stomach is controlled by a ring-like muscular structure called the **esophageal sphincter**. Relaxation of the esophageal sphincter allows the bolus to pass into the stomach. Contraction of this sphincter usually prevents the acidic contents of the stomach from backing up into the esophagus.

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Q17. Both mechanical and chemical digestion occur in the stomach. Waves of peristalsis push food against the bottom of the stomach, churning it backward, breaking it into smaller pieces, and mixing it with gastric juice to produce a thick liquid called **chyme**.

Q18. Once active, pepsin hydrolyzes proteins to yield polypeptides—a first step in protein digestion in the digestive tract.

Q19. Very few substances are absorbed from the chyme in the stomach because most substances in the chyme have not yet been broken down sufficiently. The stomach does absorb some water and salts, however, as well as certain anti-inflammatory medications, such as Aspirin™, and alcohol.

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Q20. In the small intestine, bands of circular muscle briefly contract forming closed segments. This process is called segmentation. Chyme is sloshed back and forth within the segment, causing physical digestion and mixing the nutrient macromolecules with digestive enzymes. Such movement increases contact between nutrients and the intestinal wall which enhances nutrient absorption. Peristalsis also occurs, mixing food and enzymes and pushing it on toward the large intestine.

Q21. The ridges in the inner lining of the small intestine are covered in tiny projections called villi, which, in turn, are covered in microvilli. Together, the ridges, villi, and microvilli vastly increase the absorptive surface area of the small intestine.

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Q22. The pancreas, liver, and gall bladder produce and/or store secretions necessary for digestion of macromolecules.

Pancreas: The **pancreas** delivers about 1 L of pancreatic fluid to the duodenum each day. Pancreatic fluid contains a multitude of enzymes, including:

- trypsin and chymotrypsin, which are proteases that digest proteins;
- pancreatic amylase, which is a carbohydrate that digests starch in the small intestine; and
- lipase, which digests fat.

Liver: The **liver** is the largest internal organ of the human body. The main digestion-related secretion of the liver is bile, a greenish-yellow fluid mixture that is made up of bile pigments and bile salts. Bile salts assist lipases in accessing fats because they are partly soluble in water and partly soluble in fats. Bile salts work like a detergent, dispersing large fat droplets into a fine suspension of smaller droplets in the chyme. This emulsification process produces a greater surface area of fats on which the lipases can act.

Gall Bladder: After bile is produced in the liver, it is stored in the **gall bladder**. The arrival of chyme, with a high fat concentration, in the duodenum stimulates the gall bladder to contract. This causes bile to be transported through a duct (shared by both the gall bladder and the liver) and injected into the duodenum.

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Q23. The following is one possible answer for this question.

Most of the digestion of carbohydrates does not take place until the chyme enters the small intestine, where the pH is about 8. In the small intestine, pancreatic amylase completes the digestion of starch into disaccharides. Other carbohydrases hydrolyze the disaccharides into monosaccharides, such as glucose and fructose.

Monosaccharides are absorbed by active transport into the cells of the intestinal villi. The active transport of glucose and other monosaccharides requires ATP, which is produced in the mitochondria of cells. From the cells of the intestinal lining, the monosaccharides enter the bloodstream and are transported directly to the liver.

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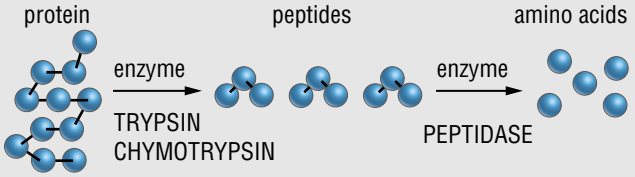
Q24. A sketch showing protein digestion and absorption might appear as follows:



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Q25. The arrival of lipids (fats) in the duodenum stimulates the secretion of bile, which emulsifies the fat droplets. The breakdown of fats by hydrolysis is carried out by lipase secreted in the duodenum. The resulting glycerol and fatty acids are absorbed into the cells of the villi by simple diffusion. Inside the cells of the intestinal lining, the fat sub-units are reassembled into triglycerides and then coated with proteins to make them soluble before they enter the lymph vessels in the villi.

Q26. In the small intestine, nucleic acids are digested by enzymes, called nucleases, to yield nucleotides. The nucleotides are hydrolyzed to their constituent bases, sugars, and phosphates. These molecules are then absorbed, like glucose and amino acids, into the bloodstream by active transport.

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Q27 Gastrin, produced by the lower part of the stomach, enters the bloodstream and stimulates the upper part of the stomach to produce more gastric juice.

Secretin and CCK, produced by the duodenal wall, stimulate the pancreas to secrete its digestive juice and the gall bladder to release bile.

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Q28. The effects of poor dietary and lifestyle habits may take weeks, months, or even years to show up. Good nutrition is the only way to provide the energy our bodies need to carry out their many activities, such as nerve transmission, muscle contraction, and cell repair and replacement. As well, good nutrition provides the essential raw materials that our bodies need as building blocks but are unable to manufacture ourselves.

- regulation, synthesis, and secretion of many substances important in maintaining homeostasis;
- storage of important nutrients such as glycogen (glucose), vitamins, and minerals; and
- purification, transformation, and clearance of waste products, drugs, and toxins.

A number of diseases can directly damage the liver. Damage to the liver can seriously affect the absorption of vitamins and nutrients, prevent waste products from being effectively removed from the system, and reduce the production of proteins needed to clot the blood.

If the damage is severe enough, transplantation may be necessary. A transplant provides a patient with a liver that can keep up with the demands of a full, active life.

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Q29. An ulcer forms when the thick layer of mucus that protects the lining of the stomach from the acids in the digestive juices is eroded.

Q30. Inflammatory bowel disease is the general name for diseases that cause inflammation in the intestines (bowels). Crohn's disease (also called ileitis or enteritis) is a serious inflammatory bowel disease that usually appears in the ileum of the small intestine but can affect any part of the digestive tract from the mouth to the anus. The inflammation extends deep into the lining of the affected organ, causing the intestines to empty frequently. This results in diarrhea and sometimes rectal bleeding. Thus, Crohn's disease is very painful.

Q31. The body depends on the liver to perform a number of vital functions. These functions can be divided into three basic categories:

Issues, edited by D.A. Long and O.P. Dickason. Harcourt: Toronto, 1996, p. 252.

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Q32. Anorexia and obesity represent normal diets gone awry. Anorexic people relentlessly pursue thinness by literally starving themselves for varying periods of time. Seriously overweight people—defined medically as those who are more than 20 percent over their ideal weight—are often plagued by compulsions to eat.

Anorexia and other eating disorders are unhealthy responses to stress, painful feelings, and other problems. While the specific cause is unknown, the condition seems to stem from a combination of psychological, biological, familial, and cultural factors. New research indicates that, in 1 anorexic out of 10, a genetic abnormality may be involved.

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Q33. You may wish to share this quotation with them:

> "Our elders teach us that although our ancestors did not have problem-free lives, our people were in excellent health before European contact. We are told that long ago people died mainly from such things as old age, complications for mothers and infants during and immediately after child-birth, and fatal injuries inflicted in battles with warring tribes. Moreover, our ancestors were very spiritual and ethical in dealing with self and others. This strength of mind contributed to the wellness of our people. So too did their healthy diet. All food was truly natural and pure. There were no such things as iodized salt, refined sugar and chemically treated food. Babies developed strong bones and immune systems as a result of being breastfed until they were three years of age. There was no trace of contemporary childhood diseases such as measles, mumps, and chicken pox. Being a migrating nation meant that everyone was physically active and generally in good condition. People walked for many miles during times of migration, hauling necessities such as water and wood by hand. Together with a strong sense of spiritual purpose, these factors contributed to the excellent physical, intellectual, emotional, and communal health of the Stoney People. Even today, our people experience a deep sense of pride in knowing that our ancestors were healthy and well-organized and that they had the ability to survive in harsh environmental conditions. Our elders also tell us that physical illness was rare before European contact, and when necessary there were medicine people to address most health needs.

Source: Long, D. A. and T. Fox. "Circle of Healing: Illness, Healing and Health Among Aboriginal People in Canada." In *Visions of the Heart: Canadian Aboriginal*