

Answer: Pollution prevention means never producing a pollutant, end-of-pipe measures capture pollutants before they are released, and remediation deals with the effects of released pollutants. Pollution prevention is the most desirable, remediation the least.

12. With respect to increased production of corn to provide fuel ethanol, it is stated in this chapter that, "Increased demand for fertilizer in the form of chemically combined nitrogen means that more ammonia is synthesized using atmospheric nitrogen and impacting the nitrogen cycle." With respect to which resource of Earth's capital is the synthetic production of nitrogen fertilizer a problem, and in respect to which resource is it **not** a problem. Explain.

Answer: Current means of producing the elemental hydrogen required for ammonia synthesis tend to deplete natural gas resources. The atmosphere's content of elemental nitrogen used to synthesize ammonia is so overwhelming that it can never be depleted.

Chapter 2

Fundamentals of Biochemistry and Toxicological Chemistry

1. Glucose and fructose are both simple sugars with a formula of $C_6H_{12}O_6$, yet they are distinct compounds. What distinguishes them? What is a particularly important place in the human body in which glucose is found and are the levels of glucose important? Do humans consume fructose and, if so, what may be the source of this carbohydrate?

Answer: These two simple sugars have different molecular structures. Glucose is very important in blood where it must stay within limits, neither too high nor too low, for normal metabolic function. Humans consume fructose as one of the two simple sugars in sucrose, table sugar.

2. Although starch in sources such as flour and potatoes is an important nutrient, the starch molecule is too large and insoluble to enter the blood stream? Considering its chemical formula and the monomers of which starch is composed, suggest what happens to starch before it can be utilized as a nutrient.

Answer: Starch is hydrolyzed enzymatically to glucose before entering the bloodstream.

3. What is a peptide linkage? In what kind of biomolecule are peptide linkages found and what function do they serve in such a molecule?

Answer: The peptide linkage is shown in Figure 2.4. It occurs in proteins where it links the amino acids together.

4. Although the triglyceride of stearic acid and the cholesterol steroid shown in Figure 2.5 are not very similar structurally, both are classified as lipids. Explain.

Answer: Both have hydrocarbon-like structural features making them soluble in organic solvents, a characteristic that defines lipids.

5. DNA is described in the text of consisting of "astoundingly long" chains. See if you can find any "gee whiz" information on the internet that describes how "astoundingly long" molecules of DNA may be.

Answer: The DNA in a human genome within a single cell consists of about 3.2 billion base pairs. If all of these could be placed in one linear molecule, it would be of the order of a meter in length. Given around 50 trillion cells in the human body, a

hypothetical single molecule composed of all the DNA in a human body would be “astoundingly long.”

6. What is recombinant DNA technology? Is it relatively new? For what purposes is it being used?

Answer: Recombinant DNA refers to transfer of DNA between different kinds of organisms. The technology has been practiced with increasing sophistication for only several decades and is now used for a variety of purposes such as making human insulin by bacteria and producing crops that synthesize pesticidal materials originally derived from bacteria.

7. Suggest how an isomerase enzyme may be involved in making fructose available for human nutrition.

Answer: An isomerase enzyme may convert fructose to glucose.

8. What molecule in living organisms is responsible for intermediate energy storage? What substance is it converted to when it releases energy?

Answer: Adenosine triphosphate (ATP) is synthesized as an energy carrier in metabolic processes and has been called “the currency of life.” When it releases energy it becomes adenosine diphosphate, ADP, from which ATP can be resynthesized.

9. In a sense, photosynthesis is the reverse of oxic respiration. Explain.

Answer: Photosynthesis captures light energy and converts it to chemical energy in biomolecules such as carbohydrate glucose, releasing O_2 . In oxic respiration, O_2 is used in a process by which the chemical energy is converted to forms including heat and mechanical energy in the form of muscle movement.

10. Exposure to vinyl chloride is known to cause a specific kind of liver cancer in humans. After doing some internet research on the subject, explain the statement that vinyl chloride is a *xenobiotic* compound and a *protoxicant*.

Answer: Vinyl chloride is synthesized by industrial chemical processes, hence is a xenobiotic compound, and it is activated by bonding with oxygen to produce a toxic intermediate, a protoxicant.

11. Classify each of the following toxic effects regarding whether or not exposure to the toxic agent is acute or chronic and whether they are local or systemic

- A. Death from inhaling carbon monoxide from an automobile left running in a garage.
- B. Cancer of the mouth from long-term use of chewing tobacco.
- C. Peripheral neuropathy from working in an atmosphere contaminated with hydrocarbon solvents over many decades.
- D. A lesion caused by spilling concentrated nitric acid on the skin.

Answer: (A) Acute systemic, (B) chronic local, (C) chronic systemic, (D) acute local

12. Suggest why the bladder is the organ that is likely to develop cancer from exposure to aromatic amines.

Answer: Toxicants, often biosynthesized from protoxicants, are eliminated with urine, which is stored in the bladder.

13. Look up the structure of lung alveoli and suggest why they are particularly significant sites of exposure to toxicants.

Answer: The alveoli are the innermost cavities in the lung and a route by which inhaled toxicants can be transferred directly to the bloodstream.

14. Suggest explanations for (A) accumulation of PCBs in fat tissue, (B) occurrence of bone cancer from exposure to radioactive radium, and (C) which organ is most likely to develop cancer from exposure to radioactive iodine.

Answer: (A) PCBs are highly lipid soluble, (B) radium is an alkaline earth like calcium for which it substitutes in bone and releases highly damaging cancer-causing alpha particles directly into bone tissue, (C) the thyroid, which accumulates iodine.

15. Though highly toxic, botulinus toxin has some important pharmaceutical and cosmetic applications. After a search of the internet explain what some of these are.

Answer: Botulinus toxin is used cosmetically to remove wrinkles and has many medical uses, such as in releasing muscle cramping.

16. What are endogenous conjugating agents? What is their function with respect to toxic substances?

Answer: Endogenous conjugating agents are produced within an organism and bind to toxic substances to reduce toxicity in some cases and facilitate their elimination such as through urine.

17. What was the “thalidomide tragedy”? To what class of toxic substances does thalidomide belong?

Answer: Thalidomide caused many birth defects before it was known to be a teratogen.

18. After an internet search regarding the nature of radium and radon, suggest why areas in which radon infiltration into dwellings may also have problems with radium in water supplies.

Answer: Radon, a radioactive gas that is a hazard in air, is produced in the decay of radium in the geosphere, which can get into groundwater.

19. The most common effect of carbon monoxide poisoning is damage to the brain, which may be fatal. Does carbon monoxide attack brain tissue directly? How does carbon monoxide result in brain damage?

Answer: Carbon monoxide prevents blood from transporting oxygen to the brain resulting in deprivation of oxygen required for brain function.

20. What is the rationale of using a test for mutagenicity to indicate carcinogenicity? What is this test called?

Answer: Because they are similar in metabolic action, mutagens have a tendency to be carcinogenic as well. The test is the Bruce Ames test used to screen for possible carcinogens.

21. What are xenoestrogens? Look up on the internet the status of research involving at least one common plasticizer suspected of being a xenoestrogen.

Answer: Xenoestrogens are synthetic substances that mimic endogenous estrogens. Bisphenol A plasticizer has xenoestrogenic effects.

22. What is the evidence from studies of organisms that live in water, including fish, frogs, and alligators that wastewaters may be contaminated by xenoestrogens?

Answer: The evidence is primarily development of feminized characteristics by aquatic organisms exposed to some kinds of wastes.

23. What is biomagnification? How is lipid tissue involved in biomagnification processes?

Answer: Biomagnification occurs when the concentrations of lipid-soluble xenobiotics increase in going up the food chain.

Chapter 3

Environmental and Toxicological Chemistry of the Hydrosphere

1. Look up proposals to restore the Hetch-Hetchy Valley in Yosemite National Park to its former state. How might this affect water supply to parts of California? What might be some benefits of restoration of this valley to its former state?

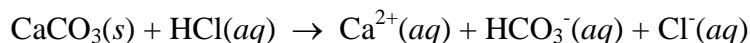
Answer: An internet search of “Restore Hetch Hetchy” yields much information regarding proposals to drain the Hetch Hetchy reservoir, which provides drinking water to approximately 2.5 million people in the San Francisco area. Voters defeated a proposal to study that possibility in a November, 2012, election. Advocates of draining the reservoir contend that the water needs could be met by modern water harvesting, conservation, recycling, and restoration methods and would restore an area now inundated by up to 100 meters of standing water to its former state of beauty.

2. Look up and explain the significance of the name Mulholland in relationship to water. How did Mulholland affect history?

Answer: William Mulholland, the superintendent of the Los Angeles City Water Company, pushed for the construction of the Los Angeles Aqueduct, which supplied a reliable source of water for the city from the Owens Valley, thus changing the history of the Los Angeles, California, area. The project was begun in 1908 and the Aqueduct dedicated in 1913.

3. Paradoxically, pollution by a strong acid such as HCl of groundwater in contact with limestone (CaCO_3) can lead to an increase in the alkalinity of the water. Using chemical reactions, explain how this may occur.

Answer: The overall reaction is the following:



All the acid is neutralized by reaction with CaCO_3 and alkalinity (capacity to neutralize H^+) is provided by the HCO_3^- in solution.

4. Tests can be performed on water that show the presence of biochemical demand (BOD) and other tests that chemically oxidize organic matter to produce CO_2 can show total organic carbon (TOC). Applied to a particular sample of water, these two tests showed relatively high TOC and relatively low BOD. What does this say about the nature of the organic pollutants in the water?

Answer: The result indicates that a large proportion of the organic matter containing carbon is not very biodegradable, possibly in the form of synthetic compounds or poorly degradable humic substances.

5. Agricultural fertilizer normally adds nitrogen, phosphorus, and potassium to soil. Explain how fertilizer runoff into a body of water can lead eventually to increased biochemical oxygen demand pollution.

Answer: These fertilizer constituents promote algal growth and formation of biodegradable organic matter, $\{\text{CH}_2\text{O}\}$. When this material undergoes biodegradation, oxygen is consumed.