

as in technical ecotoxicology. Also important to practical ecotoxicology are the following: unambiguous results, safety, and clear documentation of progress during application.

***12. Describe natural capitalism and its goals.***

“Natural capital consists of resources, living systems, and ecosystem services. Natural capitalism envisions the use of natural systems without abusing them, which is essential to sustainable use of the planet. Sustainable use of the planet requires a mutualistic relationship between human society and natural systems and affirms that a close relationship exists between ecosystem health and human health. Natural capitalism deals with the critical relationship between natural capital – natural resources, living systems and the ecosystem services they provide – and human-made capital.” (Vignette 1.1)

***13. If polycyclic aromatic hydrocarbons are naturally occurring organic compounds, why are they discussed as environmental contaminants and pollutants in the book?***

A contaminant does not have to be uniquely of human origin. A compound or class of compounds becomes a contaminant when human activities bring concentrations above natural concentrations.

## **Chapter 2**

***1. Define the terms highlighted in the chapter and check your definitions against those provided in the glossary.***

The definitions for these terms can be found in the glossary.

2. *Also provide a succinct explanation of the following background chemistry concepts and definitions.*

The explanations for these terms can be found at the end of the chapter in Section V.

3. *If metals are naturally occurring elements, how do they become environmental contaminants and pollutants?*

A contaminant is simply something released by human activities; therefore, metals can easily be classified as contaminants. A contaminant that does or could have an adverse effect at the levels realized in the environment is a pollutant, e.g., mercury released into Minamata Bay.

4. *What are the major inorganic gases of concern? Explain why each is an issue requiring attention.*

Elevated carbon dioxide in the atmosphere can lead to global warming. The  $\text{NO}_x$  and  $\text{SO}_2$  released by combustion processes can react in the atmosphere to produce acid precipitation. Respiratory and cardiovascular diseases have been linked to atmospheric  $\text{NO}_x$  and  $\text{SO}_2$ , and  $\text{SO}_2$  can cause leaf chlorosis.

5. *What is cultural eutrophication and how might it relate to the ocean dead zones of depleted oxygen described later in Chapter 12? What are some of the management strategies that are being employed to cope with cultural eutrophication?*

With cultural eutrophication, an excess of nitrogen or phosphorus nutrients in aquatic

systems disrupts the associated ecological communities. Cultural or accelerated eutrophication is the greatly accelerated aging of water bodies due to the addition of excess nitrogen and phosphorus nutrients to aquatic systems by human activities. This abnormal condition changes the structure and functioning of associated ecological communities. This is often characterized by dense algal blooms and even episodic anoxic or near anoxic events. It is often controlled by modifying nutrient input into the associated waterbody but other measures such as modification of flow dynamics or stratification can also be applied to reduce the impact of eutrophication.

**6. *What human activities introduce chlorofluorocarbons into the environment and what are the adverse impacts of their release?***

These compounds were used widely for refrigeration, air conditioning, fire fighting, foam blowing in Styrofoam and polyurethane production, various solvent applications such as electronics cleansing, propellants as those in aerosol cans, and in the case of 1-chloro-1,1-difluoroethane, as intermediates in fluoropolymer production. They can deplete ozone in the ozone layer.

**7. *What are the commercial uses for dibenzodioxin and dibenzofuran compounds?***

Neither was manufactured intentionally, but appears as a contaminant during incineration or the synthesis of other compounds such as PCBs and some herbicides. Polychlorinated dibenzofurans are released as contaminants of other commercial products such as PCB mixtures and chlorophenols. They can be generated during combustion or bleaching associated with Kraft pulp mills. Dioxins enter the environment as contaminants in

herbicides (e.g., Agent Orange) and wood preservatives. Polychlorinated dibenzo-p-dioxins (PCDDs) are contaminants in commercial products such as PCBs and chlorophenols. Dioxins are also formed as combustion byproducts and during the bleaching process of Kraft pulp mills.

8. ***Both organochlorine and pyrethroid insecticides are synthetic organic molecules.***

***Which of these two insecticide groups is less prone to microbial degradation? Why?***

The organochlorine pesticides degrade very slowly. By design, these slowly degrading pesticides are being replaced by those such as pyrethroid insecticides that degrade much more readily. The pyrethroid insecticides are synthetic analogs or derivatives of the natural plant-derived pyrethrins.

9. ***Please give the major classes of pesticides and compare them relative to mammalian toxicity, persistence in the environment and their capacity to accumulate in organisms.***

<u>Class</u>	<u>Mammalian Toxicity</u>	<u>Environmental Persistence</u>	<u>Potential for Bioaccumulation</u>
Organochlorine (OC)	Moderate/Low	Long	High
Organophosphorus(OP)	High relative to OC	Short but varies	Moderate
Carbamate	High but generally lower than OP	Short like OP	Low
Pyrethrin/pyrethroid	High for fish but not Birds nor mammals	Short	Low
Neonicotinoid	Relatively low to birds and mammals	Short	Low

Trends defined in the above table are general and some specific pesticides can be exceptions, e.g., toxicity of specific OC pesticides can vary considerably.

10. *Describe why polychlorinated biphenyls are found as mixtures. Do you think that the relative amounts of each polychlorinated biphenyl congener might be different in the source (for example, sediments) and the tissues of an organism that accumulates them from that source? Why or why not?*

The PCBs are synthesized and used as commercial mixtures of congeners so they are found in the environment as such. The PCBs do have similar general properties that would determine their movement into biota; however, differences do exist in the number and position of chlorine atoms that can result in some PCB congeners moving into biota more readily than others.

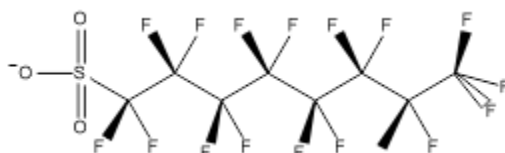
11. *You decide to begin taking omega-3 supplements after hearing positive comments about how they promote cardiovascular health. Most omega-3 supplements are fish oil preparations. You pick up a bottle of 1500 mg Odorless Norwegian Salmon Oil capsules. You know from class that some pollutants accumulate in lipids (oils and fatty acids here) of fish so you read the label which says, “This product is regularly tested (using AOAC international protocols) for freshness, potency and purity by an independent, FDA-registered laboratory and has been determined to be fresh, fully-potent and free of detectable levels of mercury, cadmium, lead, PCB’s and 28 other contaminants.” Using your knowledge of lipophilic and hydrophilic contaminants, explain whether you would have expected any of these (mercury, cadmium, lead, PCB’s) to accumulate to high concentrations in fish oils. Might one expect some but not others of these to accumulate to high levels in oils (lipids)?*

The answer to this question should involve discussion of each contaminants lipophilicity,

persistence, and resulting propensity to biomagnify. Of most concern would be PCBs, and perhaps, mercury in the form of methylmercury. Cadmium and lead would not be a concern, suggesting that their mention on the label was intended to reduce concerns of consumers who have heard about these toxic metals but did not understand the way that a contaminant might accumulate in lipids of salmon.

***12. To what general class of contaminants does the following organic compound belong?***

***Give details about this class of compounds including their origins, general fate in the environment, potential effects, and any regulatory actions taken to minimize their effects to human health and/or the environment.***



Perfluorooctane sulfonate (PFOS) is a perfluoroalkyl acid (PFA) (see Vignette 2.2). The perfluoroalkyl acids are synthetic compounds used in a variety of ways including as refrigerants, surfactants, polymers, pharmaceuticals, wetting agents, lubricants, adhesives, pesticides, corrosion inhibitors, and stain-resistant agents. Although perfluoroalkyl substances (PFS) were thought originally to be so strongly associated with large molecular weight polymers in products that they could not be an environmental problem, surprisingly high concentrations have been found in a variety of biological samples. They are resistant to biological or physical breakdown. Relative to adverse effects, environmental concentrations have not generally exceeded the thresholds for adverse effect; however, the slope of the dose-effect curve for PFOs is steep. Given these

conditions, producers and users voluntarily took action to remove this potential hazard from the environment.

***13. Describe the history, context, and consequences of pesticide use in Central America.***

This question can be answered using Vignette 2.1.

Pesticide use began in the 1950s for disease vector and agricultural uses, and increased rapidly thereafter. In the 1980s, most organochlorine pesticides were restricted; however, DDT was still allowed for vector control until 1990. A shift occurred from persistent (but less toxic to mammals) pesticides to less persistent (but more toxic to mammals) ones during the period of 1950 to 2000. Currently, the major pesticides are organophosphates, carbamates, and pyrethroids for insects, dithiocarbamic fungicides, and phenoxyacids, dipyridyls, and triazines as herbicides. Many are highly toxic to certain classes of animals and algae. Unfortunately, because most information about the effects of these chemicals in the environment comes from nontropical ecosystems and unique qualities influencing persistence and effect in tropical systems, it is difficult to assess the effects of the large amounts of these chemicals in Central America. There are several studies mentioned in Vignette 2.1 that suggest substantial harm in several regions, e.g., Choluteca River Basin of Honduras and coastal lagoons of Nicaragua.

**Chapter 3 (and Appendix 9)**

***1. Define the terms highlighted in the chapter and check your definitions against those provided in the glossary.***

The definitions for these terms can be found in the glossary.