Course Learning Outcomes for Unit III

Upon completion of this unit, students should be able to:

1. Compare and discriminate the differences and similarities between chemical carcinogenesis, mutagenesis, and teratogenesis.
2. Summarize toxicants in human breast milk and adverse infant effects.

Reading Assignment

Chapter 7: Carcinogenesis
Chapter 8: Mutagenesis
Chapter 9: Developmental Toxicology
Chapter 10: Lactation

Unit Lesson

In Unit II we learned about toxic effects of a toxicant. This unit takes a closer look at special types of toxicity: carcinogenesis, mutagenesis, developmental toxicity (teratogenesis), and the effects of toxicants on nursing infants through lactation. You may be familiar with the terminology of these special categories of toxicity. If not, do not worry because we are about to explore each one in more detail!

According to the American Cancer Society (2012), “Substances and exposures that can lead to cancer are called carcinogens. Some carcinogens do not affect DNA directly, but lead to cancer in other ways. For example, they may cause cells to divide at a faster than normal rate, which could increase the chances that DNA changes will occur” (para. 4). Cancer may be described in layman’s terms as an uncontrolled proliferation or division of cells. Cancer cells lack the control mechanism that normal cell have to control and inhibit cell division. Masses of these mutated cells form tumors that can ultimately occupy areas of the body to inhibit the normal function of processes and organs of the body. Cancer was projected to become the leading cause of death in 2010 (Business Standard, 2010). Cancer is induced by a variety of agents, the most governable on a personal level being certain life-styles, such as smoking cigarettes, drinking excessive amounts of alcoholic beverages, or chewing tobacco. However, certain chemicals in the community and workplace, as well as some therapeutic agents, also play a role. It is important to note that the health hazards of carcinogens vary, depending not only on their potency, but also on their mode of action. Carcinogens may be classified, on the basis of “weight of evidence,” into four categories: (1) human carcinogen, (2) probable human carcinogen, (3) possible human carcinogen, and (4) not classifiable (Kacew & Lee, 2013). Carcinogens may also be classified according to their mode of action into genotoxic and epigenetic (nongenotoxic) carcinogens (Kacew & Lee, 2013). Genotoxic carcinogens alter the DNA of cells, while nongenotoxic carcinogens do not damage DNA but act through other mechanisms to promote rapid cell proliferation and tumor growth (Kacew & Lee, 2013). Extensive tissue damage, disruption of hormonal function, formation of urinary stones, and saturation of DNA repair function are some of the symptoms of carcinogens.

Mutagenesis can occur as a result of interaction between mutagenic agents and genetic materials of organisms (Kacew & Lee, 2013). While spontaneous mutations and natural selection are the major means of
evolution, a number of toxicants have been found to be mutagenic to a variety of organisms (Kacew & Lee, 2013). Finally, the close relationship between mutagens and carcinogenesis must be borne in mind.

Teratogenesis is the formation of congenital defects. A connection was not suspected to exist between congenital malformation and chemicals because there was an assumption among toxicologists that the natural protective mechanisms, such as detoxication, elimination, and the placental barrier, were sufficient to shield the embryo from maternal exposure to chemicals (Kacew & Lee, 2013). The effects of a potential teratogen on fetal development depends on many factors, including the dose and length of exposure, as well as the stage of prenatal development when the fetus is exposed to the substance (Kacew & Lee, 2013).

The last topic covered in this unit is lactation. Breast-feeding has distinct advantages for infants nutritionally, immunologically, and psychologically. It should also be noted that in the presence of environmental toxicants and a condition of malnourishment, the immune system is further compromised as there is an increased sensitivity to viral infection. When the breast-feeding mother is subjected to exposure from environmental contaminants, these pollutants (silicone, mercury, lead, etc.) may be present in human milk and cause harmful effects on children's health. The pH of breast milk makes certain substances more likely to concentrate in milk than in other fluids of the body (Hardman, Limbird, Molinoff, Ruddon, & Gilman, 1996). Toxicants can bind to fat in the individuals' body, and measurable concentrations can build up and eventually work their way into the mother's milk as the body calls on fat supplies during lactation (NRDC, 2005). Toxicants in breast milk can cause a variety of adverse effects on the nursing infant that can be potentially synergistic. These effects can range from decreased weight gain or developmental delays to organ dysfunction, poor mental performance, and mental retardation (Kacew & Lee, 2013).

References


Suggested Reading

• Brown, J. (2012). Healthy interiors: If these walls could talk. Healthcare Design, 12(5), 30-34. Locate this article by searching the Business Source Complete database in the CSU Online Library.

• Radiation can be harmful even in small doses. Those who are interested can learn how to protect themselves by reading “Make Your Own Geiger Counter,” by Julia McKinnell. This may sound frivolous, but for Japanese citizens who feared contamination following the meltdown at the Fukushima Daiichi nuclear power plant in 2010, it is deadly serious. For others, the homemade tools may be a “sanity check.” Locate this article by searching the Business Complete database in the CSU Online Library.
Learning Activities (Non-Graded)

Reading Quiz

Take some time to look up the answers that you do not recall from the assigned reading.

1. Ultraviolet light has little penetrating power and therefore will only produce:
   a. hemoglobin.
   b. lipids.
   c. lead in bones.
   d. skin tumors.

2. During the predifferentiation stage, the embryo is not susceptible to:
   a. essential metals.
   b. hemosiderin.
   c. teratogenic agents.
   d. cardiomyopathy.

3. Phenytoin induces:
   a. minerals degradation.
   b. hypoxia.
   c. protein oxidation.
   d. blindness.

4. Which of the following is not known to cause lung cancer?
   a. Arsenic
   b. Asbestos
   c. Nickel
   d. Vanadium

5. _________ is a polymeric substance that is inert and is unlikely to produce a toxic manifestation.
   a. Silicone
   b. Zinc
   c. Sodium
   d. Potassium

View a Video

Visit the PBS Web site (http://www.pbs.org), and view the videos about radiation in Japan:

- “Safecast Draws on Power of the Crowd to Map Japan’s Radiation” explores levels of radiation eight months after the meltdown at the Fukushima Daiichi nuclear power plant.

- “Testing Groceries for Radiation in Japan” discusses how people still worry about radiation poisoning one year after the meltdown at the Fukushima Daiichi nuclear power plant.

Reflection Paper

For this activity, you are asked to prepare a Reflection Paper. After you finish the Reading Assignment, reflect on the new concepts you learned. Pick one or more concepts from the reading, and write about it/them.

Do you understand the concepts in the unit fully, or do you need to research them further? The purpose of this activity is to provide you with the opportunity to reflect on the unit material and expand on it. If you are unclear about a concept, either read about it again or discuss it with your professor.

This is not a summary. A Reflection Paper is an opportunity for you to express your thoughts about the unit material by writing about them. Reflection writing is a great way to study because it increases your ability to remember the course material.
Here are some guidelines for your Reflection Paper:

1. Write at least one page.
2. Include your thoughts about the main topics in the unit Reading Assignment.
3. Can you apply any of it to your career? How?
4. Does any of it apply to your personal life? How?

Use your own words, and include citations and references for other sources as needed to avoid plagiarism.

Non-graded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.

**Key Terms**

1. Chromosomal effects
2. Cytotoxicants
3. Gene mutation
4. Genotoxic carcinogens
5. Immunosuppressive drugs
6. Microbial tests
7. Mutagenesis
8. Nongenotoxic carcinogens
9. Oxidative stress
10. Peroxisome proliferators
11. Pulmonary tumor
12. Relative potency
13. Teratogens