Course Learning Outcomes for Unit V

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

5. Examine toxicity hazards related to exposure to various types and classes of hazardous substances.
   5.1 Identify how carcinogens are classified and the organizations that classify them.
   5.2 Explain toxicity hazards and the exposure related to various substances.
   5.3 Discuss the relationship between carcinogens and the cancer they cause.

Reading Assignment

Chapter 10: Chemical-Induced Mutagenesis

Click here to access the Chapter 10 PowerPoint Presentation. Click here to access a PDF version of the presentation.

Chapter 11: Chemicals and Cancer

Click here to access the Chapter 11 PowerPoint Presentation. Click here to access a PDF version of the presentation.

Unit Lesson

This unit covers Chapters 10 and 11 of the textbook, which deals with chemical-induced mutagenesis and cancer. These are important topics in toxicology because of the increasing rates of cancer from both occupational and environmental exposures.

Chapter 10: Chemical-Induced Mutagenesis

A mutation is a permanent change in the organism’s deoxyribonucleic acid (DNA). DNA provides the code for all proteins. If the code changes as a result of incorrect parting, it will result in an altered protein. Mutations can be acquired or inherited. They can be induced as a result of exposure of DNA to environmental mutagens, or they can be spontaneous, acquired, or inherited. The changes in the DNA (mutations) can lead to cancer. Some examples of mutagens are UV radiation, polycyclic aromatic hydrocarbons, and aromatic amines.

Apoptosis is either planned or programmed cell death and occurs in response to physical, biological, or chemical stressors. Apoptosis is an important method of removing genetically altered cells from the body (Richards & Bourgeois, 2014, p. 182). Chemical-induced mutations that result in adverse genetic outcomes can predispose an individual to developing cancer.

There are some tests available that can help evaluate the effects of a chemical agent on DNA. The tests include the Ames test, micronuclei assays, sister chromatid studies, and DNA repair studies.

The Ames test was developed in the 1970s by Dr. Bruce Ames. It is used as a screening test for the mutagenic potential of chemicals. The bacterium Salmonella typhimurium is used in the testing. If the chemical is mutagenic, then the bacteria undergoes a reverse mutation and will produce an amino acid and form colonies when the chemical is present. Some examples of chemical that test positive in the Ames test include formaldehyde and vinyl chloride.
Chapter 11: Chemicals and Cancer

Cancer is the uncontrolled division of abnormal cells. Some terms that you should be familiar with include:

- Tumor, which is a mass of cells different than the surrounding tissue; Neoplasm, which means new growth;
- Benign Tumor, which is a noncancerous tumor; and
- Malignant Tumor, which is any cancerous tumor (Richards & Bourgeois, 2014, p. 191).

Skin cancer is one of the most common cancers and everyone has some exposure due to UV radiation from the sun. Skin cancer is becoming a major public health problem and many campaigns have been developed to educate the public on prevention.

The characteristics of cancer cells include loss of contact growth inhibition, autonomy of proliferation, avoidance of apoptosis, aberrant differentiation, and induction of angiogenesis (Richards & Bourgeois, 2014, p. 196).

Benign tumors are named for the tissue of origin and is characterized by the encapsulation of connective tissue. Malignant tumors are named from the tissue form they came from, and a suffix is added to denote the type of cancer. The suffix carcinoma has an epithelial origin. Sarcoma has a connective tissue origin and a blastomas has an embryonic origin. (Richards & Bourgeois, 2014, p. 198)

Classification of carcinogens: There are organizations that classify carcinogens. A well-known organization is the International Agency for Research on Cancer (IARC), which classifies carcinogens into categories (groups).

- Group 1 is carcinogenic to humans.
- Group 2A is probably carcinogenic to humans.
- Group 2B is possibly carcinogenic to humans.
- Group 3 is not classifiable as to its carcinogenicity to humans.
- Group 4 is probably not carcinogenic to humans. (Richards & Bourgeois, 2014, p. 201).

The Environmental Protection Agency (EPA) since 2005 classifies carcinogens into five different categories.

- Carcinogenic to humans: There is strong evidence of human carcinogenicity.
- Likely to be carcinogenic to humans: The weight of the evidence is adequate to demonstrate carcinogenic potential to humans but not reach the weight of evidence.
- Suggestive evidence of carcinogenic potential. The data is not sufficient for a strong conclusion as to the carcinogenicity.
- Inadequate information to assess carcinogenic potential: The available data is judged inadequate for the other categories.
- Not likely to be carcinogenic to humans: There is convincing evidence that in both humans and animals the agent is not carcinogenic. (Richards & Bourgeois, 2014, p. 201).

The American Conference of Governmental Hygienists (ACGIH) classifies carcinogens into the following five categories:

- Group A1: Confirmed human carcinogenesis,
- Group A2: Suspected human carcinogen,
- Group A3: Confirmed animal carcinogen,
- Not classifiable as a human carcinogen,
- Not suspected as a human carcinogen. (Richards & Bourgeois, 2014, p. 204)

This unit covered mutagenesis and cancer. Knowing that mutagens can lead to cancer and which tests to screen for mutations are important concepts in toxicology.
Reference

Suggested Reading
The article, "Bacteria Mutation; Types, Mechanisms and Mutant Detection Methods: A Review," Further Explains Mutagenesis. The article can be found in the MyCSU Student Portal by accessing the Academic One File database within the CSU Online Library. If you have any questions, the librarians' contact information can be found on the right side of the library page.


Review the following websites for further information on cancer:
- American Cancer Society, [www.cancer.org](http://www.cancer.org)
- National Cancer Institute, [www.cancer.gov](http://www.cancer.gov)
- Centers for Disease Control and Prevention: Workplace Safety and Health Topics, [http://www.cdc.gov/niosh/topics/cancer/policy.html](http://www.cdc.gov/niosh/topics/cancer/policy.html)

Learning Activities (Non-Graded)
Classify the following carcinogens based on the IARC and ACGIH classifications. If they do not fall into similar categories, discuss why.
- Benzene
- Asbestos
- Coke Oven Emissions
- Silica
- Toluene
- Carbon Tetrachloride
- Vinyl Chloride
- Formaldehyde
- Acetaldehyde
- Acrylonitrile
- Chloroform
- DDT
- Diesel engine exhaust
- Nickel compounds

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.