Course Learning Outcomes for Unit II

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

8. Explain the toxic effects of natural products on target organs of the body.
   8.1 Identify the factors that modify toxicity.
   8.2 Explain the categories of toxins based on the organism that produces them.
   8.3 Compare and contrast bacterial and fungal toxins.

Reading Assignment

Chapter 3: Toxicity and the Factors That Modify Toxic Responses

Click here to access the Chapter 3 PowerPoint presentation. Click here to access a PDF version of the presentation.

Chapter 4: Biological Poisons: Plant and Animal Toxins

Click here to access the Chapter 4 PowerPoint presentation. Click here to access a PDF version of the presentation.

Unit Lesson

The first part of this unit lesson discusses the factors that modify toxic responses and biological poisons. The second part discusses biological poisons, including bacterial toxins, mycotoxins, and animal and plant toxins.

Chapter 3: Toxicity and the Factors that Modify Toxic Responses

There is a large variation in the effects of chemicals on the body. Some examples of chemical injury include the following:

- Cells/tissue repair themselves and return to normal function.
- A repair is incomplete, but is sufficient to return to normal function.
- There is death of an organ or organism.
- Neoplastic growth can occur, resulting in the death of the organism (Richards & Bourgeois, 2014, p. 53).
The following chart demonstrates the variability in the toxic damage to cells. From the chart you can see how the tissue will either: return to normal, be a complete loss of organ function, or result in cancer.

The effects of exposure can also be classified as acute or chronic effects. Acute effects are the immediate effects, evident in days to months. Chronic effects are delayed responses and occur from months to years after exposure. An example of this is seen in carbon monoxide exposure where the acute effects include asphyxiation through carboxyhemoglobin. The chronic effects of carbon monoxide exposure include heart and brain toxicity.

One cannot prevent exposure to all toxic chemicals. The toxicity is determined by the physical and chemical properties, the duration of exposure, the route of exposure and the health of the individual. The routes of exposure include inhalation, ingestion, and absorption. Inhalation is the most common route of exposure. Ingestion of a substance is usually accidental. Absorption through the skin usually occurs when a substance dissolves in the oils of the skin and passes through the pores (Richards & Bourgeois, 2014).

It is important to know the factors that modify toxicity when studying toxicology. The factors are age, disease, gender, lifestyle, diet, and genetics. For age, the decreased organ functions in elderly persons leave them more susceptible to hepatic and renal toxicants. Some examples of lifestyle factors are cigarette smoking, drug use, alcohol abuse, and caffeine consumption. A classic example is cigarette smoking and exposure to a substance such as asbestos. If one is exposed to asbestos and smokes, their risk of developing lung cancer can increase by about eighty percent.

There is growing research in the area of how genetics affects toxicity. The individual variations in people make some more susceptible or resilient to exposure to hazardous substances. There is a difference in the expression of the detoxification enzymes which results in different rates of biotransformation.

As one can see, there are many examples of factors that can modify the toxic response.
Chapter 4: Biological Poisons: Plant and Animal Toxins

This chapter discusses biological poisons, including bacterial toxins, mycotoxins, and animal and plant toxins. Toxins are a poisonous substance produced by living things. The categories of toxins, based on what produces them include:

- bacteria
- Fungi (mycotoxins),
- Algae (phyctotoxins),
- Plants (phyctotoxins) and
- animals (zootoxins).

An example of a bacterial toxin is the botulinum toxin produced by the bacteria *Clostridium botulinum*. The botulinum toxin is the most acutely toxic substance known and the spores are found in the soil. The bacterium *Clostridium tetani* produces the toxin tetanus. This toxin causes the skeletal muscles to contract and death results from respiratory and heart failure. This bacteria can enter the body through wounds or from piercings and tattoos.

*Staphylococcus aureus* (Staph infection) is an example of another bacteria that produces an alpha toxin. *Staphylococcus aureus* is the most common cause of nosocomial infections and it is frequently responsible for food poisoning. The symptoms of exposure include nausea, vomiting, stomach cramps, and diarrhea.

Mycotoxins are produced by fungi, some of which are found everywhere in the environment, both indoors and outdoors. Some common indoor fungi include *Cladosporium*, *Aspergillus*, and *Penicillium*. These fungi can be found growing on any damp surface in the building environment. Some fungi can be associated with a condition known as 'sick building syndrome'. *Stachybotrys* is known to cause irritation of the mucus membranes, headaches, itchy skin, nausea and fatigue. There is a lot of controversy in this area because of the individual susceptibility to the fungus.

Fungal toxins that come from mushrooms cause four main types of responses: gastrointestinal effects, disulfiram-like effects, neurotoxic effects, and cytotoxic effects. The gastrointestinal effects include nausea, vomiting, and abdominal cramps. Some mushrooms produce coprine, which interferes with the metabolism of ethanol. If alcohol is consumed within three days of exposure to coprine, the effects include nausea, headache, and vomiting. Some mushrooms can have neurotoxic effects: hallucinations, fever, coma, blurred vision, and difficulty breathing. Cytotoxic effects of mushrooms are not common, but include organ failure, jaundice, and a coma.

Animal toxins are probably the best-known toxins. For example, scorpions produce a toxin that is neurotoxic but relatively harmless to humans. Another example is venomous snakes; there are many different categories of snakes and the venom they produce. The venom of snakes contains enzymes which produce the toxic effects. Acetylcholinesterase is an example of venom that causes paralysis.

An example of a plant that produces a toxin is poison ivy. It produces an organic oil called urushiol. The oil causes an allergic reaction on the skin upon contact. Another example is the giant hogweed. This plant has a clear watery sap which is a photosensitizer. A photosensitizer sensitizes the skin to ultraviolet light. Exposure to the sap and sunlight can cause swelling, burns, and blisters. Other examples of plants that are dangerous when consumed include:

- Oleander—contains cardio-glycosides,
- Lilies,
- Privet—Produces berries that contain syringin and ligustrin,
- Wolfsbane—Contains aconitum in the seeds and roots, and
- Mayapple—Contains podophyllotoxin (Richards & Bourgeois, 2014. p. 75)

Some examples of outdoor workers who may be exposed to hazardous plants while performing their jobs are:

- construction workers,
- road crews,
- forestry workers,
- loggers,
Some corals also have toxic chemicals, the most deadly is the Palythoa. It can kill a human with only 4 micrograms of toxin. Palytoxin is one of the most toxic organic poisons. The symptoms include chest-pains, difficulty breathing, and a racing pulse. Death can occur within minutes, and currently there is no treatment.

An example of an animal toxin is spider venom. The widow spider is a well-known spider. The venom of the widow spider is neurotoxic and exposure results in pain in the lymph nodes, nausea, muscle cramps, profuse sweating, respiratory distress, and even death.

References


Suggested Reading

The following article is on biological toxins as related to toxicity. It can be found in the MyCSU Student Portal by accessing the ABI/Inform Complete 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.


Learning Activities (Non-Graded)

Research two extreme cases of plant or animal toxins in your area from the county or municipal health department websites. Find out the exposure, the symptoms, and the treatment for each case.

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.