Other Routes of Exposure

In addition to the common routes of environmental, occupational, and medical exposure (oral, respiratory, and dermal), other routes of exposure may be used for medical purposes. Many pharmaceuticals are given by parenteral routes via injection into the body using a syringe and hollow needle.

Other Exposure Routes

Intradermal injections are made directly into the skin, just under the stratum corneum. Tissue reactions are minimal and absorption is usually slow. A **subcutaneous injection** is beneath the skin. Since the subcutaneous tissue is quite vascular (consisting of vessels especially those carrying blood), absorption into the systemic circulation is generally rapid. Tissue sensitivity is also high and thus irritating substances may induce pain and an inflammatory reaction.

The **intramuscular** route is used to inject many pharmaceuticals, especially antibiotics and vaccines, directly into muscle tissue. It is an easy procedure and the muscle tissue is less likely to become inflamed compared to subcutaneous tissue. Absorption from muscle is about the same as from subcutaneous tissue.

The **intravenous** (vein) or **intra-arterial** (artery) routes are used to inject substances directly into large blood vessels when they are irritating or when an immediate action is desired, such as anesthesia.

Parenteral injections may also be made directly into body cavities, rarely in humans but frequently in laboratory animal studies. An **intraperitoneal injection** goes directly into the abdominal cavity and an **intrapleural injection** directly into the chest cavity. Since the pleura and peritoneum have minimal blood vessels, irritation is usually minimal and absorption is relatively slow.

Figure 10.5.1. Injection using a syringe
(Image Source: iStock Photos, ©)

Implantation is another route of exposure of increasing concern. A large number of pharmaceuticals and medical devices are now implanted in various areas of the body. Implants may be used to allow slow, time-release of a substance such as hormones. Implanted medical devices and materials like artificial lenses, tendons, and joints, and cosmetic reconstruction do not involve absorption.

Some materials enter the body via **skin penetration** as the result of accidents or violence (weapons, etc.). The absorption in these cases depends highly on the nature of the substance. Metallic objects (such as bullets) may be poorly absorbed whereas more

soluble materials that thrust through the skin and into the body from accidents may be absorbed rapidly into the circulation.

Novel methods of introducing substances into specific areas of the body are often used in medicine. For example, **conjunctival instillations** (eye drops) treat ocular conditions where high concentrations are needed on the outer surface of the eye, not possible by other routes.

Therapies for certain conditions require that a substance is deposited in body openings where high concentrations and slow release may be needed while keeping systemic absorption to a minimum. For these substances, the pharmaceutical agent is suspended in a poorly absorbed material such as beeswax with the material known as a **suppository**. The usual locations for use of suppositories are the rectum and vagina.

Did you know?

Cinnamic aldehyde, also called **cinnamaldehyde**, gives cinnamon its flavor and odor. It occurs naturally in the bark of cinnamon trees and other species. Cinnamic aldehyde and cinnamic alcohol are well known in the scientific literature as being associated with skin allergy in humans. Skin allergy is also called skin sensitization or allergic contact dermatitis. Cinnamic aldehyde is a more potent sensitizer than cinnamic alcohol. The skin absorption and metabolism of cinnamic aldehyde and cinnamic alcohol play an important role in the development of skin sensitization following skin exposures. Cinnamic alcohol applied to human skin is converted to cinnamic aldehyde and cinnamic acid.

Cinnamic aldehyde is a good example of how an assessment of the risk of skin sensitization can be conducted prior to the introduction of new ingredients and products into the marketplace. A published quantitative risk assessment for cinnamic aldehyde used the understanding of its chemical, cellular, and molecular properties. By estimating the exposure to cinnamic aldehyde and knowing its allergenic potency, it was possible to assess the sensitization risk of cinnamic aldehyde in different types of consumer products. This publication applied exposure-based risk assessment tools to two hypothetical products containing cinnamic aldehyde. The risk assessment predicted that an eau de toilette leave-on product containing 1000 ppm or more of cinnamic aldehyde would pose an *unacceptable risk* of skin sensitization getting induced. However, a shampoo containing the same level of cinnamic aldehyde would pose an *acceptable risk* of skin sensitization getting induced, based on there being limited exposure to the ingredient from a rinse-off product application.

Figure 10.5.2. Cinnamon sticks and powder (Image Source: iStock Photos, ©)

Knowledge Check

1) If an immediate therapeutic effect is needed, the route of exposure that would most likely be used is the:

a) Intradermal route
b) Intramuscular injection
c) Intravenous injection

Answer

Intravenous injection - **This is the correct answer.**
Substances injected into the circulatory system go directly to the target tissue where immediate reactions can occur.

2) A pharmaceutical may be implanted in the body to:

a) Allow slow-release over a long period of time
b) Assure that the substance is distributed equally throughout the body
c) Reduce irritation from the substance

Answer

Allow slow-release over a long period of time - **This is the correct answer.**
Treatment with pharmaceuticals in time-release implants is a relatively new therapeutic technique that has gained popularity for long-term chronic chemotherapy.
