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**15/MHS06/020**

**MLS 512**

**ANSWERS**

**QUESTION NUMBER ONE**

A Poisonous substance can be referred to as a poison. Poisons are biologically defined as substances that when ingested, inhaled, swallowed, administered, in contact with the body cause death, injury or harm to organs, usually by chemical reactions or the other activity on the molecular scales, when an organism absorbs a sufficient quantity.

The Grandfather of toxicology Paracelsus (1493-1541) defined poison in terms of dosage “Everything is poison, there is poison in everything. Only the dose makes a thing not a poison”

**CLASSIFICATION OF POISONS;**

Poisons are of such diverse natures that they are classified by origin, physical form, chemical nature, chemical activity and toxic effects on body.

**Classification based on origin** Poisons are of microbial, plant, animal, or synthetic origin.

1. **Microbial poisons:**

Microbial poisons are produced by microscopic organisms such as [bacteria](https://www.britannica.com/science/bacteria) and fungi. Botulinus toxin, for example, is produced by the bacterium [*Clostridium botulinum*](https://www.britannica.com/science/Clostridium-botulinum) and is capable of inducing weakness and paralysis when present in underprocessed, nonacidic canned foods or in other foods containing the spores. An example of a plant toxin is the [belladonna](https://www.britannica.com/plant/belladonna) alkaloid hyoscyamine, which is found in belladonna (*Atropa belladonna*) and jimsonweed (*Datura stramonium*).

1. **Animal poisons:**

Animal poisons are usually transferred through the bites and stings of venomous terrestrial or marine animals, the former group including poisonous snakes, scorpions, spiders, and ants, and the latter group including sea snakes, stingrays, and jellyfish.

1. **Synthetic toxins:**

Synthetic toxins are responsible for most poisonings. “Synthetic” refers to chemicals manufactured by chemists, such as drugs and pesticides, as well as chemicals purified from natural sources, such as metals from ores and solvents from petroleum. Synthetic toxins include pesticides, household cleaners, cosmetics, pharmaceuticals, and hydrocarbons.

**Classification based on physical form**

The physical form of a chemical—solid, liquid, gas, vapour, or aerosol—influences the exposure and absorbability.

1. **Solid Poisons:**

Since [solids](https://www.britannica.com/science/solid-state-of-matter) are generally not well absorbed into the blood, they must be dissolved in the aqueous liquid lining the intestinal tract if ingested or the [respiratory tract](https://www.britannica.com/science/respiratory-system) if inhaled. Solids dissolve at different rates in fluids, however. For example, compared with lead sulphate granules, granules of lead are practically nontoxic when ingested, because elemental lead is essentially insoluble in water, while lead sulphate is slightly soluble and absorbable. Even different-sized granules of the same chemical can vary in their relative toxicities because of the differences in dissolution rates. For example, arsenic trioxide is more toxic in the form of smaller granules than is the same mass of larger granules because the smaller granules dissolve faster.

1. **Liquid and Gaseous Poisons**:

A poison in a [liquid](https://www.britannica.com/science/liquid-state-of-matter) form can be absorbed by ingestion or by inhalation or through the skin. Poisons that are gases at room temperature (*e.g.,* carbon monoxide) are absorbed mainly by inhalation, as are vapours, which are the gas phase of substances that are liquids at room temperature and [atmospheric pressure](https://www.britannica.com/science/atmospheric-pressure) (*e.g.,* benzene). Because organic liquids are more volatile than inorganic liquids, inhalation of organic vapours is more common. Although vapours are generally absorbed in the lungs, some vapours that are highly soluble in lipids (*e.g.,* furfural) are also absorbed through the skin.

1. **Aerosols:**

[Aerosols](https://www.britannica.com/science/aerosol) are solid or liquid particles small enough to remain suspended in air for a few minutes. Fibres and dust are solid aerosols. Aerosol exposures occur when aerosols are deposited on the skin or inhaled. Aerosol toxicity is usually higher in the lungs than on the skin. An example of a toxic fibre is asbestos, which can cause a rare form of [lung cancer](https://www.britannica.com/science/lung-cancer) ([mesothelioma](https://www.britannica.com/science/mesothelioma)).

Many liquid poisons can exist as liquid aerosols, although highly volatile liquids, such as benzene, seldom exist as aerosols. A moderately volatile liquid poison can exist as both an aerosol and as a vapour. Airborne liquid chemicals of low volatility exist only as aerosols.

**Classification based on chemical nature** Poisons can be classified according to whether the chemical is metallic versus nonmetallic, organic versus inorganic, or acidic versus alkaline.

1. **Metallic and Non-metallic Poisons:**

[Metallic](https://www.britannica.com/science/organometallic-compound) poisons are often eliminated from the body slowly and accumulate to a greater extent than nonmetallic poisons and thus are more likely to cause toxicity during chronic exposure.

1. **Organic and Inorganic Poisons:**

[Organic](https://www.britannica.com/science/organic-compound) chemicals are more soluble in [lipids](https://www.britannica.com/science/lipid) and therefore can usually pass through the lipid-rich cell membranes more readily than can inorganic chemicals. As a result, organic chemicals are generally absorbed more extensively than inorganic chemicals.

1. **Acidic and Alkaline Poisons:**

Classification based on acidity is useful because, while both acids and alkalis are corrosive to the eyes, skin, and intestinal tract, alkalis generally penetrate the tissue more deeply than acids and tend to cause more severe tissue damage.

**Classification based on chemical activity:** [Electrophilic](https://www.britannica.com/science/electrophile) (electron-loving) chemicals attack the nucleophilic (nucleus-loving) sites of the cells’ macromolecules, such as [deoxyribonucleic acid](https://www.britannica.com/science/DNA) (DNA), producing mutations, cancers, and malformations. Poisons also may be grouped according to their ability to mimic the structure of certain important molecules in the cell. They substitute for the cells’ molecules in chemical reactions, disrupting important cellular functions. [Methotrexate](https://www.britannica.com/science/methotrexate), for example, disrupts the synthesis of DNA and [ribonucleic acid](https://www.britannica.com/science/RNA) (RNA).

**Classification based on Use**

Poisons are classified by such uses as

* Agricultural chemicals: Rodenticides, weedicides, Herbicides, insecticides pesticides, etc
* Household products: This include domestic products such as Harpic, bleach, common salt, wall paintings, thyme, whiskey, brandy, etc.
* Pharmaceuticals: Drugs of abuse, over the counter drugs, prescription drugs, herbal formulations etc.
* Organic solvents: Hydrocarbons, petrol, kerosene, toluene, etc.
* Industrial chemicals
* Food Additives: coloring agents, bread enhancers, bleaching agents, sweeteners, anti-caking agents etc.

**Classification based on their toxic effects in the body;**

1. **Local**

This includes acidic and alkaline poisons

* Acidic poisons include; Organic and Inorganic poisons

Examples of organic poisons: oxalic acid, carbolic acid, formic acid, etc.

Examples of inorganic poisons: HNO3 H2SO4, HCL,HF etc.

Examples of Alkali: OH- and CO32- of Na+ Ca++, NH4++

1. **Irritants:** can result in purging, vomiting, Abdominal pain etc

This includes Organic, Inorganic and Mechanical poisons

* Organic poisons include; Plant and animal

Examples of plants include; Semicarpus anacardium, Croton tiglium, Abrus precartorius, Capscicum, Riccnus commmunis

Examples of animals include; snake, scorpion, spider, bee, etc.

* Inorganic poisons include; Metal and Non Metal

Examples of Metals: Hg, Pb, Fe, Cu, Zn, Th, Ar, As

Examples of Non Metals: Halogen, Phosphorus

* Mechanical: examples are glass, nail, hair, etc.

1. **Systemic**

This include nervous, cardiac and respiratory

* Nervous poisons include; cerebral, spinal and peripheral

Cerebral poisons can be classified into

Somniferous: Opium and its derivative

Inebrients: Alcohol, methanol, ether etc.

Dellrients: Cocaine, cannabis and belladonna etc.

Spinal poisons can be classified into;

Stimulator: e.g strychinine

Depressor: Gelsemium

Peripheral: e.g Curare and Hemlock

* Cardiac poisons include; Nicotine, Aconite and Olender
* Respiratory Poisons include; Irrespirable gases (CO2, CO, H2S) and cyanide.

**QUESTION NUMBER 2**

Hydrophobic means “water hating”. It refers to the property of a substance to repel water. They are often also referred to as lipophillic substances (i.e. fat loving). Pharmacokinetics is a branch of pharmacology dedicated to determining the fate of substances administered to a living organism. The fate of the hydrophobic substance P is as follows;

* **Liberation/Entry into the body:** Substance q was administered orally.
* **Absorption:** the process of the substance Q entering the blood circulation (assimilation into blood stream). Since substance Q is a hydrophobic substance. There is passive diffusion into body cells. Passive diffusion involves the crossing of a pharmaceutical substance across a cell membrane from an area of high drug concentration such as in the gastrointestinal tract to an area of low drug concentration such as in the blood. This is a passive process that does not require energy, and the rate of diffusion is directly proportional to the concentration gradient. Other factors that will influence passive diffusion of substance Q include: the physiochemical properties of the substance Q (such as its; lipid solubility, molecular size, degree of ionization) and the absorptive surface area available to substance Q
* **Distribution:** This involves the dispersion or dissemination of substances throughout the fluids and tissues of the body.
* **Toxicity:** The next step is for substance Q to cause toxicity by attacking cell organelles depending on what substance Q is. For instance if substance q is gentamycin, it prevents synthesis of proteins in kidneys as it acts on ribosome so that transcription occurs but translation does not (i.e. gentamycin is nephrotoxic)
* **Metabolism (or Biotransformation or inactivation):** This is the recognition by the organism that a foreign substance is present and the irreversible transformation of parent compound into daughter metabolites. Lipophillic substances must be biotransformed to hydrophilic substance metabolites to be excreted, this occurs in the liver in order to detoxify the substance Q via 2 classes of reactions;

**Phase 1 reactions:** this includes oxygenation, dehydrogenation and reduction.

**Phase 2 reactions:** this involves attachment of ionized groups to substance q and it is this process that significantly increases their water solubility allowing excretion in bile and urine. This includes glucoronidation, sulphation reactions and acetylation reactions.

* **Excretion:** This entails the removal of the substance from the body. Since substance Q is lipophillic in nature, the liver plays an important role in its excretion via biotransformation.

It is then excreted via a number of routes such as kidney (urine), bile, sweat and breast milk.

**QUESTION NUMBER 2B**

If substance Q was hydrophilic (water loving), absorption would have been by Facilitated diffusion. This is the process of spontaneous passive transport of molecules or ions across a biological membrane via specific transmembrane integral proteins.

Also, if substance Q was hydrophilic, it would have gone straight to the kidneys from the blood for excretion and if it is not big and can pass through, it is filtered and not reabsorbed, then excreted in the urine.

**QUESTION NUMBER 3**

An antidote is a drug, chelating substance or a chemical that counter reacts (neutralizes) the effect of another drug or poison.

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| **POISONOUS SUBSTANCE** | **ANTIDOTE** |
| 1. Acetaminophen overdose | Acetylcysteine |
| 1. Organophosphates and carbamates | Atropine |
| 1. Digoxin | Digoxin immune fab |
| 1. Arsenic, gold or inorganic mercury poisoning | Dimercaprol |
| 1. Benzodiazepine overdose | Flumazenil |
| 1. Methemoglobinemia | Methylene blue |
| 1. Opioid overdose | Naloxone |
| 1. Anti- cholinesterase nerve agents | Pralidoxime |
| 1. Methotrexate | Fusilev (Levoleucovorin). |
| 1. Ethylene glycol | Fomepizole (Antizol) |
| 1. Atropine, Scopolamine, belladonna, antihistamines and some antidepressants | Physostigmine |
| 1. Adenosine receptor agonist | Theophylline/ Caffeine |
| 1. Iron | Deferoxamine mesylate |
| 1. Beta blocker poisoning | Insulin + Glucagon |
| 1. Oral toxins | Activated charcoal with sorbitol |
| 1. Lead poisoning | Succimer |
| 1. Amatoxin | I.V Silibinin |
| 1. Isoniazid poisoning | Pyridoxine |
| 1. Heparin poisoning | Protamine sulfate |
| 1. Dabigatran etexilate | Idarucizumab |

3b.A health care facility’s systematic approach to assessment of the poisoned or overdosed patient includes performing triage.

1. **Obtaining the patient’s history:**

A history of the patient’s exposure provides a framework for managing the poisoning or overdose. Key points include identifying the drug(s) or toxin(s), type of exposure, the time and duration of the exposure, amount or dose, smells or **suicide note etc.**

1. **A physical examination:**

This involves checking clothing for objects or substances. A quick but thorough physical examination is essential. These include vital signs( blood pressure, pulse, respirations) and temperature, eyes (pupil size, reactivity , mydriasis, miosis, Horizontal nystagmus, etc) and mouth (burns, soot, odors), skin(flushing, dry, bruising, cyanosis, Icterus, Excessive sweating) abdomen (Hyperactive bowel sounds, tenderness abdominal cramping and diarrhea) and nervous system (agitation or confusion, reflexes, focal seizures extremities etc).

1. **Conducting laboratory studies:**

Relevant clinical laboratory data are vital to the assessment of the poisoned or overdosed. Tests that provide clue to the agent(s) taken by the patient include arterial blood gases (ABGS), electrolytes, serum osmolality tests, urinalysis, complete blood count, electrocardiography, image findings and hepatic functions.

However the study of effects of harmful substances can be grouped into;

1. **Behavioral study:**

This entails closely monitoring the patient’s behavior. Questions like “Is individual agitated or at peace?” “Are there Reflexes, focal seizures, Fasciculation, tremor etc” “Is patient in a mixed state”, are of utmost importance when assessing behavior of patient.

1. **Immunological effects:**

This is the adverse effects on the functioning of both local and systemic immune systems that result from exposure to toxic substances this phenomena is termed “Immunotoxicity”. Scientists use both in vivo and in vitro techniques when determining effects of a substance. Changes in the adaptive immune system can be observed by measuring levels of cytokine production, modification of surface markers, activation, and cell differentiation. There are also changes in macrophages and monocyte activity indicating changes in the innate immune system

1. **Teratogenic effects:**

Teratogens are substances that may cause birth defects via a toxic effect on an embryo or fetus. Teratology is the study of abnormalities of physiological development. These may include growth retardation, delayed mental development or other congenital disorders without any structural malformations.

1. **Muracogenic effects:**

This is done to check if substance will induce mutation. Mutation is an alteration in the nucleotide sequence of the genome of an organism, virus or extra chromosomal DNA either due to mistakes when the DNA is copied or as a result of environmental factors such as UV light and cigarette smoke.

1. **Carcinogenic effects:**

This is perfomed by checking the cellular architecture to determine if substance can induce carcinogenicity. Carcinogenicity is the ability or tendency of a chemical to induce tumors (benign or malignant), increase their incidence or malignancy, or shorten time of tumor occurrence when it is inhaled, ingested, dermally applied or injected.

1. **Molecular effects:**

This involves the effects of the substance at molecular level.