

# General Toxicology

- Toxicology = the study of poisons.
- Bio toxicology = the study of poisons from living organisms.
- Zoo toxicology = the study of poisonous animals.
- **Poisons** are substances that cause harm to organisms when sufficient quantities are absorbed, inhaled or ingested.
- A **toxin** is a **poisonous** substance produced within living cells or organisms.
- The historical development of toxicology began with early cave dwellers who recognized poisonous plants and animals and used their extracts for HUNTING or in warfare.

# Toxicology in antiquity

- Medicine is an ancient science.
- The use of plant & animals substances
- to heal disease is as old as the diseases themselves.
- Early practitioners of medicine were priests or magicians/physicians, & it was commonly thought that guilty of a crime would be affected by a poison.
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- THE VEDAS (900 B. C.)
- Hindu scriptures
- ATHARVA VEDA
- First Indian text dealing with medicine
- Mention of poisoning for use in warfare

I. Arrows with ducts

II. Castor bean poison

III. Poisoned nets

IV. Hook traps

# Israel

- Ancient Hebrew people were guided in every aspect of their lives by the old Testament.
- Strict dietary laws were imposed on the people, presumably to maintain health & prevent disease. Eg: trichinosis in pork.
- Early Israelites were admonished not to eat items from the water that had neither fins nor scales (Deuteronomy 14:9-10).
- Fish with neither of these structures tend to be the most poisonous & thus should be avoided.
- One of the plagues pronounced on the Egyptians by Moses was the earliest account of red tide caused by dinoflagellates (the water turned to blood, killing all the fish—Exodus 7:19-20).

# China

- Ancient & modern Chinese medicine rely heavily on natural products for healing disease (herbal medicine, rhinoceros horn & gall bladders).
- Medical practitioners recognized scale less fish as being toxic & 1st report of ciguatera toxicosis was described from ingestion of yellowtail tuna (ca A.D. 700).

## **Greece (500 B.C to A.D. 500)**

- Modern medicine had its genesis in the Greek civilization, from 500 B.C to A.D. 500.
- Medicine became separated from myth, magic, & religion.

- Homer (600 B.C.) Odysseus obtains poison for his arrows .

## **Hippocrates (460 – 355 B.C)**

- The father of medicine.
- Introduced principles of clinical toxicology related to bioavailability of toxicants.
- knew of the toxicity of sea urchin spines.

## **ARISTOTLE (384 – 322 B.C.)**

- Aristotle (384 – 322 B.C.) knew of the stinging of jellyfish.
- Alexander the great forbade his troops to eat fish, presumably because of concern for toxicity.

## **Theophrastus (370-286 B. C.)**

- Born in Eresus, on the island of Lesbos.
- Student of Aristotle.
- Authored *De Historia Plantarum*.
- Included numerous references to poison plants.
- Considered as “The Father of Botany”.

## **Aqua Toffana**

- Arsenic containing perfumes were prepared by lady named Toffana
- Such cosmetics are termed Aqua toffana, were used to kill the foes.

## **Nero (37 – 68 A. D.)**

- Mother (Agrippina) consults with skilled poisoner (Locusta) to poison Emperor Claudius such that her son from a previous marriage (Nero), seize power & cleverly poisoned step-brother Britannicus.
- Used slaves as food tasters to differentiate poisonous mushrooms from edible ones.
- Captain James Cook of H.M.S. Resolution nearly died of tetrodotoxin poisoning after consuming fish in New Caledonia



# Modern era of toxicology

- Relatively young science based on the scientific works carried out by numerous dedicated researchers & scientists.
- It's the outcome of rational thinking, experimentation, relationship between dose & therapeutics as compared with toxic, and response to chemicals.

## **M. J. B. ORFILA (1787-1853)**

- Spanish physician considered as '**Modern Father of Toxicology**'.
- He established toxicology as a discipline distinct from others & defined toxicology as the study of poisons.
- In 1813, he published the results of many toxicological experiments under the title of "toxicologic Generale"
- He advocated the necessity of chemical analysis for medicolegal cases.
- Orfila became very proficient in the chemistry of crime scene investigation & was an early promoter of chemical evidence in the courtroom

# 19th Century

- Scientific disciplines began to proliferate viz., chemistry, physiology, pharmacology & toxicology.
- Scientific meetings provided a forum for expounding theories, & professional publications spread information throughout the world.
- Biologists studied natural history of plant & animals.
- Anatomists dissected & described the venom apparatus.
- Biochemists studied venoms & poisons, & much was learned in the 19th century about chemical structure and pharmacologic effects.
- Textbooks on toxicology were published in German, French, Japanese, English & other languages.
- Toxicology became a required course in most medical & veterinary schools.

- The field of toxicology became so broad that scientists began to narrow their fields of interest further: into plant poisoning, marine biotechnology, or pesticide toxicology.
- Scientists of the 20th century

## **FDA, 1930**

- Food & Drug Administration was founded to regulate the content and safety of consumer drugs & foods.

## **L.J. Casarett and J. Doull (1971)**

- Published the 1st modern Toxicology textbook titled “ Toxicology: The basic science of poisons ”.

## **BHOPAL GAS DISASTER, (1984)**

- occurred due to accidental release of methyl isocyanate killing thousands & injuring hundred's of people.

## **Latter half of the 20th century**

- A noteworthy achievements led to better understandings of the ecology of poisons & venoms. □ Some answers have been discovered to such puzzling questions as:
  1. Why are plants & animals poisonous/venomous ?
  2. What have poisons contributed to evolution ?
  3. How can an understanding of poisons & venoms contribute to the management of both free-ranging wild animal populations & domestic animals ?

# Coevolution

- Plants & herbivorous animals (insects) coevolved in an adversarial relationship.
- Plant population developed various strategies for coping with herbivores that could potentially destroy them! Mechanical means -thorns, spines, harsh outer coats of stems/leaves.
- Chemical deterrents - Plants Secondary Metabolites (PSM's) ,bitter tasting, offensively odorous, poisonous or have antinutritional effects.
- As plants became more efficient in producing PSM's animals, likewise improved their own methods of coping.

# Animal Toxin Ecology

- Animal toxin & venoms are used to obtain
- Food
- Deter predation
- Regulate population
- Aid in exploiting a territory
- Aid in defense against enemies.

- Poisons & venoms have served a vital role in the evolution of plants & animals.
- The pharmacological effects of plants & animals = PSM (Plants Secondary Metabolites).
- The determining factor of whether a substance is a medicine or a poison may be a matter of dosage.
- Scientists are just beginning to unravel many of the mysteries of plant/animal/animal interactions.

# Branches of Toxicology

- **Immuno toxicology** - This branch deals with toxins that impair the functioning of the immune system - for example, the ability of a toxicant to impair resistance to infection.
- **Forensic toxicology** - It is the study of unlawful use of toxic agents and their detection for judicial purposes. Forensic toxicology is concerned with the medicolegal aspects of the adverse effects of chemicals on humans and animals. Although primarily devoted to the identification of the cause and circumstances of death and the legal issues arising there from, forensic toxicologists also deal with sublethal poisoning cases.
- **Molecular toxicology** - Molecular toxicology focuses on why and how chemicals cause harm to life. The basis of cellular and molecular processes leading to toxic effects is studied under molecular toxicology.



- **Veterinary toxicology:**
- Veterinary toxicology focus in the study of diagnosis and treatment of animal poisoning including the transmission of toxin from animals to humans via milk, meat, fish, food stuff and etc.
- **Environmental toxicology:**
- It is the branch of toxicology in which study of presence of different toxicants including their metabolites and degradation products in the environment and their effects on humans and animals.
- **Clinical toxicology** – It is the study of the effects of poisons/toxicants on human beings, animals and other living organisms, their diagnosis and treatment and methods for their detection *etc.*
- **Nutritional toxicology** – It is the study of toxicological aspects of food/feed stuffs and nutritional habits.

- Analytical toxicology – It is the application of analytical chemistry tools in the quantitative and qualitative estimation of the agents involved in the process of toxicity.
- Occupational toxicology – It is the study of occupational hazards associated with individuals working in a particular industry/occupation and their correlation with the possible toxicants and also the possible remedial measures.
- Ecotoxicology – It is the study of fate and effects of toxic substances on ecosystem.
- Regulatory toxicology – It is the conduct of toxicological studies as per the content and characteristics prescribed by regulatory agencies.

- **Developmental toxicology** – It is the study of adverse effects on the developing organisms occurring any time during the life span of the organism due to exposure to chemical or physical agents before conception (either parent), during prenatal development or postnatal until the time of puberty.
- **Toxicoepidemiology** – This refers to the study of quantitative analysis of the toxicity incidences in organisms, factors affecting toxicity, species involved and the use of such knowledge in planning of prevention and control strategies.

## **The major areas of specialization in toxicology :**

1. Mechanistic toxicology (basic biology and chemistry)
2. Regulatory toxicology (rule making and compliance)
3. Descriptive toxicology (testing)