

Toxicology and Toxicology Education in Africa

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Introduction

Toxicology (the Science of poisons), is currently one of the most important fields, especially nowadays, where it is considered by many scientists that this era is “the Era of Poisons”. As a fact, no chemical is not toxic, and toxicity is dose-dependent. We are surrounded with enormous number of chemicals, natural and synthetics. Exposure to these chemicals, acute, subacute and chronic, could have very drastic health and environmental effects/impacts. These chemicals belong to several chemical groups, having different chemical and physical properties, stabilities, persistence in the environment, biological activities, uses, applications, etc. Some of them are produced for specific purposes (medical, agricultural, industrial, etc.) and others are unintentionally produced (as impurities) during the industrial production or from accidents (e.g. fires) or exhaust from vehicles or chimneys. Therefore, one could safely say that no one toxicologist can deal with all types of toxicants in terms of toxicity (to all organisms and systems), kinetics (absorption, distribution, metabolism, excretion, etc.) mode of action, site of action, fate (degradation, persistence, transboundary movements, etc.), acceptable levels, maximum residue levels, etc. Consequently, one can safely claim and emphasize that toxicology is not a one science or field, it is several sciences under the umbrella of toxicology concept. Toxicology can be divided into the following areas: I) General Toxicology and II) Applied Toxicology.

- I) **General toxicology:** Toxicologists under this field deal with the analysis, elucidating the mechanism of action, mode and site of action, chain of events, kinetics, bioassay and all the basics of toxicology.
- II) **Applied toxicology:** This area can be divided into the following sub-areas:
 - i) **According to the organism:** Human toxicology, Mammalian Toxicology, Invertebrate Toxicology, Insect Toxicology, Fish Toxicology, Avian Toxicology, etc.
 - ii) **According to the system:** Systemic Toxicology, Neurotoxicology, Eye Toxicology, Respiratory Toxicology, Circulatory Toxicology, Liver/hepatic Toxicology, kidney/ Renal Toxicology, Reproductive toxicology, Immunotoxicology, Genetic Toxicology, etc.
 - iii) **According to the chemical group:** Toxicology of Insecticides, drug Toxicology, Plastic Toxicology, Heavy Metal Toxicology, Fossil Fuel Toxicology, Social Poisons Toxicology, Solvents Toxicology, Nanotoxicology, etc.
 - iv) **According to profession:** Medical Toxicology, Veterinary Toxicology, Industrial Toxicology, Occupational Toxicology, Forensic Toxicology, Environmental Toxicology, Eco-toxicology, Food Toxicology, Natural Products Toxicology, Marine Toxicology.

Under each of these specializations, one can name more specific specializations, e.g. under the heavy metals Toxicology some are specialized in specific metals, e.g. Lead, Hg, Cr, Zn, etc. Likewise, under Insecticide Toxicology, some are specialized in one chemical group like organochlorines, organophosphates, carbamates, etc. In the area of pollution and Environmental Toxicology, some are focusing on polyaromatic hydrocarbons or dioxins and furans or poly chlorinated biphenyls, and so on and so forth.

All the above areas, even more, can be found in the developed countries (USA, Japan, Russia, China and some European countries). Some of these areas can be found in some developing countries like Egypt, Tunisia, Algeria, Morocco, South Africa, Turkey, South Korea, Malaysia, Singapore, Hong Kong. However, in Africa the case is quite different. Most of the toxicologists are either General Toxicologists or Toxicologists of Insecticides. Some of the new generation toxicologists are Environmental/Ecotoxicologists, dealing mainly with pollution and pollutants (Persistent Organic Pollutants, Persistent Toxic Substances and Heavy Metals). Their backgrounds is chemistry. The

weakest areas are the Medical Toxicology and Forensic Toxicology. The occupational toxicology and occupational health and safety is not attractive for physicians as a specialty, same applies to Industrial Toxicology (not rewarding economically).

Toxicology education in Africa

Toxicology in the African universities is mostly service department in the faculties of Pharmacy, Veterinary and Agricultural Sciences. They usually teach the introductory courses for the undergraduates and graduates. None of the universities offer B.Sc. degree in toxicology, except the university of Gezira, Faculty of Agricultural Sciences, Wad Medani, Sudan, in the Department of Pesticides and Toxicology. The rest of the African Universities offer Diploma, M.Sc., and Ph.D. in a very limited areas. The reasons behind that is the lack of specialized staff members, and the laboratory requirements. Most of these degrees are based on research only; no courses are offered during the program. What are the reason behind not offering ideal/proper programs? The following points, regarding the curricula and their design, might be the major obstacles:

- 1) Budgets (including the running cost) for executing the ideal programs and establishing suitable educational laboratories are among the major causes for the weakness of such programs.
- 2) Trained fine specialization instructors and technicians, viz. chemistry of pesticides, formulations, fungicides, acaricides, avicides, rodenticides, molluscicides and nematocides specialists are not available in any of our African universities, except Egypt.
- 3) Applied toxicology specialists are also lacking, viz. forensic, environmental, industrial, occupational, clinical, veterinary, human, animal, systemic (liver, kidney, respiratory, etc.), and others.
- 4) Qualifying pesticide specialists and toxicologists requires intensive training in all aspects of chemistry (organic, physical, analytical, biochemistry and molecular biology, which is very costly), in addition to the pharmaco- and toxicokinetics, Physiology (animal, plant and human) not to omit the environmental issues.

The requirements for qualifying a toxicologist

1. Strong chemical background.
2. Strong physiology background (human, animal and plant).
3. The ability to relate all subjects to the concepts of toxicology.
4. Concern about health and environmental Issues (nationally, regionally and internationally), including the acts and conventions.

What is expected of the graduate

1. To be able to appreciate the concepts of toxicology, especially (no chemical is nontoxic).
2. To be able to understand how toxic are the chemicals we are dealing with in all aspects of our daily life and to do his/her pest to protect his/her community.
3. To be able to analyze some toxicants adopting the GLP and SOP.
4. To be able to deal with references (periodical and books).
5. To raise the awareness of his community.
6. To help the Med. Doctors and veterinarians in diagnosis and recommending the treatment (similar to clinical pharmacist).

7. To be able to conduct Environmental Impact Assessment studies.
8. To be qualified as a research assistant, teaching assistant, or as an officer with the forensic labs (police) and with the corner's department.

Courses required

At B.Sc. (HON.): Chemistry courses: Physical, organic, analytical and separation techniques, alkaloids, biochemistry, molecular, natural products. Physiology: insect, plant and if possible, comparative. Bacteriology, mycology, virology, nematology, acarology, rodents and avians. General/ introductory Toxicol. Toxicology of Insecticides. Systemic toxicol. Applied toxicol Food Toxicants and contaminants. Human Physiology and Endocrinology. Pharmacology and drug screening techniques. Experimental animals. Cell biology. Enzymology; Seminar and Dissertation/thesis.

Graduate level: Diploma, M.Sc. and Ph.D: All of Toxicology Specialization Areas: e.g. toxicol. of insecticides, insect toxicol., human toxicol., animal toxicol., environmental Toxicol., food toxicol., risk assessment, Kinetics, metabolism, systemic toxicol, social poisons, poisoning and poison centers, pollution and pollutants, environmental Act and conventions.

All degrees are partial fulfillment including the Ph.D. All courses must be advanced.

Curricula must be flexible so as to add to them the new relevant areas/field of Sciences; Updating.

Exchange of staff and students with other universities and schools of thought, and exposure to relevant conferences/workshops/symposia.

What I want from the new generation?

1. To be better than the current generation (us)
2. To be able to solve the problems of the current and coming generations
3. To be able to Protect Africa from what is going on now and to prevent accumulation of the problems (pollution, misuse and abuse) that might harm the population and the future generations
4. To encourage the current students to enroll in in these departments
5. To be able to convince the authorities to establish the required teaching and research facilities.
6. To be able communicate with the scientists of the developed world and fill the knowledge and research gaps.
7. To strongly and significantly contribute to literature, methods, procedures and techniques for the benefit of humanity
8. Educated guess [1-9].

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