Forensic Toxicology Primer

Toxicology Subcommittee

Chemistry/Instrumental Analysis Scientific Area Committee

March 2017

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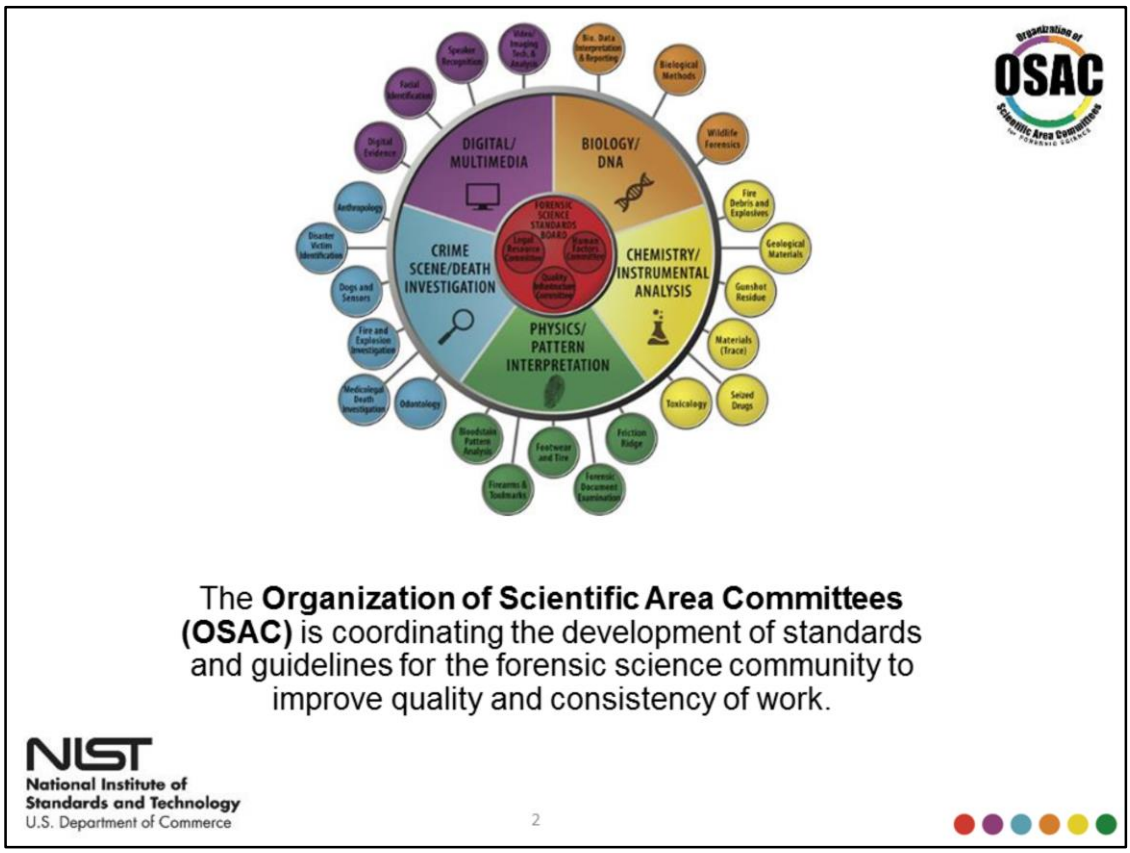
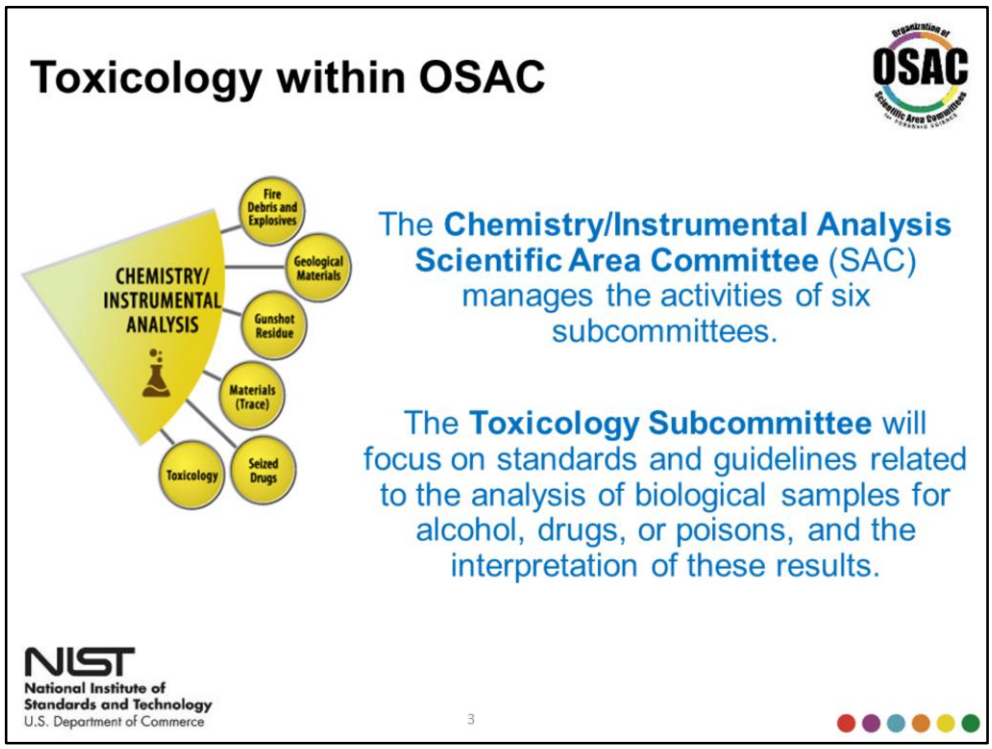
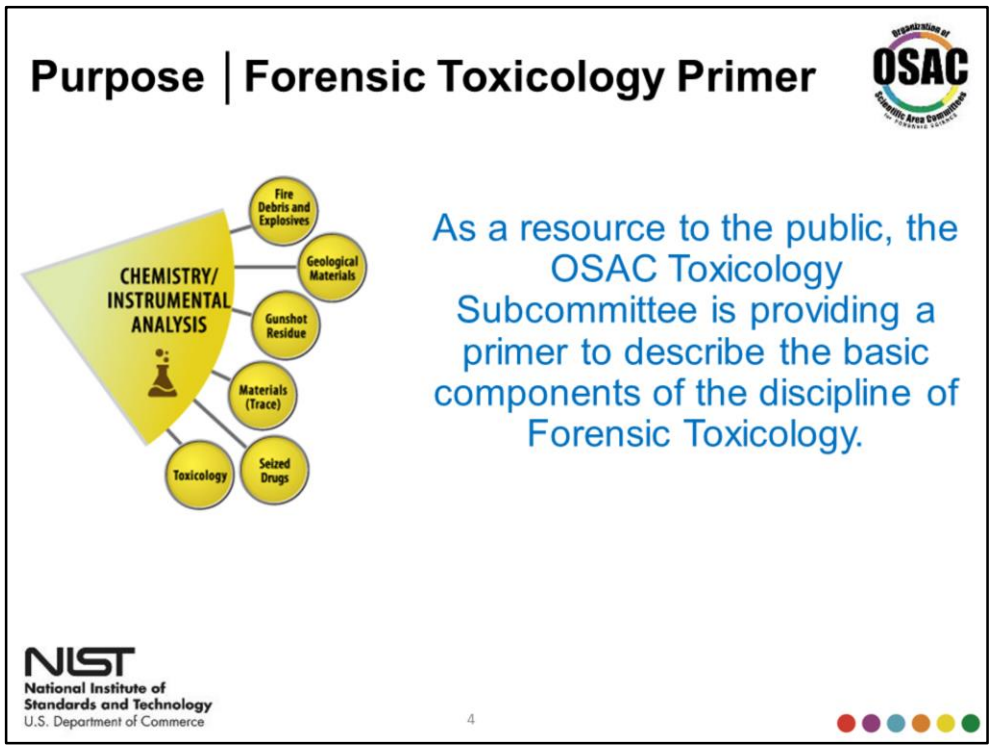
National Institute of Standards and Technology
U.S. Department of Commerce



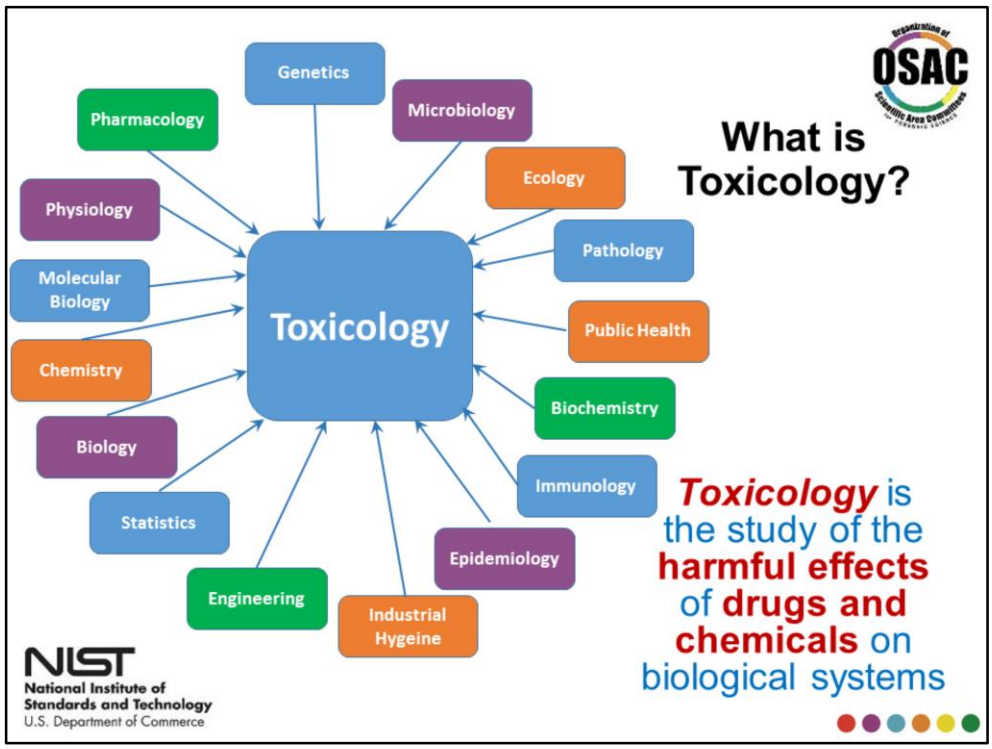
OSAC's purpose is to strengthen the nation's use of forensic science by providing technical leadership necessary to facilitate the development and promulgation of consensus-based documentary standards and guidelines for forensic science, promoting standards and guidelines that are fit-for-purpose and based on sound scientific principles, promoting the use of OSAC standards and guidelines by accreditation and certification bodies, and establishing and maintaining working relationships with other similar organizations.



The six subcommittees of the Chemistry/Instrumental Analysis SAC include Fire Debris and Explosives, Geological Materials, Gunshot Residue, Materials (Trace), Seized Drugs and Toxicology.



This resource is intended to provide a brief overview, or the “what”, “why”, “where”, and “how”, of the field of Forensic Toxicology.



Toxicology is the study of drugs and chemicals on biological systems. Toxicology relies on information from numerous scientific and social disciplines as well as engineering and statistics.

Forensic toxicology deals with the application of toxicology to cases and issues where adverse effects of the use of impairing, toxic and lethal concentrations of drugs have administrative or medicolegal consequences, and where the results are likely to be used in a legal setting.

Why?

FORENSIC TOXICOLOGY *is an exciting and rewarding profession, where science intersects with medicine and the law. It offers the opportunity to interact with other professionals with wide-ranging backgrounds and expertise.*

FORENSIC TOXICOLOGISTS *may work in medical examiner laboratories, crime laboratories, military, government, or private sector facilities.*

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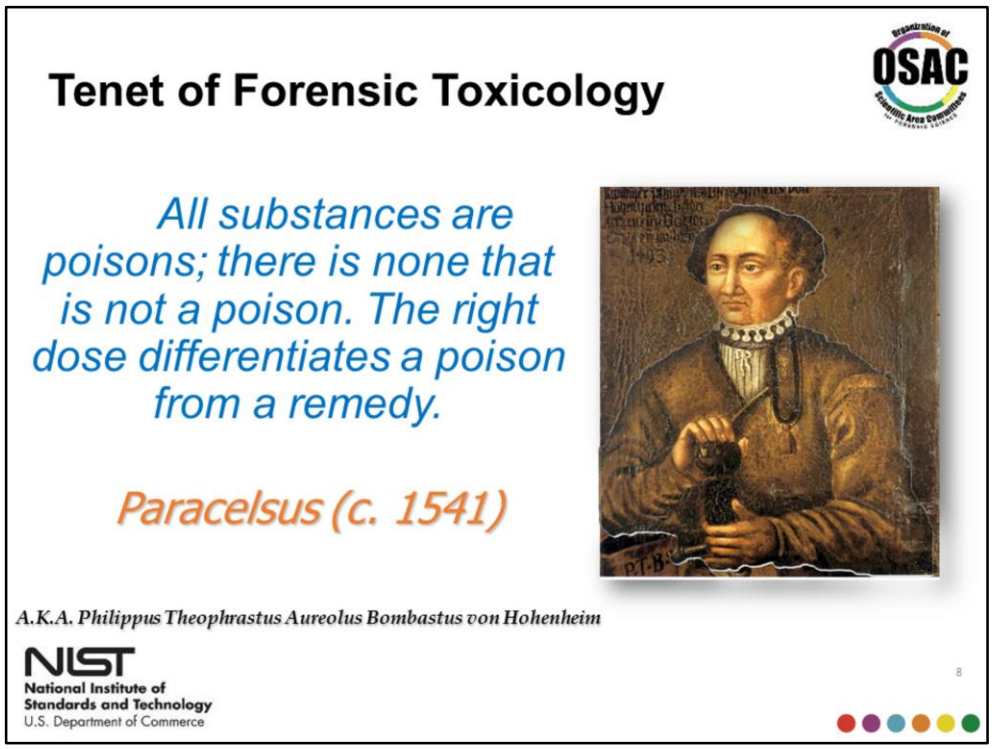
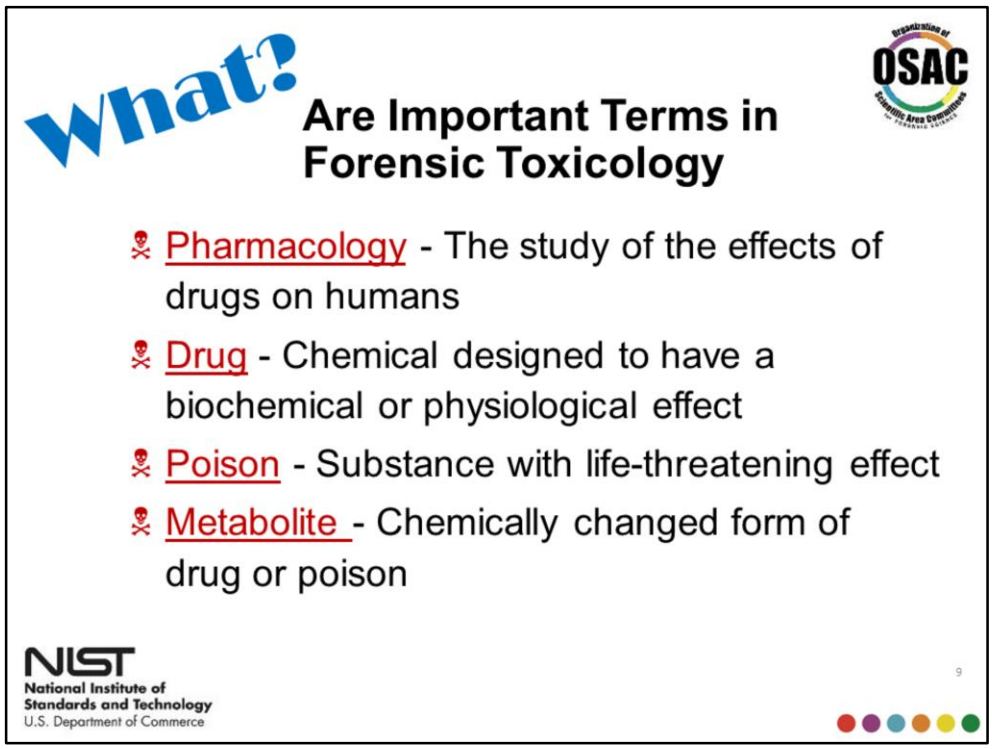
Other career opportunities exist in hospitals, universities, and industry.



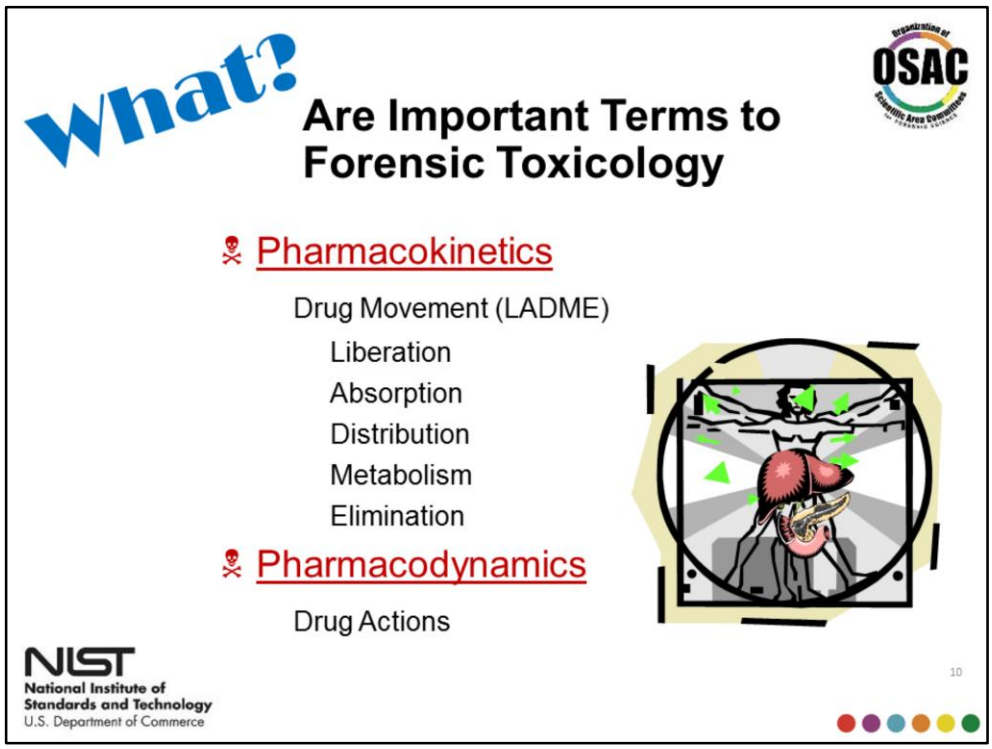
Paracelsus is often credited with one of the original conceivers of toxicology. Manly Hall, a famous author of the 19th Century called him "the precursor of chemical pharmacology and therapeutics and the most original medical thinker of the sixteenth century."

A principle tenet of forensic toxicology is that the "dose makes something a poison". For example, water is generally a safe and essential beverage all living organisms require to live, but if taken in an excessive amount this can interfere with a body's chemistry and create a toxic environment.



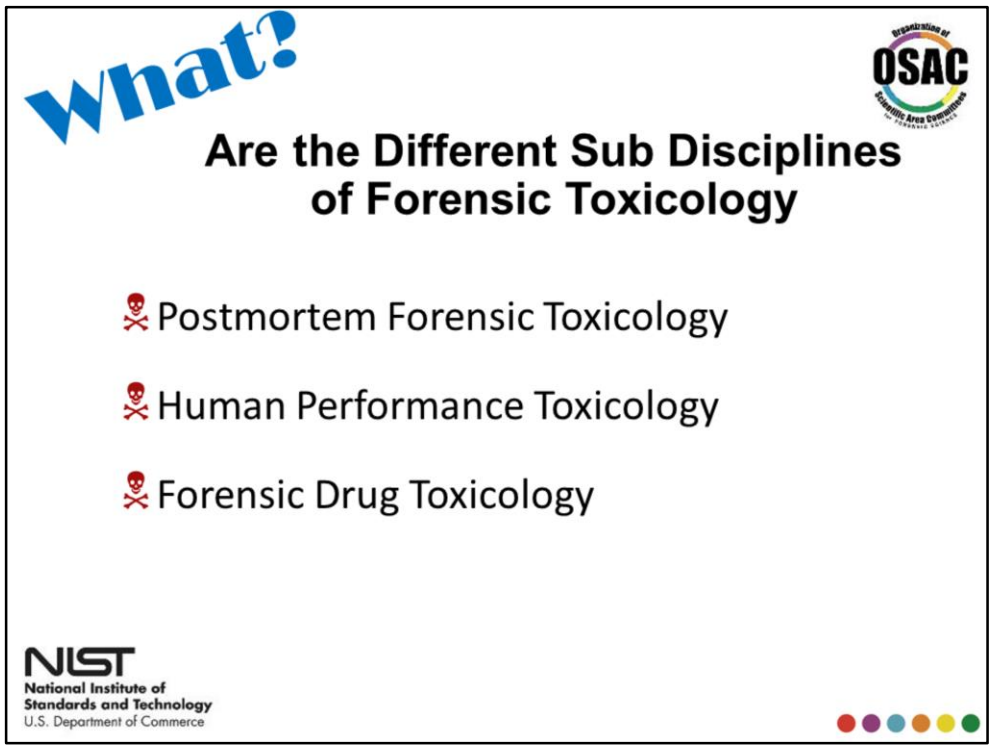
Pharmacology is the study of the effects of drugs on humans. **Drugs** are chemicals designed to have a biochemical or physiological effect on biological systems, while **poisons** are substances with life-threatening effect

Drugs and poisons are often reduced by the body to a chemical form known as a **metabolite** that promote its excretion from the body.

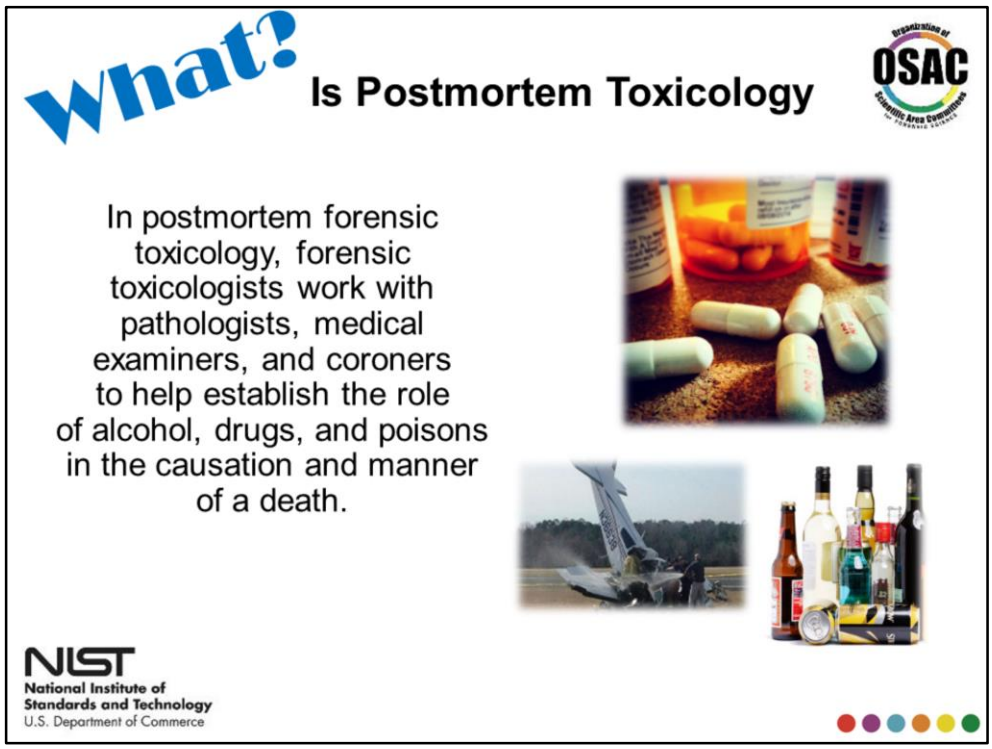


Pharmacokinetics is the branch of pharmacology concerned with the movement of drugs within the body. It is paired to **Pharmacodynamics**, or the study of how drugs act in the body. Pharmacokinetics represents what the body does to the substance and Pharmacokinetics represents what the drug does to the body.

Certain organs in the body, especially the brain, have **receptors** for which drugs can bind to exert its effects. These effects can be functions or processes. For example, a drug can cause secretion of a hormone such as insulin from the pancreas.



The field of forensic toxicology involves three main sub-disciplines: postmortem forensic toxicology, human performance toxicology, and forensic drug testing. All of these sub-disciplines measure substances in biological matrices for a given purpose.



In postmortem forensic toxicology, forensic toxicologists work with pathologists, medical examiners, and coroners to help establish the role of alcohol, drugs, and poisons in the causation of a death. Postmortem Toxicology investigates suspected drug overdoses, homicide, suicide, natural deaths and general unknown deaths where toxins are either ruled in or out through testing and interpretation.

Postmortem Application of Forensic Toxicology

The forensic toxicology laboratory identifies and quantifies the presence of drugs and chemicals in biological fluids and tissues from the body before and/or after death.

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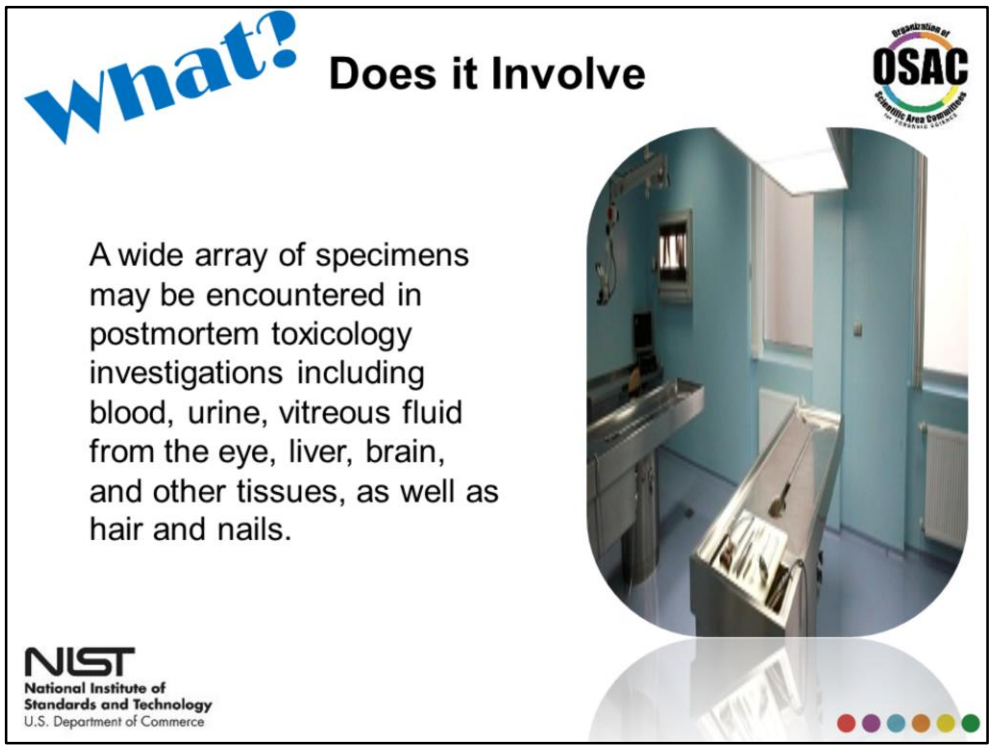
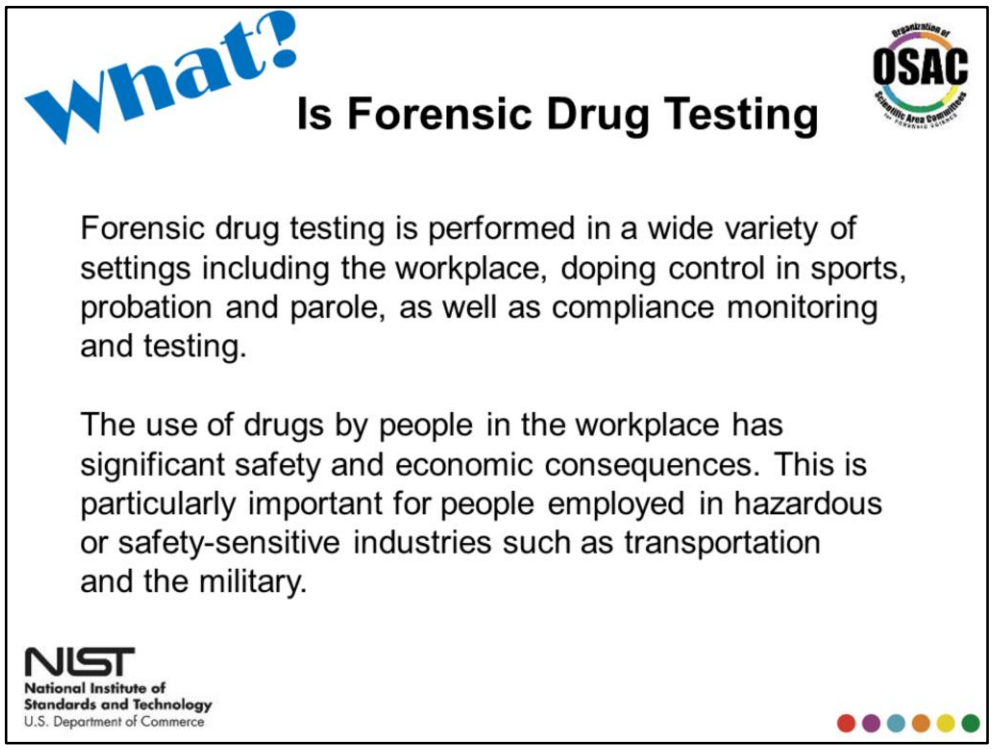
Biological fluids include blood, urine, vitreous fluid, cerebral spinal fluid, and bile. In addition to tissues, hair, nail and, in some cases, bone can be used in toxicological analysis.



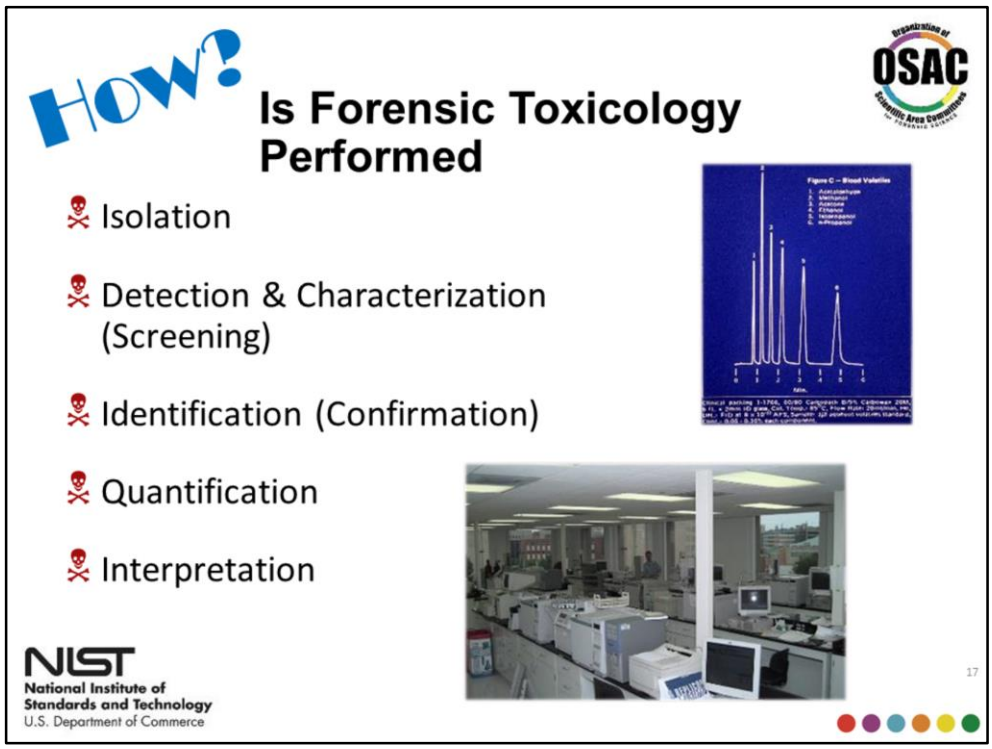
Once the testing is complete, a forensic toxicologist then interprets these findings. This information helps a forensic pathologist determine the cause and manner of death.

Criminal investigation analysis involves the same application of techniques as in the death investigation setting, but specimens are typically collected from living persons. Blood and urine are commonly encountered, but oral fluid, hair, and other specimens are also used. If samples are taken from a clinical environment, plasma and serum can be used instead of whole blood with a conversion calculation. Forensic toxicologists are frequently asked to determine the timing and extent of impairment resulting from different patterns of drug and alcohol use. The interpretation of the test results in this area is the greatest challenge, requiring the application of knowledge from clinical and medical studies and experience in the field, to give an opinion about the effects of a drug or combination of drugs on an individual at the time of a crime or accident.

Specimens with a shorter window of detection include blood, urine, breath, and oral fluid, whereas long-term detection can use alternative matrices like hair, nails,, or sweat.



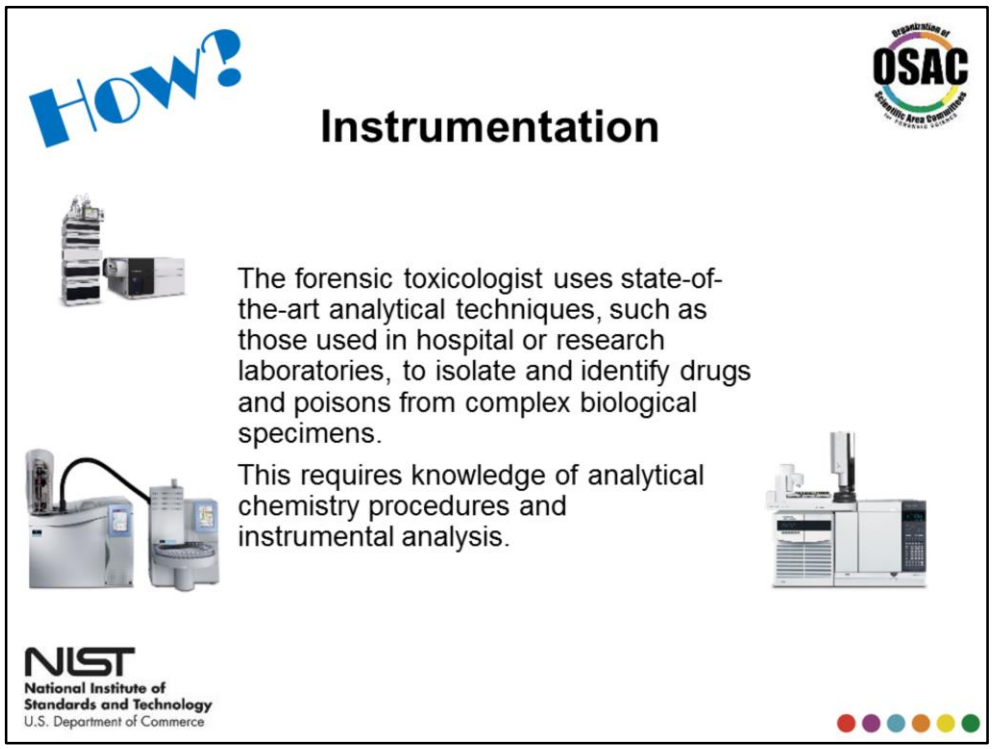
The scope of drug testing is often limited however, compared with human performance or postmortem toxicology, but the throughput of testing can be greater. Workplace drug testing laboratories may perform tens of thousands of tests per day and many times require specialized configurations of equipment such as multiplexing, which decreases analysis time and improves productivity. Urine is the most common specimen tested but oral fluid, hair, sweat, and other matrices are also used. As with all of the forensic disciplines, there is a strong emphasis on record keeping, chain-of custody documentation, stringent quality control, and data management.



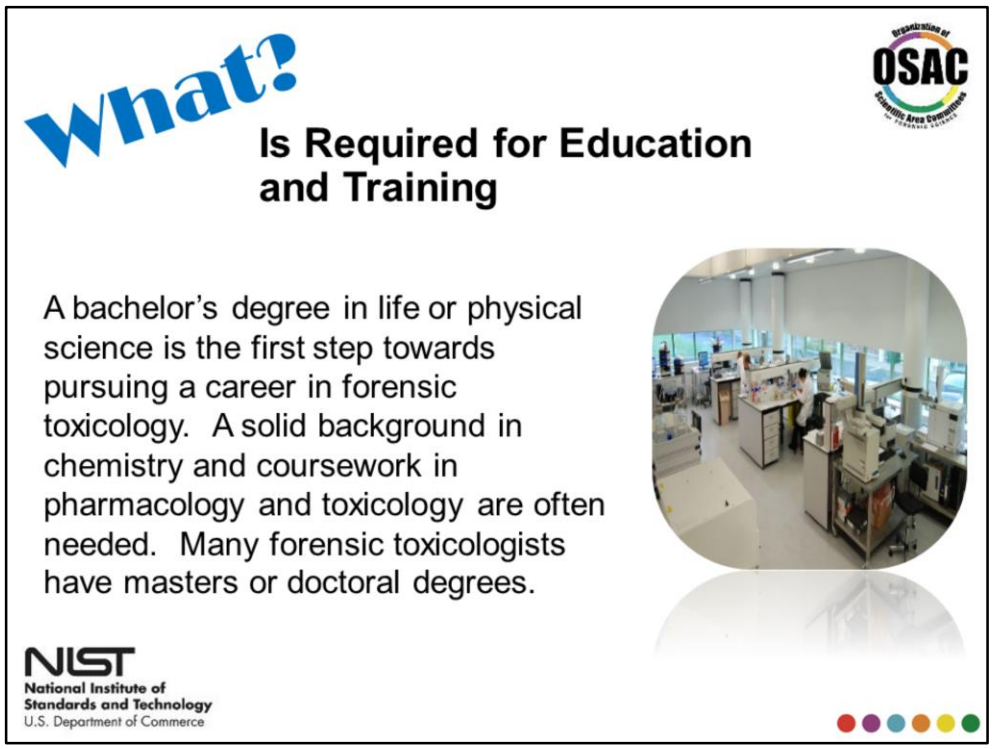
Briefly the steps in forensic analysis or treatment of the specimen to get an answer include:

Isolation of the drug/poison from the matrix, be it blood or vitreous. To do this some type of extraction method is employed to remove the substance from the biological matrix. **Detection and characterization** of the poison by comparison with known quality control reference materials (controls), calibrators, and drug libraries is the next step. **Identification** of the drug, or confirmatory testing, by matching retention times and spectrum of an unknown substance in a sample to a known substance in the drug library. **Quantification** when a concentration of the substance is determined by comparison to values of a calibration curve analyzed on the same run as the samples. Once data is reviewed, a forensic toxicologists considers all the results, the case information, and known literature to **interpret** the toxicological findings in a case.

Some of instrumentation is so precise that it is like getting a 'toxicological fingerprint' that is unique to one specific substance, referred to as an analyte.



The field of Forensic Toxicology utilizes various testing techniques to determine the presence of drugs or chemicals in a biological system.

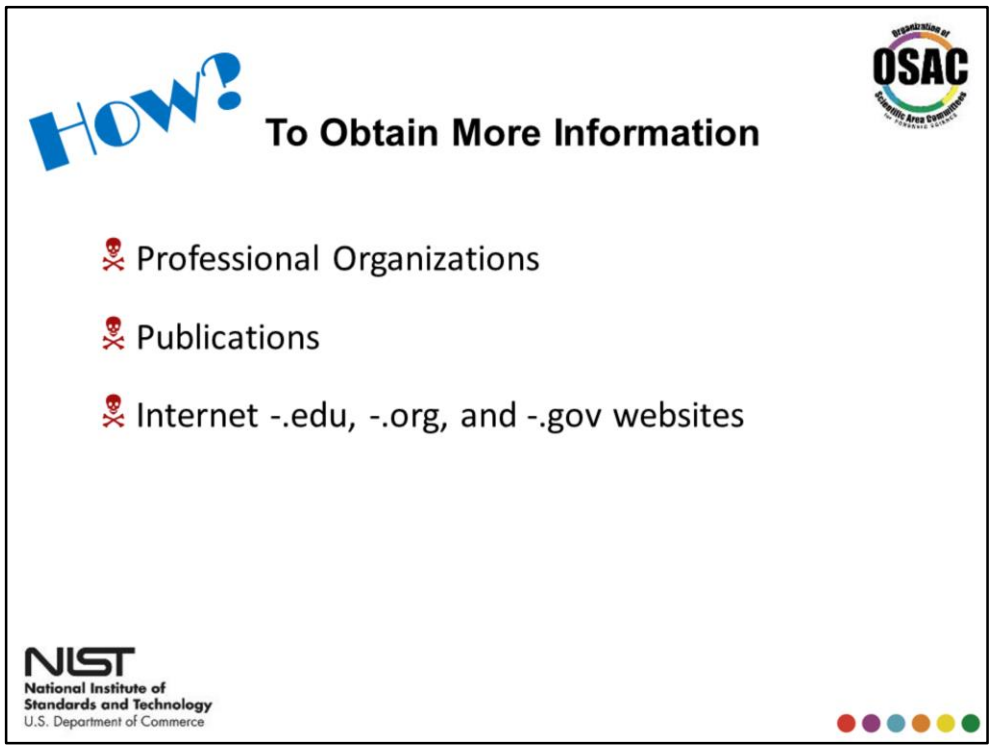


Some enter toxicology after working in, or pursuing education in, other areas such as medicinal chemistry, pharmacology, or clinical chemistry. While relevant educational requirements are necessary to enter the field of forensic toxicology, training in the laboratory furthers an individual's knowledge, experience, and ability to provide interpretation of the results. The American Board of Forensic Toxicology (www.ABFT.org) offers professional certification to scientists working in the field of forensic toxicology.

Forensic sciences for the most part occurs in the laboratory where the natural sciences can be performed in a setting that is reliable and will not impact the results of the investigation. Research laboratories are also a location for forensic toxicology to be performed in an even greater controlled environment. Roadside testing and scene investigations are also two more locations where the beginning of forensic toxicology is performed, namely to collect specimens and to do some of the initial testing. Consultation and Expert Services that include Expert Testimonies for court proceedings, laboratory inspections, and other investigations that need the expert opinion of a forensic scientist.

There are many professional organizations who members practice forensic toxicology and whose annual meetings present cases and research in the field. The Society of Forensic Toxicology (www.soft.org) primarily represents toxicologists in the United States, while TIAFT and AAFS have a more internationally represented membership. Regional meetings for forensic toxicologists include the California Association of Toxicologists and the Southeastern Association of Toxicologists. The American Board of Forensic Toxicology offers board certification for this profession.

These websites provide additional details concerning career opportunities and advances in the field of forensic toxicology.



Forensics is a growing field and there is all kinds of literature out their to feed your hunger for knowledge of this field and to help you plan your career path. Here are a few organizations and Federal Agencies that provide additional information.