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HISTORY OF TOXICOLOGY

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Introduction

The word "poison" immediately conjures up images of cloak-and-dagger conspiracies, diabolically sneering poisoners, unfaithful and murderous wives, mad and cruel kings, and greedy nieces and nephews. No other single subject has a history as full of intrigue and romance as that of poison. As is the case with every subject, the study of the history of poisons provides valuable insights. The oft-quoted maxim "those who do not study history may be condemned to repeat it," applies very aptly to poisons.

What exactly is a poison? A poison can be defined as a substance that is capable of destroying life or causing illness fairly quickly, on a biochemical basis, when introduced into, or absorbed by, a living system in small quantities. Thus, liberal consumption of saturated fats may be responsible for death by coronary atherosclerosis after a few decades; however, it cannot be called a poison because the death, although surely associated with saturated fats, is not quick. Similarly, a bubble of oxygen introduced into the vein of a human being, although capable of killing the person immediately by air embolism, cannot be construed as poison because it does not kill on a biochemical basis. Nor can a sharp pin or needle be called a poison when ingested because it would kill by physically rupturing the gastrointestinal tract. Although approximately 0.25 kg of common salt would kill a human being fairly quickly when ingested, on a biochemical basis, it could still not be construed as a poison because the lethal quantity is very high. Thus, the three most important qualifying characteristics of a poison are its speed of action, action on a biochemical basis, and its lethality in small doses. Poisons that rank high on all three scales, such as cyanide, arsenic, and phosphorus, have dominated popular imagination since time immemorial. Toxicology is the science dealing with the study of poisons.

Poisons in Mythology

Poison has been called the cowardly person's weapon. Its secretive nature has held a peculiar fascination for humanity. Since earliest times, the magic, myth, and legend of poison have been linked to hunting, crime, punishment, politics, romance, and, of course, medicine and the development of antidotes.

Toxicology has been known from very early times in all cultures. According to Indian mythology and tradition, the origin of poisons is attributed to Lord Brahma, who is one of the Holy Trinity of Indian gods (the Hindu Holy Trinity comprises Lord Brahma, the creator of the universe; Lord Vishnu, the preserver; and Lord Shiva, the destroyer of the universe). It is said that after the creator of the universe was offended by a devil (asura) named Kaitabha, he created poison to kill him. He was, no doubt, successful in destroying the demon with his new weapon, but its evil spread over the whole world. So much so that, to minimize its bad effects, Brahma had to distribute it through the vegetable, animal, and mineral kingdom and also create its antidote. Brahma thus distributed poisons into three categories: animal, mineral, and vegetable. Brahma is often cited as the first to classify poisons in this manner. Later, the Greek physician Dioscorides (AD 40–80) developed this classification independently (Table 1).

One of the foremost Indian experts in the science of toxicology was Kashyapa, a physician who lived in the times of Buddha (sixth-century BC). Kashyapa was a follower of the Brahmanic religion at first but was later converted to Buddhism. He was a successful curer of snakebite. A famous tale relating to his curative powers is frequently narrated. King Parikshita had been cursed that he would die of snakebite, but Kashyapa had taken it on himself to cure the king when the curse befell him. On the destined day when Takshaka, the king of serpents, was going to bite Parikshita, he met Kashyapa on the way and challenged him by showing his remarkable powers. It was perhaps his idea to frighten Kashyapa so that he would take back his vow. He bit a fully blossomed tree, and in front of everyone's eyes the tree turned to ashes. However, to everyone's surprise and to the shame of Takshaka, Kashyapa, using his wonderful charms and medicines, restored the tree to its original blossom. Unfortunately, Kashyapa was soon "bought over" by Takshaka, and Takshaka finally succeeded in killing Parikshita by his fatal bite.

Sure enough, this tale is mythological, but it does show the expertise of ancient Hindu doctors in the science of toxicology. The famous Indian surgeon Sushruta (seventh-century BC) defined agadatantra, which is akin to the modern term toxicology. It dealt with the diagnosis and treatment of any person bitten

Table 1 A list of 125 major events in the history of criminal poisoning and toxicology

No.	*Year*	*Event*
1.	16 000 BC	Hunters in Kenya used poison to kill
2.	4500 BC	Sumerians living in Mesopotamia (modern-day Iraq) worshipped Gula, a deity of noxious poisons. Gula is the earliest-known deity associated with poisons
3.	4000 BC	A Sumerian tablet of this period refers to the poppy as equivalent to ''joy'' plus ''plant,'' an allusion which indicates that Sumerians were aware of poppies and their effects
4.	3100–3000 BC	People in Egypt and Nubia used poisoned arrows
5.	3000 BC	Menes, the first Egyptian Pharaoh (king), cultivated and studied medicinal and poisonous plants
6.	2737 BC	The *Book of Drugs* appeared in China and described marijuana, alluding to its commercial and medical uses. The Chinese used marijuana to treat gout, malaria, and absent-mindedness
7.	2500 BC	Coca leaves (*Erythroxylon coca*), the source of cocaine, and a chewed wad of coca found near gravesites dating to this period show that coca was known to people of this era
8.	2000 BC	Chinese Emperor Shen Nung experimented with poisons and their antidotes and wrote a treatise on herbal medicine
9.	1600 BC	The *Smith Papyrus* cites the use of charms against snake poison
10.	1500 BC	The *Ebers Papyrus* (discovered in Thebes in 1872, by the German Egyptologist Georg Moritz Ebers (1837–1898)) mentions over 800 recipes (829 in all), many containing recognizable and identified poisons. Antimony, copper, lead, turpentine, verdigris, hyoscyamus and opium were used as poisons
11.	1400 BC	The *Hearst Medical Papyrus* (discovered in upper Egypt in 1899) refers to both poisons and therapeutic agents
12.	1200–900 BC	Hymns of the Rg Veda and Atharva Veda mention the use of poisoned arrows in war. Tubers of aconitum were mentioned as the major poison source
13.	*c.* 850 BC	Homer wrote *The Odyssey*, in which he mentioned how Ulysses smeared his arrows with a number of poisons, including snake venoms and extracts of *Helleborus orientalis*. Circe, one of the first great sorceresses, is described as using poisons to subdue men
14.	Seventh century BC	The famous Indian surgeon Sushruta defined agadatantra, a term akin to the modern term ''toxicology.'' The science of agadatantra deals with the diagnosis and treatment of any person bitten by poisonous insects or venomous reptiles or affected by any natural, artificial, or compound poison
15.	600 BC	The Indian physician Charaka detailed the poisons found in India in his *Charaka Samhita*
16.	525 BC	Psammentius, the king of Egypt, was forced to drink ''bull's blood,'' which killed him. ''Bull's blood'' was believed to be a poisonous substance at that time
17.	Sixth century BC	One of the foremost Indian experts in the science of toxicology, Kashyapa, flourished during the times of Buddha. He was able to cure snakebites successfully
18.	*c.* 500 BC	Han Chinese were using poisoned arrows
19.	Fifth century BC	Hippocrates (460–*c.* 370 BC), the ''father of medicine,'' suggested methods of managing poisoned patients that rely primarily on limiting the absorption of toxic agents
20.	400 BC	1. Hydrocyanic acid was known as a poison. This acid was being distilled from the kernels of peach and other cyanogenetic plants at this time 2. Persian Queen Parisatys eliminated her daughter-in-law by dexterously poisoning the knifeblade she used to carve meat for her dinner 3. Book of Job speaks of poison arrows (Job 6:4) 4. The historian Ctesias first described the mythological animal, the unicorn. It was believed that those who drank from its horn were protected from stomach trouble, epilepsy, and poison. According to Ctesias, the unicorn was very fleet of foot and difficult to capture. The actual animal behind Ctesias' description was probably the Indian rhinoceros. The unicorn's horn was to gain reputation as a poison remedy once again during the Middle Ages
21.	399 BC	The Athenian philosopher Socrates (*c.* 470–399 BC) was executed by asking him to drink a cup of poison hemlock (*Conium maculatum*). Poison hemlock (also known as ''spotted hemlock'') was widely used by the state as a method of execution at this time
22.	Fourth century BC	1. Aristotle (384–322 BC) described the preparation and use of arrow poisons 2. Theophrastus (*c.* 370–286 BC) referred to poisonous plants in his *De Historia Plantarum*. The ninth book of this encyclopedia mentions several poisonous plants such as aconite, hellebore, mandrake, and henbane
23.	331 BC	A series of deaths occurred in Rome, which were earlier attributed to pestilence. A slave revealed that the deaths were actually the result of a poison administered by a group of matrons. A search of women's houses revealed concoctions, which the women were ordered to consume. They all perished. Further investigations revealed 170 accomplices, who were tried and all found guilty. According to the Roman historian Livy (59 BC–17 AD), this was the first poisoning trial in Rome
24.	325 BC	Diodorus Siculus, in his account written during Alexander the Great's campaign in western India, mentioned that Hindus prepared a decoction of poison by decomposing snakes
25.	322 BC	Athenian statesman Demosthenes (385–322 BC), one of the greatest Greek orators, committed suicide by taking poison hidden in his pen to escape his enemies
26.	Third century BC	Apollodorus of Alexandria writes *Peri therion (On poisonous animals)*, a definitive work on animal poisons. This work is later lost, but revived by Nicander of Colophon in his poems.

Table 1 Continued

No.	Year	Event
27.	Second century BC	Nicander of Colophon (204–135 BC), working in the intellectual atmosphere created by Attalus III, wrote two poems, *Theriaca* (a 1000-line poem, dealing with poisonous animals) and *Alexipharmaca* (a 600-line poem, dealing with antidotes), that are among the earliest works on poisons. Theriac is a term derived from the word theria (dangerous or poisonous beasts). *Theriaca* is one of the earliest works on poisonous animals
28.	200 BC	First known instance of mass poisoning. Some 190 matrons, mostly of patrician birth, were executed for poisoning
29.	183 BC	Carthaginian general, Hannibal, one of the foremost military commanders in history, took his own life with cyanide
30.	138–133 BC	Attalus III, the last king of Pergamon in Asia Minor, cultivated poisonous plants, and experimented on condemned prisoners
31.	First century BC	The king of Pontus (in modern Turkey), Mithridates VI (lived *c.* 132–63 BC; reigned 120–63 BC), was fanatically fearful of poisons and developed one of the first known universal antidotes, mithridatum
32.	81 BC	The Roman dictator Sulla issued *Lex Cornelia*, the first known law in human history against poisoning. According to this law, poisoners, if they belonged to the nobility, would face exile or loss of property; if they belonged to the lower ranks, they would be thrown to the wild beasts
33.	30 BC	Cleopatra (69–30 BC) committed suicide (August 30) using the venom of an asp
34.	14 AD	Laurel water on figs was used by Livia (58 BC–AD 29) to kill her husband Augustus (31 BC–14 AD). Many historians however think that this is not true
35.	54 AD	Locusta, one of the most infamous poisoners of all time, was hired by Agrippina, Nero's mother, to poison Claudius, her husband and Nero's stepfather, with poisonous mushrooms. Some versions assert that the poison used was arsenic
36.	55 AD	Locusta fooled Britannicus, Nero's stepbrother, into drinking a soup laced with arsenic. An unusually hot soup was prepared which was officially tasted, but then required additional cooling before the intended victim took it. During the time of additional cooling, arsenic was slipped into the soup
37.	First century AD	1. The Roman naturalist and historian Pliny the Elder (*c.* AD 23–79), wrote *Naturalis Historia* in 37 volumes. Books XX–XXXII deal with medicine. They described the biologic effects of poisonous plants and animals. Curiously, Pliny the Elder died of a poisonous gas in 79 AD – from exposure to fumes from the eruption of Mount Vesuvius 2. Andromachus (AD 37–68) refined mithridatum. The new recipe became known as theriac of Andromachus 3. The Greek surgeon Pedianos Dioscorides of Anazarbus – generally known simply as Dioscorides – (AD 40–80), and widely considered as the father of materia medica, compiled the first herbal in which he described 1000 simple drugs, 600 plants, and 35 animal products. His *De Materia Medica*, written in Greek, remained an authoritative text for the next 1600 years 4. Roman Emperor Trajan (98–117 AD) was so wary of wolfsbane plant (*Aconitum napellus*, referred to by Ovid as ''stepmother's poison'') that he banned its growth in Roman domestic gardens
38.	Second century AD	Greek physician Galen (?131–201) prepared nut theriac – a remedy against bites, stings, and poisons – for Roman emperors. He wrote *De Antidotis I et II*, which provided recipes for different antidotes, including mithridaticum and panacea
39.	640 AD	Paul of Aegina wrote *Epitomae Medicinae Libri Septem*. Book five deals with toxicology, specifically bites and wounds of animals
40.	Ninth century	Ibn Jabir wrote *Book on Poisons*. Al-Tabari (born *c.* 810) wrote the *Paradise of Wisdom*. Ibn Wahshiya (late ninth century) wrote *Book on Poisons*. All three books deal with poisons
41.	10th century	1. Parts of *Liber Continens* of al-Razi (860–932) and *Canon Medicinae* of ibn Sina (980–1037) deal with poisons 2. An Arabian leader Hassan-Ibn-Sabbah wielded power by providing his followers with hashish, a potent form of marijuana
42.	1198	Moses Maimonides (1135–1204), a Jewish philosopher and physician in the service of the Sultan of Egypt, wrote *Treatise on Poisons and Their Antidotes*. He discussed suctioning to remove superficial poisons and emesis to reduce absorption. However, antidotes like theriac and mithridatium were still recommended
43.	1216	John, King of England (1167–1216) was murdered by toad toxins (October 18–19)
44.	13th century	1. English philosopher Roger Bacon (1214–1294) recommended potable gold (gold dissolved in acid) for poisoning. It was in fact supposed to be a panacea 2. Petrus of Abano (1250–1316), a professor of medicine at the University of Padua, wrote *De Venenis*, a book on poisons, which would remain popular for many generations
45.	1419	Members of a group known as the Venetian Council of Ten carried out murders by poison for a fee
46.	1499	Amerigo Vespucci, the famed explorer, described natives chewing coca leaves
47.	1527	Philippus Aureolus Theophrastus Bombastus Von Hohenheim (Paracelsus 1492–1541), the unconventional and indefatigable medical practitioner, publicly burned the books of Avicenna and Galen (on June 24), thus heralding the new age of experimental toxicology. His use of mercury in the treatment of syphilis led to accusations by his detractors of poisoning, to which he wrote the *Third Defence*, which includes the famous phrase, ''What is there that is not poison? All things are poison and nothing is without poison. Solely the dose determines that a thing is not poison.''

Continued

Table 1 Continued

No.	*Year*	*Event*
48.	1533	Catherine de Médicis (1519–1589), one of the greatest poisoners in France, married the Dauphin (later Henry II). Pope Clement VII, her uncle presented Francis I (bridegroom's father) with a piece of unicorn's horn. Unicorn's horn – first described by the historian Ctesias in around 400 BC – once again found favor as a universal remedy for poisons. So afraid of poisoning were kings at this time that unicorn's horn became part of official regal dowry. A legend was rife at this time that the unicorn purified poisoned waters with its horn so that other animals might drink. Since it was very costly, it could only be used by the kings and nobles. It was probably the tusk of a marine mammal – the narwhal, or perhaps the tusk of a rhinoceros
49.	16th century	Bezoar stones were very popular as universal remedies against poisons. These were actually fossilized concretions formed within intestines of animals, containing calcium phosphate and carbonate and not infrequently fragments of unaltered bone. They could be animal gallstones too. Charles IX of France (1550–1574) (son of the famous French poisoner Catherine de Médicis) was very proud of his possession of a bezoar stone, and though the noted surgeon Ambroise Paré (1510–1590) of Paris told him of its uselessness, he wouldn't believe him. He actually conducted an experiment on a condemned criminal, who was first given bichloride of mercury, and then the bezoar stone. The prisoner died an agonizing death within 7 h
50.	1534	Pope Clement VII (1478–1534) was murdered (on September 25) with poisonous mushrooms (*Amanita phalloides*)
51.	1542	The last legal execution by boiling was performed on Margaret Davie, who had ''pouysoned three households that she dwelled in''
52.	1543	15 December: a Franciscan monk called John of Ragusa offered the Venetian Council of Ten a selection of poisons, and stated his terms for killing various eminent personages. The rate offered was 500 ducats for the Great Sultan, 150 for the King of Spain, 100 for the Pope, 60 for the Duke of Milan, and 50 for the Marquis of Mantua. The offer was accepted the next year. Results are not known
53.	1566	The Paris Parliament prohibited the use of antimony, because of its rising use as a homicidal poison
54.	1596	Edward Squires was hired by Spain to poison Queen Elizabeth I by smearing an opium-based poison on the pommel of her saddle
55.	1613	The Countess of Somerset was found guilty of using corrosive sublimate (mercuric chloride) to murder Sir Thomas Overbury while he was imprisoned in the Tower of London
56.	1659	Hieronyma Spara of Rome – an astrologer, a sorceress, and a poisoner – was conducting a lucrative business selling poisons to young married women keen to do away with their husbands. She formed a society in which she taught women how to murder their husbands by means of poison. Her poison was a special concoction known as aquetta di Perugia. She was executed the same year
57.	1662	Louis XIV (1638–1715), king of France (1643–1715), issued a decree forbidding apothecaries to sell poisons to anyone unknown to them. In addition, purchasers were required to sign a register
58.	1666	Many American soldiers died of accidental poisoning with *Datura stramonium* (jimsonweed). The incident occurred in the early American colony, Jamestown, Virginia, when a shortage of food led them to scavenge among the fields for something to eat. Jimsonweed is a corruption of Jamestown weed
59.	1667	Madame de Montespan, the mistress of King Louis XIV, attempting to poison her rival and the King, started buying poisons from La Voisine. Continued buying till 1680, when La Voisine was finally burnt at the stake
60.	1676	Marquise de Brinvilliers of France (July 22, 1630–July 16, 1676), one of the worst mass poisoners in history who is supposed to have killed over 100 people with arsenic, was decapitated on July 16
61.	1679	1. Louis XIV, fearing for his own life, instituted la Chambre Ardente (the fiery room), or la Chambre de Poison, a special court to try poisoners (April 1679). The Affaire des Poisons (the affair of the poisons), one of the most sensational criminal cases of seventeenth-century France, revealed that nobles, prosperous bourgeois, and the common people alike had secretly been resorting to female fortune-tellers – at that time numerous in Paris – for drugs and poisons, for black masses, and for other criminal purposes 2. Jean-Baptiste Racine (1639–1699), French dramatic poet and historiographer, was accused by Catherine Deshayes (La Voisine) of having poisoned his mistress and star actress, the Marquise du Parc, but no formal charges were laid and no consequences ensued
62.	1680	Catherine Deshayes (1638–1680) a.k.a La Voisine, was tried for poisoning several thousand people, including over 2000 infants. La Voisine's daughter and accomplices testified that even King Louis XIV's mistress Mme de Montespan had been buying poisons from her (since 1667). Montespan was trying to poison her young rival Mlle de Fontanges. King Louis suspended the public proceedings after the accusations against Mme de Montespan but ordered the continuation of the inquiry. La Voisine was found guilty and burnt at the stake on February 23, 1680, thus ending the career of one of the worst mass poisoners of all time
63.	1719	Madame Giulia Toffana (*c.* 1635–1719), another mass poisoner, was executed at Naples
64.	1752	Mary Blandy, a 31-year-old spinster, was tried at Oxford for murdering her father with arsenic. She was found guilty and hanged
65.	1765	Fontana of Italy studied the effect of viper venom and other toxic substances on animals and concluded that drugs act on one type of body tissue

Table 1 Continued

No.	*Year*	*Event*
66.	1769	Secundus designed a stomach pump, making it easier to wash out poisons
67.	1773	Scheele described the nature of charcoal adsorption. Lowitz (1785) confirmed findings
68.	1775	Karl Wilhelm Scheele (1742–1786) discovered that he could change arsenious oxide to arsenious acid, which in contact with zinc produced arsine. This discovery later played a great part in the forensic detection of arsenic
69.	1776	Thomas Hickey unsuccessfully attempted to assassinate George Washington by poisoning his dish of green peas. Hickey was hanged, and became the first American executed for treason
70.	1787	Mathieu Joseph Bonaventure Orfila (1787–1853), the French toxicologist who is widely regarded as the father of toxicology, was born on April 24
71.	1799	Humphrey Davy described the effect of laughing gas on the human body
72.	1805	1. German apothecary Sertürner isolated morphine from opium 2. Philip Physick, an American surgeon, employed the pump designed by Secundus (36 years earlier) to attempt gastric lavage. He washed out the stomachs of two children who had ingested opium
73.	1809	Poisoner Mary Bateman, ''the Yorkshire witch'', was executed
74.	1813	1. Orfila published his *Traité des Poisons*, which would soon become an authoritative work on toxicology 2. M. Bertrand, a French chemist, heroically demonstrated the antidotal power of activated charcoal, by ingesting an overdose of arsenious trioxide mixed with charcoal. He survived
75.	1819	Caventou and Pelletier isolated strychnine from *Nux vomica*
76.	1820	Desosse found quinine in the bark of cinchona tree. Runge found caffeine in coffee
77.	1826	Giesecke discovered coniine in hemlock
78.	1828	Possell and Reimann isolated nicotine from tobacco
79.	1829	Sir Robert Christison (1797–1882), Professor of Forensic Medicine at Edinburgh, published *Treatise on Poisons*, which for many years was regarded as the standard work on toxicology in the English language
80.	1830	French chemists isolated amygdalin from bitter almonds
81.	1831	Touery, a French pharmacist, made a dramatic demonstration of the antidotal powers of activated charcoal before the French Academy of Science. He ingested 10 times the lethal amount of strychnine, and then took activated charcoal. He survived. He thus reenacted the heroic demonstration made 18 years previously by his countryman M. Bertrand, only this time the demonstration was made before a respectable scientific body
82.	1832	1. Codeine purified from opium 2. *Poisons and Asphyxia* by Henry Coley was published in New York. This was one of the earliest books to discuss toxicology scientifically
83.	1833	Mein extracted atropine from deadly nightshade
84.	1836	An English chemist James Marsh (1794–1846) developed the Marsh test for detecting arsenic in human tissues. This proved a boon for forensic toxicologists, who till now had no test to prove the presence of arsenic in human tissues. The ''age of arsenic'' (15th–18th century) came to an end
85.	1838	Duflos described wet ashing. This technique was later developed by Fresenius and von Babo in 1844
86.	1839	Orfila became the first toxicologist to extract arsenic from human organs (in the case of the assassin–suicide Soufflard). Previously only the gastrointestinal contents were used for analysis
87.	1840	1. Marsh test was practically put to use, for the first time, in the great arsenic homicide case of Lafarge. Marie Lafarge was suspected of poisoning her husband Charles Lafarge with arsenic. She was found guilty and sentenced to life imprisonment 2. Burton reported a blue line on the gums in victims of chronic lead poisoning. This came to be known as the Burtonian line, and became a very important diagnostic sign of chronic lead poisoning
88.	1842	German chemist Hugo Reinsch introduced Reinsch's test – a new test to detect arsenic
89.	1844	Fresenius and von Babo devised a scheme for the systematic search for all mineral poisons. They used wet ashing with chlorine
90.	1850	Quantitative determination of metals in organs became possible. Metal is weighed as the sulfate or oxide
91.	1851	1. The UK passed the Arsenic Act, in an attempt to control the availability of arsenic, which was being commonly used for homicides. 2. Belgian toxicologist Jean-Servais Stas (1813–1891) developed the first ever method to detect alkaloids from biological specimens, while investigating the alleged poisoning of Gustave Fougnies by nicotine
92.	1852	Marie Lafarge (see entry for 1840) was released by Napoleon III, but died the same year
93.	1853	Alexander Wood perfected the hypodermic syringe, paving the way for emergence of morphine addicts. Ironically, his aim was to reduce opiate addiction by circumventing the oral route
94.	1862	The electrolyte deposition method was first used for quantitative determination of metals in organs. Previously sulfate or oxide of metal was the weight for such quantitative determination
95.	1865	Microsublimation was first demonstrated by Helwig
96.	1867	1. Theodore Wormley published *Microchemistry of Poisons* 2. Schmiedeberg developed a method to determine levels of chloroform
97.	1868	Hofmann developed isonitrile reaction for chloroform

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Table 1 Continued

No.	*Year*	*Event*
98.	1870	Lieben developed the iodoform test for alcohol
99.	1874	Selmi showed that a substance (reported to be morphine) isolated from the organs of a body that had been buried 2 weeks was in reality a morphine-like ptomaine or cadaveric alkaloid. Many other alkaloid-like ptomaines have since been discovered
100.	1880	Fodor developed a method of quantitative determination of carbon monoxide in the blood
101.	1887	L. Edeleano, a German scientist, synthesized amphetamine, the first member of this class to be synthesized
102.	1888	Schwartz developed the resorcin reaction for chloroform
103.	1898	1. Eduard Schiff, a dermatologist, showed that arsenic might be found with astonishing frequency in hair. He suggested that hair should be tested as a standard step in any investigation of possible poisoning 2. Bayer marketed heroin as a substitute for morphine. Ironically, the idea was to reduce addiction, but heroin would emerge as a greater scourge
104.	1906	Nicloux published a micromethod for the quantitative determination of alcohol in blood
105.	1910	Russian botanist Mikhail Semyonovich Tsvet (1872–1919) published his book describing adsorption chromatography. This technique and its modifications were to become very important later in the detection of poisons
106.	1913	J.J. Thomson (1856–1940), the discoverer of electrons, built the first mass spectrometer, known as the hyperbola spectrograph
107.	1927	Gordon Alles discovered the major physiological effects of amphetamine by self-administering this drug
108.	1932	Swedish scientist Erik Matteo Prochet Widmark (1889–1945) measured ethyl alcohol in the blood to calculate intoxication
109.	1944	Gas chromatography, a strong technique to detect poisons, was first carried out in Austria by the chemist Erika Cremer
110.	1947	Sir Bernard Spilsbury (1877–1947), who was depressed during the last years of his life, took his own life by gassing himself with coal gas (December 17)
111.	1954	R.F. Borkenstein, captain of the Indiana State Police, invented the breathalyzer for field sobriety testing
112.	1956	1. Golay first showed wall-coated open tubular (WCOT) columns for gas chromatography to be theoretically ideal 2. The infamous Minamata Bay disaster (poisoning due to methyl mercury) struck Japan. More than 17 000 were affected
113.	1957	Kenneth Barlow, a 38-year-old male nurse, killed his wife by insulin. This was the first known case of murder using this novel drug. He was found guilty and sentenced to life imprisonment
114.	1958	The infamous Kerala food-poisoning tragedy occurred in Kerala, India. Wheat flour and sugar had inadvertently been stored in the same cabin on a ship as parathion, and the parathion leaked into the flour and sugar. Over 1000 people were poisoned subsequently, of whom more than 100 died
115.	1962	Rachel Carson published *Silent Spring*, in which she successfully argued the case against pesticides. Although highly controversial, the book stimulated an organized approach to the study of chemical effects on ecosystems
116.	1968	American Academy of Clinical Toxicology (AACT) established. First issue of *Clinical Toxicology* appeared
117.	1978	Georgi Markov, a 49-year-old Bulgarian defector to the UK, was shot at the back of his right thigh, on September 7, with a pellet of ricin. He died 4 days later on September 11. This was the first known case of assassination with ricin
118.	1983	Using protocols written by David L. von Minden, the US Navy adopted SIM (Single Ion Monitoring) gas chromatography–mass spectrometry confirmation of the THC metabolite of marijuana, establishing the procedure as the ''gold standard'' for drug confirmation in the USA
119.	1984	2000 people died in Bhopal, India due to accidental release of methyl isocyanate (MIC) from a small pesticide division of Union Carbide Company manufacturing carbaryl (December 2)
120.	1988	George Trepal, a member of Mensa, killed his neighbor Peggy Carr by tampering with her Coca-Cola bottles and mixing in thallium. One of her sons was permanently disabled by the effects of thallium. Trepal was convicted of first-degree murder and sentenced to death in 1991
121.	1991	President Zachary Taylor's (1784–1850) body was exhumed on June 17 to test for arsenic poisoning. It was increasingly suspected that he had been poisoned by the pro-slavery faction. Nothing was found however
122.	1992	A report of the first and only poisonous bird, the hooded pitohui (*Pitohui dichrous*), was published in *Science*. It was found in Papua New Guinea: the skin and feathers of this bird contain almost the same homobatrachotoxin as the poison-arrow frogs
123.	1997	Thirty-nine unidentified flying object cult members committed suicide with phenobarbital and vodka (March 26)
124.	2000	Dr. Harold Shipman – one of the most notorious mass poisoners of modern times – was convicted at Preston, UK on January 31, of murdering 15 of his patients by administering lethal doses of diamorphine (pharmaceutical heroin). Investigations indicated that, during his working life, he killed about 220–240 of his patients. Shipman hanged himself at Wakefield Prison on January 13, 2004
125.	2003	V.V. Pillay, one of the greatest Asian toxicologists, published his definitive *Comprehensive Medical Toxicology*. A number of poisons native to Asia and their treatments are described

by poisonous insects or venomous reptiles or affected by any natural, artificial, or compound poison.

Another popular Indian legend related to poisons is about Lord Shiva, whose neck turned blue when he drank the deadly poison produced by the churning of the ocean, through which he saved the world from destruction. For this reason, Lord Shiva is also known in India as Neelkanth (one with a blue throat).

Historical Beginnings

Modern humans (*Homo sapiens*) appeared in Africa and possibly in Asia perhaps about 100 000 years ago and eventually migrated to Europe. Among these European peoples, the best known are the Cro-Magnons. The emergence of fully modern humans in other areas of the world seems to have occurred 30 000–15 000 years ago and involved various migrations and the intermingling of different populations. Humans learned to write and record their experiences in about 5000 BC. The history of toxicology from 100 000 to 5000 BC can only be extrapolated from available anthropological evidence.

Primitive humans must have observed that animals intuitively avoided certain plants. This may have aroused curiosity, and it must have required only a little experimentation to discover that the juices of these plants could kill easily. Poisonous plants such as curare, strophanthus, oleander, aconite, calotropis, *Abrus precatorius*, and *Ricinus communis* must have been the first to be noticed.

Since early humans were essentially hunters, the next logical step was to smear the tips of their arrows with the juices of these plants. The observation that animals could be killed faster with this method must have given them a sense of immense power. Even today, many tribal people hunt with poison-tipped arrows. Many Amazon tribes hunt with darts smeared with the juice of *Strychnos toxifera* (curare) or other similar plant poisons. They even grade the strength of their poison according to the number of trees a monkey can jump through before falling from a poisoned dart. If a monkey falls after jumping through just one tree, it is called one-tree poison, which is considered strong enough for hunting. If a monkey jumps through as many as three trees before falling, it is a three-tree poison, which is too weak for hunting.

The observation of present-day tribes preparing poisons from poisonous plants is akin to viewing the past through a time machine. Cultural anthropologists inform us that not much has changed in their practices over the centuries. Amazon Indians strip the bark of poisonous trees (e.g., *S. toxifera*), pound it, mix water thoroughly with the fibrous pulp, and boil to concentrate it. Finally, they add juices of other trees (e.g., the kiracaguero tree) to produce a sticky syrup, which can easily be smeared on the tips of their arrows. These tribes have been known to mix other poisonous substances in the concoction, including the fangs and livers of venomous snakes and spiders and even the stingers of poisonous ants.

Present-day tribes throughout the world carry out similar practices. The Bushmen of the Kalahari desert use the intestine of a caterpillar for poisoning their arrows, whereas the Chocos of Colombia tip their darts with a poison excreted from the skin of small but brilliantly colored frogs. The frogs are stimulated to perspire, their sweat is collected, and darts are dipped into the sweat. A few frogs yield sufficient poison for more than 100 arrows. Pygmies poison their arrows with red ant substances.

The realization that those very same animal products and plant juices could help kill human beings too must have aroused latent homicidal tendencies. At last there was a weapon which could enable you to strike surreptitiously without coming into the forefront. All that was needed was somehow to mix the juices into the enemy's food. Thus arose the first homicidal poisoner.

Nobody knows who was the first homicidal poisoner, or even when, where, and what poison was used, because there are no written records. However, reasonable guesses can be made. There was no single first homicidal poisoner; there were probably several, spread over a large triangular area ranging from China and India in the orient to Greece and Italy in the occident and Egypt in the south. These are the regions that saw the emergence of the earliest "intelligent" civilizations, and it is only reasonable to assume that these civilizations were the first to discover the use of poison to their advantage. These are also the regions rich and abundant in the previously mentioned toxic plants and animals.

The Toxicology of the Egyptians

Humans learned to write in about 5000 BC, and from this point onward, the history of toxicology is clearer. The earliest of all poison recipes can be gleaned amid Egyptian papyrus rolls dating back to about 4500 BC, now preserved in the Louvre museum in Paris. Three millennia before Christ, Menes, the first of the Pharaohs, is reported to have cultivated and studied poisonous and medicinal plants and to have accumulated animal, mineral, and vegetable poisons. In *Ebers Papyrus*, more than 800 recipes are described, many containing recognizable and identified poisons: for example, hemlock, aconite, opium, and some

toxic heavy metals, such as lead and antimony. Some of the pharaohs are known to have experimented with poisons, perhaps for practical matters of government and state.

Toxicology in the Greek Period

The mythology and literature of classic Greek history show a considerable knowledge of poisons, although in ancient Greece autopsies were not performed. In the *Odyssey of Homer*, Helen is described as discreetly introducing into the wine of Telemachus and Menelaus a drug that acted as a powerful anodyne. In Greek legend, Hecate was knowledgeable about aconite, Medea was familiar with the properties of colchicum, and Hercules is said to have met his end from wearing a shirt after his wife had impregnated it with poison. The first professional treatment of toxicology appears in various Greek writings in approximately the third and fourth century BC. Thus, Theophrastus (370–286 BC), a pupil of Aristotle, included numerous references to poisonous plants in his work *De Historia Plantarum*. Nicander of Colophon (204–138 BC) wrote two treatises, which are the most ancient works devoted entirely to poisons. One was on snake poisons and the other on plant poisons, including opium, henbane, poisonous fungi, colchicum, aconite, and conium. Nicander classified poisons into those that killed quickly and those that killed slowly, and he recommended emetics in the treatment of poisoning, a recommendation that is valid even today.

The Greek physician Dioscorides (AD 40–90) classified poisons as: (1) animal poisons, such as from cantharides, toads, and snakes; (2) poisons from plants, including opium, hyoscyamus, mandrake, hemlock, aconite, cherry laurel, and yew; and (3) mineral poisons, including arsenic, copper, mercury, and lead. This simple classification (which, according to Indian mythology and tradition, was first used by Brahma) remained in use for many centuries and is still vaguely recognizable in modern classifications of poisons.

Poisons were used by the Greeks as a means of capital punishment, the best-remembered case being that of Socrates (who was made to drink from a cup of poison hemlock; similar cups of poison were offered to Plutarch, Midas, and Themistocles, among others). It was also used as a means of political assassination, although this was developed on a much greater scale by the Romans subsequently. Thus started the search for antidotes for poisons. In fact, it became a practical necessity if the king wished to survive in office.

Ancient Rome

From simple hunting to complicated court crimes, poison was dexterously used and women in ancient times were adept in the art of poisoning. In approximately the second-century BC, the Roman Senate is believed to have executed about 190 such women who are said to have hailed from noble families but were driven by jealousy, hatred, and revenge (Table 1).

In those days, little value was attached to human life and many people lived in fear of poisoning. This gave birth to amulet vendors, who developed charms and talismans to work as antidotes for poison.

The Persian Queen Parisatys (400 BC) eliminated her daughter-in-law by dexterously poisoning the knife blade she used for carving meat for her dinner. Locusta was another mastermind in the art of poisoning. She was commissioned by Nero's mother, Agrippina, to poison her husband, Emperor Claudius (54 AD).

Indeed, she received royal patronage and was appointed the State Poisoner. In pursuit of her art, she was liberally offered slaves on whom to try out her poisonous prescriptions, and her nefarious activities were kept alive through a school of well-trained students.

The Age of Arsenic

Italy was known for the Renaissance and its poisoners. Poisoning was rife throughout society, and there were many incredible stories relating to it. There were stories of poisons that could be smeared on the pages of a book so that anyone reading it would be poisoned through the pores of his or her fingers.

Arsenic was the favorite choice of all poisoners during this period because it had many qualities of an ideal homicidal poison. It was colorless, odorless, and tasteless; its symptoms resembled those of a natural disease, cholera; it was required in very small quantities (a pinch of arsenious oxide could kill as many as five people); it was readily available (it was used by arsenophagists to increase their sexual vigor and by women to improve their complexion); and no scientific test was known to detect it. In 1740, the celebrated English novelist Henry Fielding (1707–1754) appealed to scientists to make this poison visible in some way but was told that there was no way to do this.

So dreaded was this poison that it became variously known as the "king of poisons," "the poison of poisons," and "le poudre de succession" (inheritance powder). The period between the fifteenth and eighteenth centuries can rightfully be called "the age of arsenic" because poisoning with arsenic was rife

during this period. Other poisons were undoubtedly used as well, although to a lesser extent. This period may also be referred to as "the age of indiscriminate poisoning." People were poisoning their enemies seemingly for trivial reasons, simply because they knew they could get away with it.

The Borgias, a notorious Spanish family living in Italy, were the most feared poisoners during this time. So feared were they that a number of anecdotal stories were told about them. It was said that they had a special ring with a tiny poisoned spike. Anyone shaking hands with them would be clandestinely punctured and killed. One member of this family, Cesare Borgia (1476–1507), is reputed to have killed hundreds of his enemies with arsenic.

By the sixteenth century, Italian women had the reputation of being at the forefront of poisoning. It is said that they even prepared poisons for sleeping persons. These women did not hesitate to poison their husbands. Toffana was one such woman; she was popular in Naples for creating the perfect poison, called aqua toffana or aquettaa-di-Napoli, which was a tasteless, colorless, and odorless liquid. Six drops were enough to kill a person in a few hours. The Italians were so popular as poisoners that the British coined words such as "italianated" or "italianation" for secret poisonings.

The French were not lagging far behind in the world of poisons. Marie Madeleine d'Aubray (1630–1676; also variously known as Marquise de Brinvilliers or Madame de Brinvilliers) was so beautiful that no one suspected that she was engaged in poisoning, which she practiced on patients in hospitals she often visited on the pretext of charity. She was guillotined in 1676 after she had taken several lives, including those of her husband, father, two brothers, and one sister, in addition to the lives of her lovers and onlookers who stood in her way.

The age of arsenic was finally brought to an end by two celebrated toxicologists, a Spaniard turned Frenchman, Mathieu Joseph Bonaventure Orfila (1787–1853), and an Englishman, James Marsh (1794–1846). Marsh developed the celebrated Marsh test in 1836, by which arsenic could be detected very easily. Orfila used this test in a criminal case just 4 years later and won a conviction.

Antidotes through the Ages

The most famous example of an antidote was that devised by King Mithridates VI. He was king of Pontus in Asia Minor, living from 132 to 63 BC. The Roman scholar Pliny the Elder (AD 23–79) wrote extensively about him. Mithridates experimented with poisons, testing them on condemned criminals, and he also tried various antidotes to the poisons on these prisoners, either before they were poisoned or immediately after they were poisoned, to determine whether the antidotes were effective. In this way, he discovered various antidotes or what he considered to be antidotes against different poisons, and he compounded them together in order to produce a universal antidote that could neutralize any poison.

Adopting an overcautious approach, he then began taking this supposed universal antidote daily. It is often stated that the original recipe had more than 36 ingredients (according to the Greek physician Galen (AD 130–200) there were 54). Eventually, Mithridates was defeated by the Roman general and statesman Pompey (106–48 BC) and "holed up" in his fortress. He massacred his wives, concubines, and daughters and then took poison. However, protected as he was by a daily dose of his magnificent antidote, the poison failed to act. The antidote by this time was known as mithridatium. He had to get his Celtic soldier servant to stab him to death with his sword.

After Mithridates' defeat and death, Pompey discovered Mithridates' notebooks on antidotes for poisons, and so mithridatium became known in Rome. The Roman emperor Nero (AD 37–68) showed a great interest in poisons. Andromachus, one of Nero's personal physicians, improved the formula and it then became known as theriac of Andromachus, containing 64 ingredients, including the flesh of vipers. For some reason, people have always thought that the flesh of vipers is a good antidote to poison. Perhaps this thought arose because the snakes are poisonous but they do not die of their poison, so it is rather reasonable to think that the snakes' flesh acts as an antidote. Viper's flesh was a very common ingredient of any antidote developed in ancient times.

In the course of time, theriac became not only an antidote against poison but also a panacea against all diseases, and it was in medical use until the eighteenth century. To prevent fraud, in many cities, including Venice, Montpellier, Toulouse, and Strasburg, theriac was carefully compounded and prepared in public under official supervision. Even today, theriac jars can be seen in museums.

Other universal antidotes to poisons that survived and remained in popular use for centuries include bezoars (stomach stones) found in certain animals, particularly ruminants and some varieties of goats. These were first used in the Middle East and were introduced into Europe by the Arabs, who continue to have some faith in them even to this day. These stones were pulverized and put into wine to treat cases of poisoning, but small stones were also

Table 2 Twenty-five most notorious homicidal poisons and their major proponents

No.	*Poison*	*Major proponent*	*Details of the case*
1.	Aconite	Dr. George Henry Lamson (1853–28 April 1882) (male, UK)	Lamson, an English physician, was a morphine addict and needed funds. On December 3, 1881, Lamson visited his 18-year-old invalid brother-in-law, Percy Malcolm John, who lived at Blenheim House School at Wimbledon. In the presence of the school principal, Lamson gave his brother-in-law a capsule and a ready-cut piece of Dundee cake. He had bought aconitine, a little known vegetable poison at that time, from a manufacturing chemist on November 24, and had put it in the cake. Soon after giving the cake, he left, saying he had to take a train to Paris. Percy fell ill within 10 min of his departure and died later that night. Lamson was found guilty and executed at Wandsworth prison, after confessing to the chaplain
2.	Antimony	Dr. William Palmer (a.k.a. the Rugeley poisoner) (male, UK)	Dr. Palmer killed at least 14 people with antimony at the place of his residence, Rugeley (hence the name Rugeley poisoner). The death of his last victim John Parsons Cook aroused suspicion. An autopsy was ordered and small traces of antimony were found in the dead body. Palmer was found guilty and hanged outside Stafford Gaol on June 14, 1856
3.	Arsenic	Mary Ann Cotton (1833–24 March 1873) (female, UK)	It is difficult to find a single major proponent of arsenic, which has been called the ''king of poisons.'' Mary Ann Cotton was believed to have killed at least 20 people with arsenic. This included her husband, lover, her own young baby, stepsons, and many others. She was tried for the poisoning of her stepson. Her defense was that the dead boy had been poisoned accidentally by arsenic contained in green floral wallpaper used in his home. She was found guilty and executed by hanging on March 24, 1873. She had a young baby, who was forcibly taken away from her 5 days before her execution. Hieronyma Spara (died 1659), La Toffana (*c.* 1635–1719), and Catherine Deshayes (a.k.a. La Voisine) (1638–1680), may also be considered as major proponents of arsenic, but there is no unanimity among historians regarding the poisons they used
4.	Bacteria	Henri Girard (1912–1918) (male, France)	A number of bacteria have been used for murder. These include typhoid (Henry Girard, France), diphtheria (Arthur Warren Waite, USA) and plague (Pakur murder case). Henry Girard killed Louis Pernotte of France with typhoid cultures on December 1, 1912, and then killed Mme Monin in April 1918. He escaped justice, as he swallowed his own culture of bacteria and died. He is known as the first scientific murderer
5.	Cantharidin (Spanish fly)	Arthur Kendrick Ford (male, UK)	On April 26, 1954, 44-year-old Ford, office manager of a wholesale chemist's firm in London's Euston Road, having a charge of 26 people (22 women and 4 men), gave some of his female staff coconut candies laced with cantharidin. The idea was to make them sexually inclined towards him. Two women, Betty Margaret Grant (27) and June Florence Malins (19), died the next day. Ford was convicted of manslaughter and sentenced to 5 years in prison
6.	Chloroform	Adelaide Bartlett (female, UK)	19-year-old Adelaide married Edwin Bartlett in 1875. In 1885, she fell in love with Rev. George Dyson, and, in collusion with him, killed her husband with chloroform. On autopsy, a large quantity of chloroform was found in Bartlett's stomach. Dyson was known to have bought chloroform from various chemists just before the murder. However Dyson was never tried, and even Adelaide Bartlett was acquitted by jury for lack of sufficient evidence
7.	Copper	Pierre-Désiré Moreau (male, France)	Moreau, a 32-year-old Parisian, killed his two wives with copper sulfate, with the aim of receiving their dowry. He was guillotined in Paris on October 14, 1874 before a large crowd
8.	Cyanide (HCN, prussic acid)	Richard Brinkley (male, UK)	A carpenter by trade, Brinkley first killed a 77-year-old widow, Johanna Maria Louisa Blume, after fraudulently getting her signatures on her will, giving all her property to him. When the dead woman's daughter refused to part with property (she employed a solicitor instead), he went on to eliminate two witnesses, whose signatures were also taken fraudulently. By an error a different couple was killed, taking his total toll with cyanide to three. Brinkley was hanged at Wandsworth Prison on August 13, 1907

Table 2 Continued

No.	*Poison*	*Major proponent*	*Details of the case*
9.	Digitalis	Dr. Edmond de la Pommerais (male, France)	Pommerais had a modest medical practice in Paris in 1859. In 1861, he married the rich Mlle Dubisy, and her mother died shortly afterwards. A little later Pommerais' mistress Mme Séraphine de Pawr also died, apparently of cholera. When Pommerais applied for her insurance money of half-a-million francs, the company began an investigation, which led to exhumation of Mme de Pawr's body. Massive amounts of digitalis were found in her body. Pommerais was guillotined in 1864. He continued pleading his innocence until the end
10.	Gas	Reginald Ivor Hinks (male, UK)	Born in 1901, Hinks was a Hoover salesman in Bath, UK, in 1933. He married Constance Anne Pullen, a divorcée with one child, who lived with her 85-year-old father James Pullen. After moving into Pullen's house, Hinks murdered the old Pullen by shoving his head against the gas oven; the old man died of gas poisoning. Hinks was hanged at Bristol on May 4, 1934
11.	Glibenclamide (oral hypoglycemic agent)	Reverend P (1978–1979) (male, Sri Lanka)	Reverend P, an Anglican priest in his early 60s, developed adulterous relations with Mrs. I. His problem was to remove his wife (Mrs. P) and Mrs. I's husband (Mr. I). This he safely did with glibenclamide, an oral hypoglycemic agent. He was a diabetic, and shortly before the murders, he had made a visit to the UK (in 1978), where he had bought 100 tablets of glibenclamide. The first to go was Mr. I (on August 10, 1978). Mrs. P was next to go on March 19, 1979. Both Reverend P and Mrs. I were found guilty and sentenced to death. On appeal Mrs. I was acquitted for lack of evidence. Reverend P received a presidential pardon, and was imprisoned for life. This case, which appeared in *Medicine, Science and the Law* 1999; 39: 354–358, only gives the initials of the characters instead of their full names
12.	Heroin (pharmaceutical)	Dr. Harold Frederick Shipman (male, UK)	Between 1990 and 2000, Shipman murdered an estimated 240 of his patients with diamorphine (pharmaceutical heroin). Shipman was convicted on January 31, 2000, at Preston, UK, of murdering 15 of his patients and of forging the will of one of them. He was sentenced to 15 concurrent terms of life imprisonment and told by the judge that in his case life imprisonment would mean that he would remain in prison until his death. Shipman hanged himself at Wakefield prison on January 13, 2004
13.	Hyoscine	Dr. Hawley Harvey Crippen (male, UK)	Crippen, an American doctor, came to England in 1900, with his second wife Cora Turner. He fell in love with his secretary, Ethel le Neve, and murdered Cora early in 1910, using hyoscine. Hiding her remains in the cellar, both Crippen and his secretary fled to Antwerp. He was brought back to England, tried, and found guilty and hanged on November 23, 1910
14.	Insulin	Kenneth Barlow (1957) (male, UK)	On May 3, 1957, Kenneth Barlow, a 38-year-old male nurse called a doctor to his house in Thornbury Crescent, Bradford (at 11.30 p.m.), saying that he suspected his wife had drowned in her bath. Attempts at artificial respiration had proved to be of no avail. A postmortem examination revealed four needle marks in the woman's buttocks (two in each buttock). Police suspected Barlow, because there were no signs of splash in the bathroom and his pyjamas were quite dry (contradicting his statement that he had given artificial respiration to his wife). Eventually insulin was detected at the injection sites. A novel defense put up by Barlow was that, just before death, his wife's body had discharged insulin in great quantities, reacting to a state of fear. However such physiological responses could not raise the levels of insulin to the level found in the dead woman's buttocks. Barlow was found guilty and sentenced to life imprisonment
15.	Morphine	Dorothea Nancy Waddingham (1935) (female, UK)	Waddigham was a 36-year-old self-styled nurse, who killed 89-year-old Mrs. Baguley and her 50-year-old daughter Ada Baguley with morphine in 1935. She had seen to it that Mrs. Baguley had first made a will in her favor. She was found guilty and hanged on April 16, 1936 at Winson Green Prison, Birmingham

Continued

Table 2 Continued

No.	*Poison*	*Major proponent*	*Details of the case*
16.	Mushrooms, poisonous (*Amanita phalloides*)	Julia Agrippina (16–59 AD) (female, Rome)	Agrippina was supposed to have killed a number of people with poisonous mushrooms (between 49 and 59 AD), including her two husbands, Passienus Crispus and Claudius I. She was helped by the court poisoner, Locusta, in her royal poisonings
17.	Nicotine	Hippolyte de Bocarme (1851) (male, Belgium)	Bocarme was a Belgian nobleman who murdered his brother-in-law (wife's brother) Gustave with nicotine. He was tried at the Palais de Justice in Mons on May 27, 1851 and found guilty. He was guillotined in July 1851
18.	Parathion (E-605)	Christa Ambrose Lehmann (female, Germany)	In February 1954, Lehmann bought five chocolate truffle candies, lacing one of them with parathion, a newly developed insecticide. She intended to give it to a female neighbor, who regarded Lehmann as an unwanted intruder. The unsuspecting neighbor preserved the candy for her daughter, who ate some and accidentally dropped some of it on the floor, whereupon a pet dog seized upon it, and ate it. Both the young girl and the pet dog died within a short time. Lehmann was found guilty and sentenced to life in prison. While in police custody, she confessed to having murdered her husband and father-in-law with the same poison
19.	Phosphorus	Louisa May Merrifield (1953) (female, UK)	Louisa Merrifield, in collusion with her husband, killed their employer Mrs. Sarah Ann Ricketts on April 14, 1953 with rat poison containing phosphorus. Louisa and her 71-year-old husband Alfred were tried for murder. Alfred was released, but Louisa was found guilty and hanged at Manchester's Strangeways prison on September 18, 1953
20.	Ricin	The KGB (suspected)	On September 7, 1978, Georgi Markov, a 49-year-old Bulgarian defector to the UK, was waiting for his evening bus home on Waterloo Bridge, London, when he was shot at the back of his right thigh with a pellet of ricin. The firing device was an umbrella, in which presumably a gas-powered device had been fitted. He died 4 days later on September 11. Pathologist M. Rufus Crompton conducted an autopsy on September 12, and preserved large blocks of tissue from the left and right thigh. A tiny hollow pellet made of 90% platinum and 10% iridium was recovered from the block from the right thigh. A mere 1.52 mm in diameter, it had two holes (0.34 mm wide) cut through it. No trace of ricin was ever found in Markov's corpse, but his symptoms pointed to ricin poisoning. It was presumed that the metal ball was full of ricin, a deadly poison lethal in very small quantities. The pellet could contain about 2 mg ricin, which is enough to kill a human being. After the collapse of communism in 1991, the new Russian government admitted that their predecessors had sanctioned several assassinations of Bulgarian defectors, including Georgi Markov
21.	Seconal	John Armstrong (1955) (male, UK)	John Armstrong was a 25-year-old Royal Navy sick berth attendant, who killed his 5-month-old son with seconal. At autopsy red skins were recovered from the dead child's stomach and windpipe. At first thought to be the skins of some poisonous berry, they soon turned out to be the remains of the gelatine capsules of the drug seconal. Both John and his wife Janet were arrested and tried for murder. Janet was acquitted. John was pronounced guilty, but was reprieved
22.	Strychnine	Ethel Lillie Major (1934) (female, UK)	Ethel Lillie Major killed her husband Arthur Major by mixing strychnine in his food. On May 22, 1934, Arthur ate some corned beef and was soon taken ill. Ethel had access to strychnine, which her father, an ex-gamekeeper, kept with him to eliminate vermin. While eating, Arthur had complained about the bad taste of corned beef and had thrown some of it to his neighbor's dog, who quickly lapped it up and died on May 23 after suffering muscular spasms. Arthur died on May 24, 1934 at 10.40 p.m. after suffering from severe convulsions and spasms. On postmortem examination, strychnine was found in his body. Ethel was found guilty and executed at Hull Prison on December 19, 1934

Table 2 Continued

No.	Poison	Major proponent	Details of the case
23.	Succinylcholine	Dr. Carl Coppolino (1967) (male, USA)	Carl Coppolino was a poor boy, who married Carmela, a doctor's daughter, and both went on to become doctors. Carl became an anesthesiologist. In 1962, Carl became infatuated with one Marjorie Farber, the 48-year-old wife of a retired army colonel. He killed Colonel Farber in 1963, with succinylcholine, an injection he had instructed Marjorie to administer. In 1965, he became infatuated with Mary Gibson, a 38-year-old divorcée. Within months – on August 28, 1965 – Carmela died, and within 5 weeks of her death Carl married the rich divorcée Mary Gibson. The bodies of both Colonel Farber and Carmela were exhumed. A puncture mark was found on Carmela's body. After a great deal of scientific testimony, Carl was found guilty of second-degree murder, and imprisoned for life
24.	Thallium	George Trepal (1988) (male, USA)	Trepal killed his neighbor Peggy Carr by spiking her Coca-Cola bottles with thallium, because their household listened to loud music, and Carr's dogs chased Trepal's cats. Both these things disturbed Trepal. He was found guilty and sentenced to death
25.	Venom (snake)	Dr. Grimesby Roylott (male, literary character, England)	Homicide with snakes appears such a natural death that no culprit has been found to date, although undoubtedly there should be several – certainly in Asian countries, where death with snakebites is so common that it does not raise an eyebrow. Sir Arthur Conan Doyle, in his story *The Adventure of the Speckled Band*, tells us how Dr. Grimesby Roylott kills one of his stepdaughters, Julia Stoner, with a snake (swamp adder). Two years later he tries the trick on the other stepdaughter, Helen (Julia's twin), but is accidentally bitten by the snake himself. Holmes and Watson find him dead in his room, with the snake coiling his head like a speckled band

mounted and worn as amulets as a protection against poison.

Another universal antidote was terra sigillata, a special clay earth from the island of Lemnos. To prevent fraud, this special clay was prepared in tablets and stamped with a seal, thus giving the substance its name. Later, other sources of similar earth were found in different areas of Europe, and in the sixteenth and seventeenth centuries mugs were made from it, from which anyone could drink without fear of poisoning.

Modern Era

> *We can never be fully in possession of a science until we know the history of its development.*
>
> Charles Greene Cumston

The period since the mid-1850s has seen great progress in the analysis of poisons. Today, with modern techniques and instrumentation, the most minute traces of alien compounds can be detected, not only from tissues and organs collected at the time of postmortem examination but also in biological samples such as blood and urine collected during life. The study of antidotes has become more scientific. We have moved from the age of mithridatium, bezoars, and terra sigillata to the age of physiological antidotes and chelating agents. A number of medical journals are devoted solely to the study of toxicology. Toxicology is taken up by promising young students as a career. It is no longer the murky, shady, crime-infested vocation of the poisoners; instead, it has become a true science pursued by brilliant investigators.

The number of poisoners in the modern world has certainly decreased, but by no means have they vanished altogether. Sporadic cases of homicidal poisonings still occur. Table 2 provides an idea of the amazing variety of poisons that poisoners have used during the past century. However, due to modern analytical methods, each one of them was apprehended and prosecuted.

Modern analytical methods in toxicology have also enabled historians to rewrite history. When the 12th president of the USA, Zachary Taylor (1784–1850), died, it was believed that he died of gastroenteritis. However, since he was opposed to slavery, it was increasingly suspected that he had been poisoned by people from the pro-slavery faction. It was believed that he was poisoned with arsenic since his symptoms were very similar to arsenic poisoning. The emergence of highly sensitive analytical techniques in toxicology convinced the coroner of Jefferson County, Kentucky, to allow his body to be exhumed on June 17, 1991. Gutzeit test, neutron activation analysis,

and X-ray microanalysis done on hair and nail samples showed that Taylor had not been poisoned with arsenic.

Such was not the case with Napoleon Bonaparte (1769–1821), however. A neutron activation analysis of his locks of hair showed high levels of arsenic, and many historians now think that Napoleon may have been poisoned with arsenic by his enemies while he was exiled on the island of St. Helena. Similarly, analysis of locks of Newton's (1642–1727) hair show that he may have suffered from mercury poisoning during the years 1692 and 1693. He recovered though, and he lived to be 85 years old.

See Also

History of Forensic Medicine; **Mass Poisonings**; **Toxicology:** Overview; **Venom**

Further Reading

Aggrawal A (1997) Poisons, antidotes and anecdotes. *Science Reporter* 26–29. [Also available online at http://prof_anil_aggrawal.tripod.com/poiso001.html].

Aggrawal A (2002) Poisons and antidotes through the ages, with special reference to Indian history and mythology. *Mithridata (Toxicological History Society Newsletter)* 12(2): 13–18.

Aggrawal A (2003) 250 greatest forensic scientists of all time. *Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology* 4(2): http://www.geradts.com/~anil/ij/vol_004_no_002/others/250.html; accessed October 29, 2003.

Aggrawal A (2004) Agrippina, the first forensic odontologist and the greatest poisoner in ancient Rome. *Mithridata (Toxicological History Society Newsletter)* XIV(1): 6–11.

Borzelleca JF (2001) The art, the science, and the seduction of toxicology: an evolutionary development. In: Hayes AW (ed.) *Principles and Methods of Toxicology,* 4th edn, pp. 1–21. London: Taylor & Francis.

Gallo MA (2001) History and scope of toxicology. In: Klaassen CD (ed.) *Casarett and Doull's Toxicology: The Basic Science of Poisons,* 6th edn, pp. 3–10. New York: McGraw-Hill.

Jones RG (ed.) (2002) *The Mammoth Book of Women Who Kill.* London: Robinson.

Pillay VV (2003) *Comprehensive Medical Toxicology.* Hyderabad, India: Paras.

Smith S (1952) Poisons and poisoners through the ages. *Medicolegal Journal* 20: 153–167.

Thompson CJS (1899) *Poison Romance and Poison Mysteries.* London: Scientific Press.

Thompson CJS (1931) *Poisons and Poisoners.* London: Harold Shaylor.

Trestrail JH III (2000) *Criminal Poisoning.* Totowa, NJ: Humana.

Trestrail JH III (2000) *Mithridata: The Newsletter of the Toxicological History Society – The First Ten Years (Jan 1991–July 2000).* Grand Rapids, MI: Center for the Study of Criminal Poisoning.

Wax PM (1994) Historical principles and perspectives. In: Goldfrank LR, Flomenbaum NE, Lewin NA, *et al.* (eds.) *Goldfrank's Toxicologic Emergencies,* 5th edn, pp. 1–20. Norwalk, CT: Appleton & Lange.

Wilson C (1989) *Written in Blood – A History of Forensic Detection.* London: Equation.

HUMAN RIGHTS, CONTROLS AND PRINCIPLES

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Introduction

International human rights law and international humanitarian law (IHL) are two different but related areas of law with the common goal of safeguarding the fundamental rights of the individual. International human rights law focuses on the relationship between the state and the individual. All human rights are considered to be interdependent, indivisible, and interrelated. The law applies to all people simply because they are human, and is therefore universal and inalienable. Humanitarian law focuses on issues arising in times of armed conflict, when many human rights may be restricted. It seeks to limit the effects of armed conflict on those who are not, or are no longer, participating in hostilities, and to restrict the means and methods of war to the attainment of the objectives of the conflict. These two branches of public international law are contained in international treaties and conventions and in what is known as "customary law" – a rule of conduct that as a result of long and consistent practice has come to be considered by states to be legally binding. The International Bill of Rights comprising the Universal Declaration of Human Rights (UDHR), the International Covenant on Civil and Political Rights, and the International Covenant on Economic, Cultural and