Understanding Poisons from a Creationist Perspective

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ABSTRACT

The problem of poisons is considered, and it is concluded that a false dichotomy exists between poisonous and non-poisonous chemicals. Nothing is toxic in small amounts, and all chemicals are toxic at high levels. Further, virtually all chemicals, even poisons and toxins, have an important function in life or human society. Because compounds can be used in a harmful way does not negate their importance when used appropriately. Fire serves us well by heating our homes, cooking our food and sterilising medical equipment, yet fire has caused the loss of an enormous number of lives. Likewise, many major poisons and toxins are shown to play critically important beneficial roles in society. It is not the compound that is the problem, but the use to which it is put. Actually, life could not exist without some compounds that are toxic to some lifeforms. Conversely, our body has a complex means of protecting itself from toxins which renders virtually all toxins harmless in the amounts to which most of us are exposed.

INTRODUCTION

Toxins are poisons produced by plants, animals and bacteria or found naturally in the air, water and soil. A poison is any substance that produces injury to the body by chemical means. Some are corrosives that destroy tissue directly; others are irritants that inflame mucous membranes. The two terms 'toxins' and 'poisons' are largely synonymous and are used here interchangeably. The term poison tends to be the lay term, while toxin is the scientific term.

The subject of poisons is burdened with many misconceptions and is far more complex than assumed just a few years ago. When reading about mercury or lead poisoning, or murders in which someone used a deadly poison such as arsenic, some may ask, *'Why would God create chemicals that cause so much harm to people?'* Atheists commonly argue that a loving God would not make deadly chemicals which have killed millions of people. Young concludes that germs and poisons are

> *'perfectly understandable in terms of evolution* [but] *make no sense whatever in terms of design by an infinitely intelligent, wise, and compassionate Creator'}*

Actually, evolution — specifically natural selection — can 'explain' either situation. If no poisons existed natural selection could explain this situation by explaining that poisons 'selected' to extinction those animals that had less defence against them. In fact, poisons that the body cannot easily handle occur relatively rarely in nature. Levy and Primack note:

> *'While there are some 7,000 plants and fungi that produce or contain toxic substances, only a few are really very dangerous. According to the Food and Drug Administration's National Clearing House for Poison Control Centers, there were only 7,710 cases of exposure to plant poisons recorded in 1975. Of these victims, 1,990 reported symptoms, 186 were hospitalized and 3 died. . . most plant poisonings are relatively mild and your overt overreaction can amplify the symptoms . . .'*[2]

A major reason for toxins in this post-Fall world is to maintain the ecological balance so necessary for life to exist on the Earth. An example is penicillin, a toxin to bacteria but harmless to humans, which has saved millions of lives. Most plants produce toxins to protect themselves from pathogens. Further, bacteria are necessary for life because they serve as recyclers of organic materials. Without them,

all of the organic nutrients would eventually become locked-up in non-bioavailable forms and eventually life would become extinct on Earth. The only concern is to prevent recycling until the animal is dead. This is the function of the animal's defence system, which includes the use of toxins.

The terms 'poison', 'toxic', 'pesticide' and 'herbicide' all imply that because some chemicals may function as toxins in some situations, they are therefore always detrimental to humans. The implied dichotomy between the words 'toxic' and 'non-toxic' is wholly artificial and impedes understanding the toxicity problem.[3] Chemicals are not toxic or poisonous, **only amounts are;** no chemical is toxic at low levels, and all chemicals are toxic in large amounts.[4] In Stevens' words, *'Anything in a large enough dose can prove toxic* '.[5]

Even water is toxic if certain amounts are ingested and can cause a coma or death if ingested in high levels during a short time period.[6] Such water intoxication is actually an excellent example of the fact that all substances are toxic in large amounts. Tisdale describes the result of water toxication:-

> *'The volume of water both inside and outside the cells increases, but the salt does not, and brain cells swell, then shrink .... Water intoxication can occur accidentally, especially in the medical treatment of a dehydrated person. But it happens most frequently among schizophrenics . . . schizophrenics sometimes have a compulsive need to drink water.'*[7]

And a Food and Drug Administration report stated they receive many reports of hospitalisations involving

> *'water intoxication of young infants. Preliminary reports indicate that three infants were admitted to the hospital with seizures and hyponatremia apparently associated with relatively large intakes of free water. The other two infants were reported to have low blood sodium levels on admission that were believed to be related to water ingestion.'*[8]

Oxygen is also necessary for life, but, as every nurse knows, excess amounts are lethal and lower excesses have been a major cause of blindness in premature babies. Oxygen toxicity develops when the $p(0_2)$ rises above 2.5 atm. (36.8 psi). The result is oxidation of certain enzymes, which damages the central nervous system and causes coma, and eventually death. A major problem in abiogenesis is how early life survived an oxygen environment, and for this reason evolutionists must postulate that a non-oxygen atmosphere existed at this time, that is, a **reducing atmosphere** (for the evidence against the reducing atmosphere hypothesis, see Thaxton *et al.*[9]).

Many poisons have critical uses in certain areas of life and society.[10] A poison is merely an **excess** amount of a chemical in the **wrong** place at the wrong time. Low amounts of many 'poisons' in the right cells are actually **necessary** for life, and all vitamins and minerals are toxic above certain levels. Vitamins A and E are critical for life but **highly** toxic if taken in high dosages. The standard vitamin-mineral reference lists toxicity data for all vitamins, minerals and food supplements.[11]

THALIDOMIDE: CURSE OR MIRACLE CURE?

The drug thalidomide became infamous for causing a large number of birth defects, primarily if taken at a certain time during pregnancy. Actually, only one of its enantiomers was a teratogenic agent which caused children to be born with missing or misshapen limbs.[1213] Although the image of this drug has caused researchers to avoid exploring its many potential uses, recent studies have found that it is among the most effective treatments known for leprosy and can also improve enormously the survival rate of patients who receive bone-marrow transplants.

Thalidomide has also been successfully used to treat other potentially fatal disorders, including **aplastic anaemia** and certain kinds of bone cancers. Aplastic anaemia is a deficiency in the quality or quantity of the erythrocytes caused by **aplasia,** a failure of a red blood-cell-producing organ to develop. Specifically, the bone marrow — where most blood cells are produced — fails to develop or becomes diseased. Thalidomide also reduces the **graft-versus-host disease** problem by moderating the voracity with which the grafted foreign tissue attempts to reject its new home. Nor is thalidomide the only toxin that is a miracle drug. In one listing of plant poisons, their use for medicine is obvious:

> *'The development of blatantly poisonous compounds by plants and fungi is extraordinary in the variety of toxins that they produce. These compounds are chemically very diverse and include powerful substances that affect heart muscle and blood pressure, smooth muscle relaxants, cyanides that block cell respiration, cell poisons that inhibit protein synthesis, hormone-like compounds, hallucinogenic chemicals, irritants, blistering agents, photosensitizers and plant allergens. Some act rapidly, causing instant irritation, nausea, vomiting and diarrhoea, while others are more insidious, producing deadly delayed reactions. While the development of these potent and sophisticated chemical defenses has helped plants and fungi avoid being eaten, these poisons have also caused deaths, pain, itching and a variety of ills to people who have either eaten or come in contact with them.'*[14]

All of these classes of poisons have become the miracles of twentieth century medicine, and more are being discovered all the time. Actually, the wonders of modern medicine are **primarily** due to the discovery of drugs which can cure or help persons survive what were once fatal diseases.

Toxins can also be critical for survival for other reasons. One example is the Pink Pigeon which lives on the island of Mauritius in the Indian Ocean, the island famous for being the home of the now extinct Dodo. The Pink Pigeon

may be alive today only because of a mechanism called **aposematism.** This mechanism uses chemicals as warning signals and for protection. In this case, humans or animals who dine on the Pink Pigeon become extremely ill. Animals soon learn this and avoid the bird.

Interestingly, the source of the birds' toxic chemicals is evidently from a fruit — the pigeons commonly dine on this fruit and accumulate the toxin without ill effects, but it poisons those animals who eat them.[15] Also, animals that defend themselves by toxins often use conspicuous colouration to easily differentiate themselves from other animals. This allows their predators to easily identify them and to avoid them.

Since high energy levels and low weight are critical for birds, obtaining the toxin from food rather than manufacturing it from scratch eliminates the need for them to use their own energy to manufacture the toxin themselves. Rarely do these toxins kill the predator; most often they make predators sick enough so that they avoid the animal which causes the problem. These mechanisms are **critical** to help maintain the balance of nature which is necessary for life to survive in the post-Fall world.

THE BOTULINUM TOXIN

The most poisonous substance known to mankind is botulin, a neurotoxin produced by the single-celled bacterium *Clostridium botulinum.*[16] The bacterium that causes it is an extremely common soil and water bacteria spore. The proper conditions cause the spore to develop into the rod-shaped bacterium *Clostridium botulinum.* Botulin is *'six million times more toxic than rattle-snake venom',* and a lethal dose for humans is a mere 1/10,000th of a milligram.[17] Botulin poisoning usually results from eating improperly canned or contaminated food, and produces muscle paralysis.[18]

The toxin firmly attaches itself to nerve endings and permanently blocks neurotransmitters — chemicals which allow the nerve impulse to travel from one nerve to another at the synapse junction. Binding to nerve endings prevents the release of the neurotransmitter acetylcholine. Similar to jamming a light switch permanently so it cannot be turned on, botulin blocks the nerves, preventing the brain's signals from reaching a muscle. If enough nerves are blocked, the muscle becomes severely weakened or paralysed. Death occurs because the chest muscles cannot perform their breathing function, producing suffocation.

Yet, this most dreaded of all toxins is a miracle drug for those suffering from **dystonias** and other health problems. Dystonias produce involuntary muscle spasms which cause the eyelids to blink or clamp shut, the neck to twist into painful contortions, the fingers to cramp, and vocal cords to freeze.[19] The dystonias in general result from excess nerve signals to the muscles, causing them to overreact. This uncontrolled muscle spasm can result from both voluntary and involuntary production of excessive electrical brain impulses.

Botulin treatment is also highly effective in about 85 per cent of patients with the cross-eye condition named **strabismus.** This malady is usually outgrown by about age six months, but if it persists surgery was often the only alternative until the development of botulin treatment. Strabismus is caused by an over-active eye muscle on one side and a weak muscle on the other. The brain processes light information picked up by the retina by combining both the left and right signals. If the weak eye is too far out of alignment with the dominant one, the brain relies solely upon the stronger eye signals. If this continues for too long, the brain becomes unable to interpret images from the weaker eye, thus lets it drift — a condition called **amblyopia** or lazy eye. As a result, the person can use only one eye and consequently has little depth of field and experiences major difficulty in judging distances. Amblyopia also carries considerable social stigma and often results in major psychological and social adjustment problems.

The surgical treatment involves cutting away a portion of the hyperactive muscle to weaken it and allow the other eye to line up properly. The new treatment uses precisely targeted injections of botulin to inactivate the spastic or hyperactive muscle. This technique in most cases restores normal control to the patient without the need for invasive surgery. Botulin weakens the spastic or over-developed eye muscles in the same way that it weakens the muscle pull of persons suffering from botulism toxin. Unfortunately, the results are not permanent — new nerve endings eventually replace those blocked by the drug. Nonetheless, it is now the most effective treatment for amblyopia and is regarded as an established medical procedure.

Botulin therapy is a major breakthrough for **blepharospasm,** an uncontrollable eye blinking that sometimes involves other facial, throat and neck muscles. It is also effective for both chronic writer's and musician's cramps — an especially severe problem for students and persons whose work involves much writing or the use of fingers such as musicians, especially violinists and pianists. Botulin also holds enormous promise for millions of Americans in helping to control spasticity and tics due to cerebral palsy or other causes.[20-23]

Success has also been achieved with severe stuttering by injecting the toxin into the vocal cords to provide potential relief for millions of sufferers. It is also effective for **spasmodic dysphonia,** a muscle spasm which affects the pharynx and results in an extremely strained voice.[24] The treatment involves injection of botulin into the thyroarytenoid muscles that control the vocal cords. Additionally, one of the most useful areas for botulin is the treatment of **spasmodic torticollis,** an extremely painful, debilitating neck spasm which causes the head to thrust about uncontrollably.[25]

Other uses include treatment of **laryngeal dystonia** (larynx muscle spasms which cause speech difficulties), and **temporomandibular dystonia** (involuntary movements

of the jaw, lower facial, and tongue muscles). It is even helpful for tremors such as **hemifacial spasm,** an involuntary twitching or contraction of the muscles on one side of the face.[26] The dystonia family of diseases affects about 390 people per million population. Before the botulin treatment, few effective methods existed to help the large number of people afflicted with these problems. One study found the botulin treatment success rate was 85 per cent in a long term follow-up.[27] Many persons assumed that these diseases were psychosomatic, and the discovery that they are not has both relieved sufferers and helped to reassure physicians that these patients are treatable.

Botulin is an extremely complex molecule — its molecular weight is a whopping 80 times that of insulin. Its large number of atoms must be assembled with the precision of a fine watch. Its commercial and laboratory production, primarily directed by Ed Schantz, is a complex speciality which still is more art than science. Schantz has spent almost a half century researching methods of effectively extracting the pure toxin from the bacteria. His lifetime experience was required to achieve the skill needed to isolate it effectively from the bacteria for therapy use. Because it is so toxic, a lethal dose is usually only about one-ten thousandth of a milligram.[28]

Ironically, the usefulness of botulin to the bacterium itself is not yet known. It is an anaerobic organism, once a major problem when home canning was common and food preservation techniques were less developed than today. Although one occasionally reads about cases, it is rare today because commercial canners must by law heat their products up to temperatures and pressures high enough to kill not just the bacterium, but also the botulism spores: Unfortunately this high heat-pressure level also destroys many of the food's vitamins.

ARSENIC — A POISON AND A VITAL MINERAL

Probably the most famous of all poisons, arsenic, is actually a vital mineral for many animal metabolic systems. It is commonly used as an insecticide or rodenticide, and most arsenic-based pest control products contain copper acetoarsenate, or calcium or lead arsenate.[29] Arsenic compounds cause death by interfering with the body's energy-producing processes in the cell mitochondria. The specific mechanism of arsenic poisoning is usually its inhibition of pyruvate dehydrogenase, the enzyme that breaks pyruvates down in the mitochondria so they can be processed for energy production. Arsenic also decreases glucose storage and inhibits glucose production.[30] It is also carcinogenic and teratogenic.

Conversely, as Lederer and Fersterheim[31] note, the research data indicate that *'arsenic is an essential element for several animal species including humans*'. One vital role that arsenic plays in many animals is as an enzyme component to metabolise protein and certain amino acids, including arginine and methionine. Human adults need *'about 12 to 25 micrograms'* per day.[32] The most common methods of measuring body arsenic levels are analyses of urine, hair and fingernail samples.[33] Normal persons have an average concentration of 0.005 mg of arsenic per hundred grams of hair, and excrete between 0.01 and 0.06 mg arsenic per litre of urine. Arsenic is also a vital element in the electronics industry, and is needed for preparing tissue for transmission microscopic work.

OTHER TOXINS NOW KNOWN TO BE ESSENTIAL MINERALS

Whitney *et al.*[34] summarise some of the evidence that indicates many other well-known toxins, including lead, mercury, barium, silver and cadmium, all play key roles in nutrition and health. Barium, a poison rated '5' on a scale of 1-6 (thus extremely toxic), which even in low levels can severely irritate the eyes, nose, throat and skin, is vital for proper growth and may protect the body from ulcers. Slightly greater levels of it cause cardiac irregularities, convulsions, and death from cardiac and respiratory failure.[35]

Other highly toxic vital minerals include iodine (also a toxicity rating of 5) which is required for thyroid hormone synthesis. Copper is needed for normal blood-cell formation and has a major role in the production of several enzymes involved in respiration, central nervous system functioning and connective-tissue formation.[36] Vanadium is required for bone development and normal reproduction; cobalt is an essential part of vitamin B12; silicon is involved in bone calcification; and nickel is critical for certain enzymes to work and evidently also for iron metabolism.[37]

THE MIRACLE ELEMENT SELENIUM

Many other trace minerals necessary for proper health are also toxic in relatively low amounts.[38] Selenium is extremely poisonous (toxic at 0.2 mg/m^3) and, if inhaled in sufficient amounts, causes nervous system disorders, tooth damage and Lou Gehrig's disease. It is also an essential element needed as a co-factor for the enzymes that function as antioxidants. These compounds reduce the amount of polyunsaturated acid oxidation, now considered by many researchers to be a major cause of arteriosclerosis.[39] Selenium's role as an antioxidant is also complementary to that of vitamin E, and neither can replace the other. The recommended intake for adults is 0.05 to 0.2 mg daily.[40]

Selenium also may have a protective effect against certain cancers, although its most important biological function is probably part of the enzyme **glutathione peroxidase.** This compound helps to minimise a cellular structure damage problem called **peroxidation** which, regardless of whether it occurs naturally or is chemically induced, can lead to cancer. The glutathione peroxidase enzyme destroys oxidative compounds that would otherwise oxidise chemicals in the cell, consequently destroying some

organelles and eventually the cell. Selenium is also probably extremely important in bolstering the body's immune system, and its ability to reduce the incidence of cancer may be so dramatic that some researchers recommend daily supplements for the general population.

One past outbreak of heart disease involving hundreds of thousands of children and young women in large areas of western China in the 1970s was due partly to selenium deficiency. Correction of this diet deficiency has now largely eliminated the problem called **Keshan disease.**[41] The cause of the deficiency was the low levels of selenium in the soil in those areas, a situation that also correlates with certain kinds of cancer. Most Westerners are largely protected from severe selenium deficiencies because their food is generally obtained from a wide variety of areas around the country.[42] Also, meat and animal products which are good selenium sources are a major part of the Western diet.

CHROMIUM — ANOTHER MIRACLE METAL

Chromium causes cancer, corrodes skin and nasal membranes, and can damage the kidneys and the body's immune response system (toxic at 0.1 mg/m^3 or less). Conversely, it has now been proven to be an essential trace element.[43] Studies of patients for whom prolonged intravenous feeding was the sole source of nutrition have vividly demonstrated the importance of chromium for normal glucose metabolism. It interacts with insulin to aid the entry of glucose into the cell at the cell membrane entry port, and consequently it controls the energy supply for cell use. When chromium is lacking, insulin effectiveness is also impaired.

Because chromium tissue concentration typically declines with advancing age, and its deficiency may be a major cause of the development of adult-onset diabetes, many nutritionists recommend regular use of chromium supplements. Studies of diets which include chromium supplements have found that the element can help control blood pressure, increase stamina and build muscle.[44]

Chromium also plays a critical role in carbohydrate and lipid (fat) metabolism. Chromium supplements can help to correct glucose imbalances by lowering high blood glucose concentration in diabetics, raising low blood glucose concentrations as found in hypoglycaemia patients. Because chromium deficiency can also raise serum cholesterol and LDL concentration and lower HDL concentration, chromium supplements can help to prevent coronary artery disease. Unfortunately, the **more** refined the food, typically the less chromium it contains. Some researchers estimate that a high proportion of the population does not ingest enough dietary chromium for this reason. Fisher concludes that up to 90 per cent of Westerners do not take in enough of this vital nutrient.[45]

Chromium is unusually high in vegetable oils, brewer's yeast, whole grains, nuts, egg yolks, meats, and certain kinds of cheeses but is often poorly absorbed; thus supplements are often recommended. Chromium absorption levels depend upon the ion ingested, and the Cr^{3+} ion seems to be the form best absorbed and is most effective in living systems. The dietary supplement that is evidently most bioavailable is **chromium picolinate.** The body also has a natural protective mechanism to prevent **over** absorption by causing absorption to **increase** with **low** dietary intake and **decrease** with **high** dietary intake.

VITAMINS — TOO MUCH OF A GOOD THING?

Almost every school child knows that vitamins are necessary for good health. Unfortunately though, many people believe that because small amounts of all vitamins are essential, larger amounts are better and megadoses are better yet. This belief may be one reason vitamin overdose is now a major problem. Called **hypervitaminosis,** the most common symptoms include nausea, diarrhoea, rashes, fatigue, and eventually death. Especially of concern are the fat soluble vitamins (A, D, E and K), and the most common overdose problem is vitamin A.[46] Although necessary in moderate amounts for the maintenance of skin, hair and mucous membranes, as well as vision and bone and tooth growth, high vitamin A intake can cause serious health problems and occasionally death. Many health experts recommend for this reason that supplementary vitamins should be taken **only** under the advice of a physician.

THE NATURAL VERSUS SYNTHETIC DEBATE

Much of the concern over toxicity relates to the labels **synthetic** versus **natural,** a chemical division that is artificial and often meaningless. The common assumption that compounds made by nature are good and those made by humans are bad (or at least have a far greater chance of being damaging) is erroneous. Although legal definitions have been attempted, most **synthetic** chemicals are nothing more than modified, and sometimes not greatly so, natural chemicals. Many are identical to the natural, but are able to be produced more simply and cheaply outside of a plant or animal. Each chemical also has to be evaluated separately for toxicity concerns **regardless** of its source. Because this is true for all of the ten million chemical substances listed in the 1997 **Chemical Abstracts,** scientists have much work ahead of them.

Many persons tend to think of natural compounds as non-poisonous and human-made ones as more likely to be harmful. This generalisation is not valid; all plants, including those used by us for food, produce their own specific natural compounds which were designed to be toxic as a means of protection against pests, including insects, fungi, and animals.[47] Eating a balanced diet consisting of small amounts of a wide variety of foods is generally safe. Since all foods contain toxins, the only concern should be

the **level** to which we are exposed of **each** type of compound and whether our liver can adequately detoxify the level of the compound ingested. This organ is marvellously efficient at rendering excess amounts of potentially lethal compounds harmless. Our body, if healthy and not overburdened, is actually extremely effective in rendering normally-encountered levels of most toxins inert.

We should also be very cautious, but not paranoid, about utilising chemicals which have not yet been adequately tested. Many chemicals exist which we know are extremely toxic to humans, and yet many people do not seem very concerned about them.[48] An example is the finding that hundreds of the over 4,000 chemicals commonly found in cigarette smoke are extremely toxic to humans. One, radioactive polonium-210 (half-life = 138.4 days), is one of the most toxic substances known to mankind, and yet many people tend to worry more about Aspartame® which has a toxicity of something like a millionth of polonium-210.[49] This information could also mean saving lives if applied to reducing toxins in one's environment.

HOW OUR BODY PROTECTS US AGAINST EXCESS TOXINS

The average person today probably is exposed to 360 millirems of radiation annually from cosmic and terrestrial sources alone. The major cosmic source is from galactic and extragalactic locations, and the primarily terrestrial source is from radon gas and smoking.[50] Researchers have discerned that a phenomenon called **hormesis** exists to protect us against toxins and poisons. Hormesis primarily involves the toxin stimulating the development of the body's defences against that toxin, producing **antitoxins.** Thus, small amounts of many toxins including radiation may be a **necessary** requirement to keep the body's immune and defence systems healthy. Arsenic, copper and selenium all play an important role in metabolism — and they also may trigger the body's defences against excess amounts.

One research study which supported this conclusion was completed by Bernard Cohen of the University of Pittsburgh. He found that up to several hundred millirems of radiation produced no discernible negative effect on health. Beyond this though, he found a slight but significant **decrease** in radiation-induced carcinomas. These data were unexpected because it has been assumed, in harmony with Nuclear Regulatory Commission policy, that a zero level radiation threshold exists and that the damage rises linearly until it reaches the lethal dose level.

Cohen found that the downward trend does reverse itself, but **only** after it rises **above** a base line of about 5 rems a year, about 50 times greater than the Nuclear Regulatory Commission's annual recommended limit. Evidently, exposure does not cause problems until about 100 rems a year is reached. This finding was supported by the research on Hiroshima and Nagasaki's 80,000 survivors, who were divided into control and radiation-exposed groups. The control group, about half of the subjects, experienced normal background radiation. The experimental group experienced significantly higher levels. About 120 incidences of carcinoma were found in the **control** group, a discovery which ran 180 degrees counter to the then current conventional wisdom.[51]

Studies of people living in high elevations who are exposed to more cosmic sources of radiation and those who live in high radon areas, as well as people who have cardiac pacemakers which use plutonium power, also confirmed that radiation exposures **up to a certain level** seemed to be beneficial. A possible conclusion is that these medium levels of toxins stimulate the body's defence system, significantly benefiting the person.

DETOXIFYING COMPOUNDS

An estimated 10 million organic compounds are known to exist naturally or have been created by the labs of the world's scientists. The body does not have enough genes to respond in a unique way to detoxify each one of these 10 million or more compounds that exist. The body deals with this problem in a special way described below.

Compounds that are not made by the body, including pesticides, environmental pollutants, carcinogens and drugs, as well as harmless compounds, are all called **xenobiotics.** The term means a chemical compound that is foreign to the body *(xeno* is Greek for stranger). Xenobiotics typically are dealt with by a two-pronged attack. The first step is to cause a chemical reaction which makes them more hydrophilic and water soluble to prevent their accumulation in fatty tissues. The second step involves enzymes that modify the xenobiotic structure to cause it to be even more water soluble, and consequently more likely to be excreted.[52]

To make xenobiotics more hydrophilic, a hydrogen atom is replaced by hydroxylation reaction which is caused by a monooxygenase enzyme complex, specifically **cytochrome P-450.** Cytochrome P-450 is a member of the large cytochrome family, which is famous in the electron transport system for tweaking all the energy possible out of food at the end of the Krebs cycle. The T-450' designation refers to its light-absorption level, a measure used to classify compounds. This compound absorbs light most strongly at the 450 nanometre wavelength.

The second phase of xenobiotic metabolism involves bonding through either an oxygen, nitrogen, or a sulphur atom to a more highly polar group, often the glucose derivative **glucuronic acid** or the amino acid derivative **glutathione.**

About half of all drugs are metabolised by cytochrome P-450, primarily in the liver as the drugs pass through on their way into general circulation. Consequently, drugs need to be taken in a steady dose. In this way the physician can control the amount in the body. Lowering doses rapidly lowers the blood level of the drug; conversely, increasing doses rapidly increases the blood level. If the drugs were

not rapidly broken down, the body could only very slowly reduce the blood level of a drug, and one would have far less control of a drug's level at any one time. This is critical: drugs which are harmful are rapidly broken down by the body if taken in an overdose, reducing the likelihood of long-term damage. Phenobarbital, for example, a drug commonly taken to commit suicide, is rapidly hydroxylated by cytochrome P-450; then it is dissolved in the blood and excreted. For this reason large amounts must be ingested in order to be lethal.

Although the cytochrome P-450 molecule effectively detoxifies many poisons, it can convert some compounds **into** carcinogens. These converted compounds may damage DNA, causing cancer or other problems. The best example is **polycyclic aromatic hydrocarbons** (PAHs) produced by incomplete burning and found in most smoke, especially cigarette smoke (and in some meteorites). (Complete burning, that is, with enough oxygen, does not produce polycyclic hydrocarbons.) These compounds are broken down in the body into compounds which cause serious problems. Although exposure to combustion by-products as smoke is not rare, it generally does not cause a problem because the cough reflex is triggered if the environmental smoke level is excessive. Unfortunately, this cough effect can in some cases be overcome, such as in the case of certain kinds of so-called mild tobacco smoke.

The origin of this 'mild tobacco smoke strain' that does not as effectively trigger the cough reflex, thus bypassing this important defence mechanism, was a mutation. Therefore, when a person is smoking tobacco, this important protection is often not triggered. Consequently, in the United States alone over half a million people die annually from tobacco smoke, and it is estimated that of those alive today, smoking will take almost a billion lives throughout the world.

Cytochrome P-450 is an **inducible biomolecule,** meaning that if more is needed, more is made by the body. Not unexpectedly, smokers have more cytochrome P-450 than non-smokers.[53] The body's response to carcinogens varies with genetic makeup, previous exposure, and total exposure. Even if one has a genetic weakness which allows dangerous compounds to have a greater deleterious effect, avoiding exposure will reduce this problem. Actually, the people most at risk for poisoning today in the Western world are smokers,.certain industrial workers and the following persons:

> *'Ever-increasing numbers of people are gathering wild plants in search of new gastronomic natural treats, bringing into jeopardy another segment of the population. Some of these wild harvests involve misidentified plants and can cause a most unhappy or even deadly experience. The number of people practicing herbal medicine (a tradition that goes back to before the time of Christ) is also on the rise. People seeking natural products (roots, leaves, and bark) to make their concoctions and potions can err and experience mild to severe poisoning. Another group* . . . [using] *wild plants, sometimes at considerable risk to themselves, are those people looking for a natural high from smoking or eating plants which contain hallucinogens, although the greatest risk here comes when such a person stumbles across a hidden marijuana plot guarded by a trigger-happy protector of his crop. There have been several deaths due to such accidental encounters.'*[54]

In a perfect world these mechanisms would be fully adequate to prevent toxins from causing problems to humans. In the fallen world, mutations in plants and animals plus destructive behaviour on the part of humans offsets this balance, causing the problems so apparent in the world around us. Nonetheless, in spite of the fact that toxins are all around us, it is rare today for a human being to die from these causes, even though the level of toxins has dramatically increased recently due to the industrial revolution, and earlier ignorance in using such items as lead drinking cups. We are now aware of many of these dangers, and in the wealthier societies at least we have largely been able to reduce these problems by pollution control. No doubt too the fallen state since Adam has changed the world in other ways. The focus here, though, is on humans as noted in the question in the beginning of the paper.

SOME CONCLUSIONS

The problems with poisons are only due to excessive amounts and how the compounds are used. Compounds which are highly toxic in some situations can be life-saving in others. The toxicity problem is solely a matter of degree, that is, all compounds are toxic in high enough levels, and no compound is toxic in low enough levels. The toxicity concern is best described as one of fit: in one situation a compound is functional, in another the same level is dysfunctional. The fact that low levels of some compounds are dysfunctional in certain situations does not support the common conclusion that some compounds are innately not dangerous and others are dangerous or toxic. The focus should be on the **proper use** of a compound **in a given situation.** A review of selected common poisons and toxins demonstrates that they serve very specific roles in health even though research on many of these elements such as arsenic and botulism toxins, has only just begun. The reason God created toxins is because they are necessary for life, especially in a post-Fall world. All compounds and elements can be either beneficial, neutral or harmful, depending upon the situation and the amount.

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