Chapter 13.6: Practice of Forensic Toxicology

Introduction

A major part of forensic toxicology deals with determining the presence and amount of certain chemicals found in a forensic sample. These samples can come from a variety of sources such as from a medical examiner’s autopsy, unidentified compounds seized during an arrest, chemicals extracted from pieces of evidence, and many of other sources related to investigations. At times very little is known about the sample. But sometimes, particular substances are suspected, based upon a person’s behavior that dictates the type of analysis that will be performed.

Toxicology and Forensic Medicine

Forensic toxicologists are frequently called upon to answer a number of important questions: what substances are present in a sample, what is the unambiguous identity of a particular chemical, how much of each chemical is present in the sample, when was a drug taken, and was a compound naturally occurring in the body, or accidentally or intentionally put there. Forensic toxicologists employ an impressive arsenal of analytical tools to provide answers to these questions. While these techniques have largely been presented in detail in previous chapters, in summary they include:

- **Physico-chemical Methods** (Chapter 11): measurement of the physical (e.g., determination of color, density, refractive index, etc.) and chemical properties of a substance (e.g., titration, etc.).
- **Spectroscopic Methods** (Chapter 12): identifying and quantifying a chemical in a sample based upon the absorption or emission of certain wavelengths of light.
- **Chromatography/Mass Spectrometry** (Chapters 11 and 12): separating a mixture into its components using chromatographic techniques followed by the analysis of each component by mass spectrometry.
- **Immunoassay** (Chapter 6): identifying a compound based upon antibody-antigen specific reactions (e.g., ELISA, EMIT, etc.).

Different types of tests are performed, depending upon the information and level of certainty required. In the field, presumptive tests are often done to quickly screen an unknown substance to see if it contains illicit compounds and should be more carefully examined. For example, the Marquise test (Figure 13.6.1) is a presumptive color-change test – if the color of the solution changes when the Marquise reagent is mixed with a suspected material, then it is likely to contain alkaloids, compounds such as MDMA, methamphetamine, or LSD. In contrast, confirmatory tests, such as mass spectrometry, immunoassay, or infrared spectrometry,
are very discriminating and can unambiguously identify each substance in the sample.

The work of the toxicologist is complicated by a number of issues that require careful attention. When part of a death investigation, the amount of a drug or poison in the sample might be extremely small and requires careful handling and analysis (as little as $1 \times 10^{-9}$ grams). Additionally, the compounds of interest may be part of a very complex mixture that requires careful separation before any analysis can be completed.

Information provided by a toxicologist can help the medical examiner answer the question of whether an unexplained or sudden death occurred by poisoning and whether that poisoning involved an intentional or an accidental dose. This can be, of course, a difficult determination and the quantity and type of drug or poison found in the body can provide one important piece of information to help the medico-legal investigation team come to a defensible determination.

### Sample Collection

Biological samples can come from a variety of sources. Samples from a medical examiner’s investigation can come from body fluids and from solid organs. A partial list of these sources is given in table 13.6.1.

**Table 13.6.1.** Some common sources of biological toxicology samples.

<table>
<thead>
<tr>
<th>Fluids</th>
<th>Organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>Skin</td>
</tr>
<tr>
<td>Urine</td>
<td>Lungs</td>
</tr>
<tr>
<td>Vitreous Humor</td>
<td>Hair</td>
</tr>
<tr>
<td>Oral Fluid</td>
<td>Fingernails</td>
</tr>
<tr>
<td>Semen</td>
<td>Liver</td>
</tr>
<tr>
<td>Stomach Contents</td>
<td>Kidney</td>
</tr>
<tr>
<td>Bile</td>
<td>Bone</td>
</tr>
<tr>
<td>Vomit</td>
<td>Other (heart, brain, etc.)</td>
</tr>
<tr>
<td>Semen</td>
<td></td>
</tr>
<tr>
<td>Sweat</td>
<td></td>
</tr>
</tbody>
</table>

Blood is a very common fluid used for toxicology testing. It matters, however, where in the body the blood is sampled. For example, blood taken near the liver or other solid organs may contain much higher concentrations of a drug or poison than blood sampled elsewhere since the drug may diffuse post mortem out of the organ and into the surrounding blood. Usually, pathologists try to take blood from the femoral artery (in the leg, Figure 13.6.3) since it is far from the major organs of the body. Heart, jugular artery, and solid organ samples may also be taken for analysis and comparison.

Urine is good for determining whether a drug was used but does not give a good indication of how much was taken since drug concentration in the urine is greatly affected by many factors including how long it has been accumulating, how much liquid someone has taken in (hydrated or

Figure 13.6.2. Forensic toxicology report form (www.xenu.net/archive/hubbardcoroner/hubbard_toxicology_report.jpg).
dehydrated), and how long ago they last voided their bladder. Urine is, however, usually easily sampled and can be rapidly analyzed for drug presence. This type of analysis is particularly useful and common in workplace, parole, and compliance testing where the amount of a drug is less important than that it is found at all (zero tolerance).

Other body fluids and organs can also be sampled. The vitreous humor (eye fluid) is commonly used since it is easily collected, is quite stable, and correlates very well with blood data.

It is essential that representative samples be taken for the analysis. A representative sample is a small amount of material that is taken from the total sample present that possesses the same chemical characteristics of the larger sample. Once the sample is taken, it is important to make sure that samples collected are appropriately packaged, transported, and stored correctly. Storage of the samples must be arranged to avoid sample loss, prevent any chemical reactions or degradation from occurring before the analysis is performed, and eliminate any possible sources of contamination. Reporting, statistical information, and chain of custody requirements must also be to the highest standards to ensure that the toxicological evidence can stand up to the scrutiny of the courtroom (Figure 13.6.2).

Different drugs also reside within the body for varying periods of time. The half-life of a drug or poison is the amount of time it takes for one-half of the chemical to be eliminated. Often, however, since we can measure very small amounts of compounds, a drug can be detected for many half-lives in the body’s fluids. Table 13.6.2 gives typical amounts of time for a given drug to clear the body to undetectable levels.

### Toxicology Cases

When working with a

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**Table 13.6.2. Typical times for drugs to clear the body to undetectable levels**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>0-4 hours</td>
<td>&lt;=6-8 hours</td>
</tr>
<tr>
<td>Amphetamines</td>
<td>2-7 hours</td>
<td>2-4 days</td>
</tr>
<tr>
<td>Anabolic Steroids</td>
<td>4-6 hours</td>
<td>Oral: 2-3 weeks / Injected: 1-3 months (Nandrolone 8 months+)</td>
</tr>
</tbody>
</table>
| Barbiturates                | 2-4 hours| Short acting type (Alphenal, Amobarbital, Allobarbital, Butethal, Secobarbital) 1-4 days.
|                             |         | Long acting type (Phenobarbital, Barbitol) 2-3 weeks or longer |
| Benzodiazepines             | 2-7 hours| Infrequent user: 3 days / Chronic user: 4-6 weeks |
| Cannabinoids (THC-Marijuana)* | 6-18 hours | *Infrequent user: up to 10 days / Chronic user: 30 days or longer |
| Cocaine Metabolite          | 1-4 hours| 2-4 days                    |
| LSD                         | 2 hours  | 1-4 days                    |
| Mescaline                   | 1-2 hours| 2-4 days                    |
| Methadone                   | 2 hours  | 2-6 days                    |
| Methamphetamines            | 1-3 hours| 2-4 days                    |
| Methaqualone                | 3-8 hours| Up to 10 days               |
| MDMA (ecstasy)              | 1 hour  | 2-3 days                    |
| Nicotine (Tobacco)**        | 4-6 hours| **Infrequent user: 2-3 days / Chronic user: 7 to 14 days |
| Opiates (Heroin, Morphine, Codeine) | 2 hours | 2-3 days |
| Oxycodone                   | 1 hour  | 1-2 days                    |
| Phencyclidine (PCP)*        | 5-7 hours| *Infrequent user: 6-8 days / Chronic user: 21-28 days+ |
| Propoxyphene                 | 4-6 hours| 1-2 days                    |
| Psilocybin (Mushrooms)      | 2 hours  | 1-3 days                    |
| Rohypnol                    | 1 hour  | <8 hours                    |
| GHB                         | 1 hour  | <8 hours                    |
| Tricyclic Antidepressants (TCA) | 8-12 hours | 2-7 days                   |

* THC and PCP in particular are stored by the system in the fatty lipid tissue and are gradually released into the blood stream until cleared. For chronic users with a high body fat count, this process can take several weeks.

** Nicotine is one of the most addictive drugs known. Consequently most users of nicotine are chronic users by default. Nicotine consumption includes all forms of the drug including tobacco, snuff, transdermal patches and smoking.
medical examiner, a toxicologist may be called upon to provide information concerning a deceased patient (post mortem toxicology). Typically, these types of investigations include suspected drug-related deaths, road traffic deaths, and homicide cases. Toxicology testing for living suspects may involve drunk/drugged driving, drug-facilitated sexual assault (DFSA), workplace testing, or athletic contesting cases, among others.

Workplace testing usually is focused at determining a person’s integrity, their prior drug use background, or compliance with job-related regulations. Increasingly, restrictions are being made on a person’s use of drugs outside of their working hours. This is very similar to the trend for very strict testing and drug compliance rules for international athletic events, especially the Olympics (Figure 13.6.4).

Finally, the practicing forensic toxicologist may be called into court to testify about the many parts of the testing process – from sample collection through analysis and interpretation of the data. A toxicologist may also be called upon to assess the role that a particular drug would have upon a person’s behavior.

![Figure 13.6.4. Trends in Olympic drug testing](www.cbsnews.com/htdocs/sports/doping/framesource_chart.html).

The New York Times
By DAVID MARGOLICK (Published: July 26, 1995)

“LOS ANGELES, July 25— Blood on a sock retrieved from O. J Simpson's bedroom and on the gate behind Nicole Brown Simpson's home did not contain a preservative, but only some vague and inconclusive hints of one, a scientist from the Federal Bureau of Investigation testified today at Mr. Simpson's trial.

Defense lawyers called the F.B.I. special agent, Roger Martz, to buttress their claims that corrupt police officers removed the Simpsons' blood from test tubes containing an anti-coagulating substance used in laboratories, EDTA, and sprinkled it on the sock and gate.

DNA tests have all but proved that the blood on the sock was Mrs. Simpson's, and that the blood smeared on the gate matched Mr. Simpson's. But Mr. Martz said there was no proof that the chemical on the two exhibits was EDTA and even if it were, that it was not of the concentration found in preserved blood.

"Everyone is saying that I found EDTA, but I am not saying that," said Mr. Martz, chief of the F.B.I.'s chemistry toxicology unit, with a hint of frustration. "I was asked to determine whether those blood stains came from preserved blood. Those blood stains did not come from preserved blood."

Mr. Simpson's lawyers had to call Mr. Martz because he conducted the experiments about which Dr. Frederic Rieders, an expert for the defense, testified on Monday. Although Mr. Martz technically was one of their own, from the outset Mr. Simpson's lawyers attacked him.

Mr. Martz conceded to Robert Blasier, a lawyer for Mr. Simpson, that blood found on the
sock and the gate shared some of the physical properties and molecular characteristics of EDTA. In highly technical language that left even the lawyers tripping over their tongues, he said the blood samples "responded like EDTA responded" and "was consistent with the presence of EDTA."

Analyzing Mr. Martz's data on Monday, Dr. Rieders said the two blood samples did contain EDTA. But Mr. Martz said Dr. Rieders had jumped to conclusions in what he called a "very dangerous" fashion. While one test revealed some of the same ions as EDTA, he said, two others precluded its presence.

"It is not appropriate to identify EDTA based on the data I have provided for the sock and the gate," he testified.

The police have said they initially overlooked that blood smear on the gate, collecting it several weeks after Mrs. Simpson and Ronald L. Goldman were killed. Defense lawyers say the police planted it after the fact. And on the sock, they say, unidentified police officers smeared blood taken from Mrs. Simpson during her autopsy.

Examined by Deputy District Attorney Marcia Clark, Mr. Martz distanced himself still further from Dr. Rieders. He offered a bar graph comparing the number of ions associated with EDTA that were found in samples of the Simpsons' blood taken from the test tubes to those found in blood samples from the gate and sock. Those taken from the test tubes resembled orange skyscrapers; those from the gate and sock looked like empty city blocks.

Mr. Martz also restated that tests of his own blood showed the possible presence of EDTA, a preservative used in breakfast cereal, mayonnaise and other foods, in the same trace amounts as on the gate and sock. But what looks like EDTA, he said, could just as easily be a number of similar chemical compounds, or contamination from the testing instrument.

"It's only logical to assume that if a person is eating EDTA, some of it will be in their blood," he said. "The question is how much. I don't think anyone knows today."

But Mr. Blasier got Mr. Martz to concede, for instance, that he had never been asked previously to look for EDTA in blood. Mr. Blasier even pointed out that there was nothing special about special agents, since every F.B.I. agent is one.

Mr. Blasier has depicted Mr. Martz as a hired gun, noting that when the prosecution enlisted him last February, it was, as Deputy District Attorney Rockne Harmon put it in a letter, "to refute the possibility" that the sock contained EDTA.

In rapid-fire questions Ms. Clark asked him: "Sir, did you take that to mean that we were demanding a particular result from you? Would it have mattered to you if you thought we had been? Did you take that to mean anything more than the confidence that the prosecution felt that they were not planted?"

To each question, Mr. Martz said, "No."
CHAPTER 13 REFERENCES AND BIBLIOGRAPHY

Barry Levine, Principles of Forensic Toxicology, American Association for Clinical Chemistry (3rd Ed.), American Association for Clinical Chemistry, 2010.


Christopher P. Holstege, Thomas Neer, Gregory B. Saathoff, and R. Brent Furbee, Criminal Poisoning: Clinical and Forensic Perspectives, Jones and Bartlett Publishers, 2010.


GLOSSARY OF TERMS

Absorption – In spectroscopy, it is the absorption or uptake of light by a substance, accompanied by an increase in the energy of the molecules or atoms of the substance.

Acidosis: The acidification of the blood.

Acute Dose: An amount of a chemical administered over a short period of time.

Alcohol: An organic compound with an OH group but the terms generally refers to ethanol when consumed.

Alcohol Dehydrogenase Enzyme: An enzyme of the liver that converts ethanol (CH₃CH₂OH) into acetaldehyde (CH₃CHO).

Analgesic: A compound that relieves pain.

Analyte: The compound that you’re analyzing for.

BAC (Blood Alcohol Concentration): A measure of the amount of alcohol in the bloodstream, usually given in terms of grams of alcohol in 100 mL of blood (sometimes referred to as milligram percent).

Barbiturates: Derivatives of barbituric acid that act as depressants.

Bioaccumulation: The accumulation of a substance in an organism.

Bioavailability: The amount of the compound that reaches the bloodstream.

Breathalyzer: A device for measuring the alcohol in a person’s expired breath.

Breath Testing: A method for measuring BAC levels from the alcohol in a person’s breath.

Chronic Exposure: An amount of a chemical administered over a long period of time.

Congeners: Other substances, besides alcohol, that are found in alcoholic beverages.

Controlled Substance Act (CSA): A law that established the legal US foundation for the criminal guidelines for holding different amounts of controlled substances.

Corrosive Poisons: Substances that physically destroy tissues upon direct contact and usually act immediately, such as strong acids and bases.

Cytotoxin: A substance that is toxic to cells.

Depressants: Compounds that act to depress the functioning of the central nervous system, bringing about calmness and sleep.

Distribution: The spreading of a substance after administration throughout an organism.

Dose: The amount of a substance administered at a particular time.

Drug: A substance that is given for medical purpose, such as the prevention, diagnosis or treatment of disease.

Elimination: The removal of substances, such as metabolic waste products, from the body.

Ethanol: The chemical compound CH₃CH₂OH, usually refers to the alcohol used in all human consumption.

Ethnopharmacology: The exploration of traditional folk remedies for finding new drugs.

Field Sobriety Test: Testing that involves a series of behavioral tasks done by a person suspected of being intoxicated.

Fermentation: The use of certain strains of yeast to metabolize sugars into carbon dioxide and ethanol.

Half-life (t½): The amount of time necessary for one-half of the original sample to change, decompose or decay away.

Hallucinogens: Compounds that alter normal thought processes, perceptions, personal awareness, and psychological moods.

Henry’s Law: The physical principle that states that when a solution containing a dissolved volatile compound is brought into contact with a gas, a fixed equilibrium is setup between the amount of the volatile compound in the air and the amount dissolved in the liquid.
**Horizontal Gaze Nystagamus (HGN):** A test that examines the involuntary jerking of the eye as a person looks from side to side to gage levels of alcohol impairment.

**Ingestion:** Oral (by mouth) The entry of a chemical into the body through the gastrointestinal tract.

**Intramuscular:** The injection of a substance directly into a muscle.

**Intravenous:** The injection of a substance directly into a blood vessel.

**Injection:** The insertion of a compound either directly into the bloodstream or nearby tissue.

**Lethal Dose (LD_{50}):** The amount of a substance administered at one time that is necessary to cause death, usually given a probability of death for a portion of a population.

**Metabolic Poisons:** Compounds that act by affecting the biochemical functioning of cells and tissues

**Metabolite:** Compound formed from the metabolism of a drug.

**Medicine:** A drug or chemical used for the prevention, diagnosis or treatment of disease.

**Narcotic:** A drug that brings relief from pain and brings sleep.

**Neuron:** Nerve cells.

**Neurotoxins:** Molecules that interfere with the normal functioning of nerve cells.

**Opiods:** Drugs made independently in the laboratory that function similarly to the opiates.

**Opiates:** Compounds derived from opium sap.

**Pharmacodynamics:** The study of how a drug works on a person.

**Pharmacokinetics:** The study of how a person works on the drug.

**Poison:** A compound that function primarily by killing cells.

**Semi-synthetic Opiates:** Drugs made synthetically from the naturally occurring opiates.

**Side Effect:** A secondary effect from a medical treatment.

**Standardized Field Sobriety Test (SFST):** A battery of tasks used to evaluate impairment as the basis of a probable cause for arrest.

**Steroids:** Compounds that promote muscle growth and repair, regulate metabolism and immune function, and control blood properties.

**Stimulants:** Compounds that increase alertness and activity.

**Subcutaneous:** The injection of a substance directly into the skin layers.

**Synapses:** Junctions between nerve cells that complete the electrical connections in the nervous system.

**Synesthesia:** An effect that occurs when stimulation of one sensory form leads to stimulation of another sensation.

**Tolerance:** The capacity of an organism to endure administration of a dose of a chemical.

**Toxicology:** The field that deals with the effects or poisons and their effects.

**Toxin:** A subset of poisons that are produced specifically by living organisms.

**Venom:** A toxin that is injected directly into a victim.
QUESTIONS FOR FURTHER PRACTICE AND MASTERY

13.1. One of the most commonly found laboratory techniques that is used for identifying a poison in a blood sample is:
   (a) atomic absorption.
   (b) gas chromatography.
   (c) ultraviolet-visible spectrophotometry.
   (d) gas chromatography-mass spectrometry.
   (e) neutron activation analysis.

13.2. An narcotic drug:
   (a) stimulates the central nervous system.
   (b) reduces or eliminates pain.
   (c) depresses the central nervous system.
   (d) causes hallucinogenic effects.
   (e) none of the above.

13.3. Alcohol is eliminated from the body chemically as CH₃CH₂OH in:
   (a) Urine.
   (b) Breath.
   (c) Perspiration.
   (d) All of the above.
   (e) None of the above.

13.4. The study of body fluids for the presence of drugs and poisons is called
   (a) pathology
   (b) toxicology
   (c) virology
   (d) urology
   (e) odontology

13.5. Which of the following is not a depressant?
   (a) Valium
   (b) barbuturates
   (c) Cocaine
   (d) Ethyl Alcohol
   (e) all of these are depressants

13.6. Most alcohol enters the bloodstream through the:
   (a) stomach
   (b) small intestines
   (c) large intestines
   (d) liver
   (e) pancreas

13.7. Cocaine is considered to be a:
   (a) depressant
   (b) stimulant
   (c) narcotic
   (d) hallucinogen
   (e) steroid

13.8. Which of the following is not a stimulant?
   (a) Caffeine
   (b) Amphetamine
(c) Cocaine
(d) Ethyl Alcohol
(e) all of these are stimulants

13.9. Marijuana is considered to be a:
(a) depressant
(b) stimulant
(c) narcotic
(d) hallucinogen
(e) steroid

13.10. The formula for the alcohol most commonly consumed in alcoholic beverages is
(a) CH₃OH
(b) CH₃CH₂OH
(c) CH₃CH₂CH₂OH
(d) CH₃C(O)OH
(e) CH₃OCH₃

13.11. According to the Controlled Substances Act, drugs that have the highest potential for abuse and without any accepted current medical use are listed in which schedule of the Act?
(a) I
(b) II
(c) III
(d) IV
(e) V

13.12. Alcohol, CH₃CH₂OH, is eliminated from the body chemically unchanged in
(a) urine
(b) breath
(c) perspiration
(d) all of these
(e) none of these

13.13. Alcohol is first oxidized by the body primarily in the
(a) kidneys
(b) small intestine
(c) stomach
(d) liver
(e) lungs

13.14. Which of the following statements is false?
(a) Most alcohol absorption occurs in the stomach.
(b) Alcohol is considered to be a depressant.
(c) Any alcohol that is absorbed into the blood stream is very rapidly distributed relatively evenly throughout water portions of the body
(d) The chemical formula for the alcohol consumed in alcoholic beverages is CH₃CH₂OH.
(e) All of the above are true.

13.15. Which drug is often incorrectly classified as a narcotic?
(a) codeine
(b) morphine
(c) marijuana
(d) heroin
(e) they are all narcotics
13.16. Which is are factor(s) in determining the rate at which alcohol is absorbed into the bloodstream?
   (a) the alcoholic content of the beverage
   (b) the amount consumed
   (c) the presence or absence of food in the stomach
   (d) all of the above
   (e) none of the above

13.17. The presence of high levels of carbon monoxide in the blood of a victim found at the scene of a suspicious fire is suggestive that the victim:
   (a) died elsewhere and was brought to the fire scene after death.
   (b) died before the fire started.
   (c) was the arsonist.
   (d) perished after the fire started.

13.18. The concentration of alcohol in an exhaled breath is in direct proportion to that of the blood (Henry's Law) of the individual. The ratio of this relationship is closest to:
   (a) 10:1
   (b) 100:1
   (c) 200:1
   (d) 1000:1
   (e) 2000:1

13.19. Most alcohol enters the bloodstream through the:
   (a) stomach
   (b) small intestines
   (c) large intestines
   (d) liver
   (e) pancreas

13.20. The LD50 dose of cyanide for a 60 kg person is (note; LD50 for cyanide is 10 mg/Kg)
   (a) 10 mg
   (b) 600 mg
   (c) 7 mg
   (d) 600 grams
   (e) 700 mg

13.21. Which of the following statements is false?
   (a) Alcohol is broken down in the liver by oxidation
   (b) Alcohol depresses the central nervous system
   (c) Alcohol is distributed nearly evenly throughout water (aqueous) portions of the body by the blood
   (d) Most of the consumed alcohol is absorbed through the stomach walls.
   (e) Methanol (wood alcohol) and isopropyl alcohol (rubbing alcohol) are much more toxic than ethyl alcohol

13.22. What is meant by “off label” use of drugs and related compounds?
13.23. What is toxicology?
13.25. What are some of the ways a drug act on the body pharmacodynamically?
13.26. What are metabolites?
13.27. What is a drug half-life?
13.28. Why do the same drugs have different effects on different people?
13.29. In the general public’s mind was is the difference between medicine and drugs?
13.30. What is a poison?
13.31. What is the difference between acute toxicity and chronic toxicity?
13.32. What is a LD value and what does LD50 mean?
13.33. What are the three ways prior exposure to a chemical can influence a person’s response to a new exposure?
13.34. What does the acronym “ADME” stand for? Describe each step.
13.35. What are the different means of delivering a drug to the body?
13.36. What is bioavailability?
13.37. What organ “screens” chemicals before they enter the bloodstream?
13.38. What is the blood-brain barrier?
13.39. What are the different ways that drugs are discovered or designed?
13.40. Differentiate between a poison, a toxin and a venom.
13.41. What damage results from a corrosive poison?
13.42. What is a metabolic poison?
13.43. What is the biological mechanism of carbon monoxide poisoning? How does the victim appear physically?
13.44. What is the “mode of action” in cyanide poisoning? In heavy metal poisoning?
13.45. What is a neurotoxin?
13.46. What is the” mode of action” for most neurotoxins?
13.47. What are the general designated categories for drug abuse?
13.48. What is a narcotic? What is an opiate?
13.49. What is a hallucinogen? What is the mode of action of a hallucinogen?
13.50. What are a synthetic opiate and an opioid? Give examples.
13.51. For approximately how long after a chronic marijuana smoker stops smoking can the drug be detected in the user’s urine?
13.52. LSD, peyote, PCP and psilocybin belong to what classification of drugs?
13.53. What are the effects of depressants on a person physiologically and psychologically?
13.54. What is meant by a “date-rape” drug?
13.55. How does a stimulant, like cocaine, typically produce its “high”?
13.56. How does the biological operation of an amphetamine differ from cocaine?
13.57. What are the risks associated with steroid abuse?
13.58. What is the most abused drug worldwide?
13.59. What does ’80 Proof” mean with respect to an alcohol solution?
13.60. What is a congener?
13.61. What factors affect the rate of absorption of alcohol into the bloodstream?
13.62. What is meant by blood alcohol concentration, BAC? What is the US legal BAC limit?
13.63. What are the three tests used in a field sobriety test?
13.64. How does an IR intoxilyzer work?
13.65. How does fuel cell BAC analysis work?
13.66. What are some of the problems with the results of presumptive BAC tests?
13.67. What are some of the methods used as confirmatory tests for BAC?
13.68. What is the only non-medical “treatment” effective at lowering BAC?
13.69. What is the legal importance of the US Supreme Court’s decision in ‘Schmerber v California’ in 1966?
13.70. What is the presumptive Marquise test used to identify?

**EXTENSIVE QUESTIONS**
13.71. Water has a LD50 value of 90,000mg/kg. How many gallons of water must a 150 lbs. person drink to have a 50% chance of dying? (1 lb. = 454 g, 1 kg = 2.2 lbs., 1 gallon of water = 8 lbs.)

13.72. Explain the five different drug schedules developed by the CSA (Controlled Substance Act). Be sure to include schedule number, potential for abuse and examples of drugs included.

13.73. Describe the effects that increasing levels of absorbed alcohol have on various regions of the brain and the resultant behavioral and motor skill changes in the individual.

13.74. Henry’s Law is the basis for many field breathalyzer tests. Explain how Henry’s Law is used to determine a presumptive BAC.

13.75. A toxicologist receives several vials of blood collected from a victim of vehicular accident. The blood samples were collected from the femoral artery, the abdominal cavity near the liver and the carotid artery. The resultant toxicology showed a very different level of alcohol in the blood from the femoral artery as compared to the blood from the area near the liver. The alcohol level was much lower from the femoral artery. What could account for the higher level in the blood collected near the liver?

13.76. Drugs can be detected in a person’s system for varying amounts of time after taking depending upon the drug. What is the maximum detection time for each of the following to show a positive test in a sample? A) alcohol B) marijuana - chronic user C) ecstasy D) rohypnol E) opiates F) marijuana - infrequent user.