Chapter 13.4: Drugs of Abuse

Introduction

While poisons ultimately act by killing cells, drugs typically act either by subtly modifying chemical processes or by supplying missing molecules to our bodies. Drugs are, therefore, by design intended for therapeutic uses – dealing with medical problems, delivering necessary biomolecules, or reducing problematic symptoms. The level of health and longevity today is largely attributable to the amazing array of drugs available to physicians for dealing with the many diseases and symptoms that we face, with new medications coming on the market faster than ever. But today, the term “drug” has come to have vastly different meanings to different people, ranging from their recognition as life-sustaining pharmaceuticals to a view that they are substances taken for recreation and escape.

The same drugs that have been carefully developed to maximize their beneficial therapeutic action may also be taken for uses not originally intended. These compounds, deemed by society as drugs of abuse, are taken in efforts to quickly become stronger, look better, change mood, modify personal outlook, find release and escape from difficult situations, or end lives. Prescription drugs are among the most common of all abused drugs, with hundreds of formulations readily available in home medicine cabinets, on pharmacies shelves, and for sale illegally on the street, as shown in Figure 13.4.1. Increasingly, people turn to drugs to find rapid relief from personal problems and for recreational pleasure, often without considering the consequences of their actions.

All commercial drugs, both over the counter and those prescribed by a physician, have been closely scrutinized for their safety and usefulness before they ever reach a consumer. These drugs are manufactured under exceptionally strict quality control standards before they are carefully administered and monitored for a patient, with a well-trained medical professional weighing the dosages needed against any potential side effects. When drugs are taken for “off-label” uses in an uncontrolled fashion, guided by often misinformed street lore, the

Figure 13.4.1. Just a few of the common prescription drugs that are abused
(3.bp.blogspot.com/_MDZPARKD1rE/Tw+SGNDX0I8/AAAAAAAAB8E/OC6sG56MNXg/s1600/Abused_Drugs_4.jpg).

Figure 13.4.2 Relationship of various drugs with dependence and the potential for physical harm (The Lancet 2007; 369:1047-1053.).
consequences are usually predictably bad, Figure 13.4.2. Drugs from street sources may be far from
ygienic and the presence of possible contaminants, diluents, and poisons, along with the identity of
the drug, are always suspect. Taking drugs from unknown sources essentially negates the untold
efforts and billions of dollars of research expended to ensure a safe and effective product. Under
these conditions, people often become addicted to an illicit drug, spiral out of control, and then turn
to crime or self-harm to perpetuate their dependence to the exclusion of all other aspects of their
lives. This is, of course, where forensic science steps in to try to understand which drug contributed
to a particular criminal action or observed personal behavior. Drug analysis has, in fact, driven much of
the development of forensic laboratories worldwide. All societies are struggling with the
effects of illicit drug use and combating the associated personal dereliction, crime, and violence.

The vast majority of crimes today have drug use implications, either necessitated by drug related
demands or committed while under the influence of personality-modifying chemicals. Estimates
indicate that about 80% of all crimes are somehow drug related. These are not victim-less crimes,
but clearly injure the perpetrators themselves, their families, friends, co-workers, neighborhoods and
communities. Each year, at least 40 million serious illnesses and injuries result from illicit drugs use,
including untold injuries and deaths to innocent bystanders.

Illicit drug use has reached epidemic proportions worldwide. In a recent U.S. government study,
over 15 million people age 12 and over reported using an illicit drug on a current basis, about 6% of
households nationally. One-half of all adults reported use of marijuana at least once in their lifetime and
41% of high school seniors reported using an illicit drug within the previous year (Figure 13.4.3). When
those consuming alcohol are added to the list, the number skyrockets to an estimated 100 million Americans,
20 million of whom have a severe alcohol problem. While this

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**Figure 13.4.3.** Drug use of high school seniors by substance, US Gov’t data ([www.enowid.org](http://www.enowid.org/psychoactives/statistics/statistics_drug_use.shtml)).

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**Figure 13.5.4.** Alcohol abuse levels report by age group in 2002 ([www.oas.sanbna.gov/oshaa/2k2nsdh/results/2k2Results.htm](http://www.oas.sanbna.gov/oshaa/2k2nsdh/results/2k2Results.htm)).
represents a drop in overall use in the past thirty years, it is still touches a very large segment of the population. The United Nations has reported that the annual use of illicit drugs in the 15-64 age group is about 10% of the world’s population.

Many people deceive themselves by thinking that drug users come from a different part of society from their own. This is clearly not true. Statistics from the National Criminal Justice Reference Service report that three-quarters of regular drug users have jobs. Drug dependence reaches every type of social, educational, cultural, age, and income group. As can be seen in Figure 13.4.5, the levels of drug use are about the same across economic backgrounds. It is often true, however, that lower income abusers may lack sufficient resources to pay for adequate treatment and communities with a rampant drug trade typically sees increases in crime, violence, failed businesses, and community decay.

Drug dependence, not just use, also cuts across all socio-economic strata of society. As described in earlier sections, different drugs have varying potential for dependence (Figure 13.4.2). The dependence may be physical (physiological), psychological, or both. For example, some drugs such as LSD and marijuana have a relatively lower potential for physical dependence but a relatively high potential for psychological dependence. This means that, while the body may not respond as severely to removing the drug, a person’s psychological make-up may drive them very strongly towards continued use. In contrast, the use of some drugs, such as heroin and cocaine, results in a very strong physiological dependence upon the drug – with severe, even life-threatening, consequences arising from withdrawal from the drug. As an aside, the risk of overdose death increases dramatically when a person returns to a drug after a period of abstinence and withdrawal. As mentioned before, with continued use, the body grows accustomed to the drug and requires continually increasing quantities to achieve the same effect. When someone stops use for a while, their physiological tolerance of the drug decreases but when they then return to the drug and administer a dose of the same size as their last dose, their

Figure 13.4.5. Percentage of youths age 12 to 17 reporting regular substance use by annual family income in 2003 (www.oas.samhsa.gov/2k4/youthIncome/youthIncome.htm).
body is now less tolerant of the compound and an overdose results. Unfortunately, this is a frequent occurrence seen by medical examiner’s offices.

Most drugs of abuse fall into just a few general categories: narcotics, hallucinogens, depressants, stimulants, steroids, and club drugs. In the following sections, each of these classes will be explored. But because of the enormous abuse of alcohol worldwide, alcohol toxicology will be treated separately later in this chapter.

**Narcotics:** The term narcotic is often misused to indicate all drugs of abuse. But the correct and proper use of the terms deals specifically with a class of drugs that bring relief from pain and puts a person to sleep. Narcotics are specifically analgesic compounds – chemicals that relieve pain by depressing parts of the nervous system. Common members of this group include opium, morphine, heroin, codeine, oxycodone, and methadone, among others.

Confusion in the use of the term narcotic, however, still persists in places such as law enforcement and criminal justice systems and some state laws still classify non-narcotic drugs, such as marijuana (hallucinogen), methamphetamine (stimulant) and cocaine (stimulant), as narcotics.

Most narcotics are derived from naturally harvested opium – the sticky white sap from the opium poppy plant (*Papaver somniferum*), Figure 13.5.3, grown all across the world, but especially in Asia. Once the beautiful red flowers drop off, the bulb is “injured” to allow the opium sap to seep out of the bulb. The opium typically contains about 10% morphine, along with some codeine and thebaine, from which a variety of other opiate narcotics can be chemically prepared. Heroin, morphine, codeine, and all opium-derived narcotics are related by their chemical structures, as shown in Figure 13.5.7. Naturally occurring compounds in this family contained in the opium sap are called opiates (e.g., morphine, codeine and thebaine), those that are made synthetically from the naturally occurring compounds in this family are called semi-synthetic opiates (e.g., codeine, oxycodone) and those that are made synthetically from the naturally occurring compounds in this family are called synthetic opiates (e.g., fentanyl, methadone, dextropropoxyphene).

**Figure 13.4.7.** Opiate narcotics prepared from opium derived from poppy plants (*Papaver somniferum*).

**Figure 13.4.8.** Effects of long-term heroin use: same person before (left) and after (right) several years of heroin use (www.thegooddrugsguide.com/gallery/before-and-after-drug-abuse/heroin-abuse/awful-transformation-after-abusing-heroin.htm).
Opiates are called semi-synthetic opiates (e.g., heroin, hydrocodone, and oxycodone), and those independently prepared in the laboratory are synthetic opioids (fentanyl, methadone, dextropropoxyphene, etc.). The synthetic opioids usually are not structurally related to the opium-derived compounds, as can be seen from Figure 13.4.7, but have narcotic properties to varying degrees similar to those of the opiates.

Morphine is named, for good reason, for Morpheus - the Greek god of dreams, son of Nyx (goddess of the night), and attendant to Hypnos (god of sleep). It is present at about 10-15% of the total weight of opium sap. It is one of the most powerful analgesics known to medicine and provides relief from deep-seated pain. The chemical structure of morphine allows it to precisely fit into special nerve cell receptors in a “lock-and-key” fashion, effectively blocking pain signals from ever reaching the brain. Morphine is the most commonly prescribed drug for severe pain relief today but its use is tightly controlled well beyond the level of most prescription medications. The physician must register with the US Drug Enforcement Administration and report to them how much and to whom it is prescribed – if they prescribe too much, they face legal action.

Morphine is also highly addictive and prolonged use requires ever increasing dosages to achieve the same effect. A lethal dose of morphine by ingestion is 120-250 mg for an adult human. When taken orally, about 25% of the morphine makes it into the bloodstream while nearly 100% is immediately bioavailable when injected intravenously.

Heroin is produced from morphine by chemically replacing morphine’s two OH groups with two organic ester groups (CH₃C(O)O) (Figure 13.4.7). Because of this chemical change, heroin is

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**Left and Right Handed Molecules?**

Sometimes, very subtle modifications in a molecule can dramatically change how it impacts the body. In organic chemistry, some molecules can have a “twin” that has different properties. For example, levorphan and dextrorphan (shown below) are two molecules with exactly the same chemical components and only differing in that they are mirror images of each other. Despite the very similar appearance of their structures, when you try to place one directly on top of the other to compare, they are not the same – just as our right and left hands are mirror images and are not superimposable. When you place one hand on top of the other, the major parts don’t line up even though both hands are composed of the exact same parts. So, like our hands, we can say that the two molecules have a “handedness” – or are chiral – both our hands and levorphan/dextrophan are chiral. In fact, their names derive from this fact – “levo” comes from the word for left and dextro comes from the word for right.

Our bodies have many chiral molecules within them that interact differently with other handed molecules - right handed molecules react differently than left handed molecules, much as the way our right hand interacts different with a right and left handed gloves. For example, levorphan is a more potent pain killer than morphine and is very addictive while its mirror image, dextrophan, is completely non-addicting and without any analgesic properties.

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**Figure 13.4.9.** Heroin use through insufflation ([http://reachfoundation.org.in/php/drug-heroin.php](http://reachfoundation.org.in/php/drug-heroin.php)).
less water soluble than morphine and must be injected directly into the bloodstream or made into a salt to increase its water solubility. Once in the bloodstream, however, it is able to pass more quickly across the blood-brain barrier than morphine, causing it to be more potent, faster acting, but also shorter lived than morphine. When absorbed by tissues, heroin is chemically changed rapidly back into morphine. Long term use of heroin causes remarkable physical changes including apathy, loss of appetite, and personal neglect, as illustrated by the before and after pictures taken just a few years apart in Figure 13.5.8. Heroin produces a euphoric effect by suppressing the central nervous system to produce a warm and calming feeling due to blood vessel dilation.

Heroin is administered in a variety of ways including by injection (probably most common), orally, smoking, insufflation (inhaled) (Figure 13.4.9), and suppository (anal insertion). Many varieties of heroin are available on the street, differing in purity and the nature of contaminants (Figure 13.4.10). Street heroin is very commonly diluted by adding a variety of compounds, most commonly caffeine, acetaminophen (e.g., Tylenol), quinine and lactose (a sugar), with the typical concentration of heroin ranging between 3% to 50%.

Uncertainty in the actual amount of heroin in any given sample makes it very difficult and dangerous for a user to know how much to inject, with different heroin samples varying more that 1500% in the concentration of its active ingredient. This would be like guessing how much aspirin to take for a headache with a possible range of potency varying between one to twenty tablets. Typically, abusers are little concerned with what dosage they are really receiving or the consequences of mixing heroin with the other 50-plus% of the material that they inject.

In the body, heroin, like all opiates, is broken down by our metabolism into other compounds that are ultimately excreted from the body. Toxicologists are able to identify these metabolites to verify the use of opiates even after the heroin itself is completely metabolized. This provides a relatively long window of time for showing that opiate use has occurred. Part of the metabolic pathway for heroin and codeine, for example, is shown in

![Figure 13.4.10. Different forms of heroin](www.stopheroin.net/apps/photos/photo?photoid=7140626).

![Figure 13.4.11. Compounds produced in the metabolism of heroin that can be analyzed for to confirm a diagnosis of heroin poisoning](http://cg.xipur-guidegoods.net/to-is-tramadol6fm.html).
Figure 13.4.11.

Codeine, while found in varying degrees in natural opium sap, is also produced directly from morphine by replacing one –OH group with an –OCH₃ group (called an ether). It is a mild pain reliever but finds most of its prescription use as a cough suppressant (antitussive) by decreasing the activity level in the part of the brain that controls coughing (as do most opiates). Codeine is less addictive than other opiates but it still can cause dependency. In some states and countries (e.g., Canada, Europe), formulations with low dosages of codeine are available without a prescription, although usually there are restrictions on the amount that can be purchased and by whom. Because of its increasing regulation and its lack of potency relative to other opiates, it is typically not a choice of adult abusers but is still of concern for younger abusers since it is found in many household medicine cabinets.

A variety of narcotics are chemically synthesized in the laboratory. These substances are called opioids since they are not derived directly from opium (opiates are chemically derived from opium) but are classified with opiates because they act in a similar fashion. Methadone is a completely synthetic molecule (opioid) that is today used as a substitute drug for opium addicts, although it has pain-reducing properties of its own. Levorphan and dextrorphan are two other synthetic opioids whose action is regulated by a simple modification of their structures, called chiral molecules (see box “Right and Left Handed Molecules”).

Oxycontin (e.g., percocet) and hydrocodone (e.g., vicodin) are medications widely prescribed for mild pain relief. Often, these compounds are teamed up with other drugs such as acetaminophen (e.g., Tylenol) and are available in time-released formulations to provide longer lasting pain relief. Because of their ready availability, they are also targets of abuse. Since Oxycontin and

Figure 13.4.13. Structure of THC (Δ⁹-
Tetrahydrocannabinol), the primary psychoactive
ingredient in marijuana

Figure 13.4.14. Leaf pattern of Cannabis
sativa (marijuana) (health.howstuffworks.com/wellness/drugs-
alcohol/marijuana1.htm).
hydrocodone are frequently prescribed, abusers have found insidious ways to obtain these drugs including pharmacy robberies and receiving multiple prescriptions for the same aliment from different, unsuspecting doctors.

**Hallucinogens:** Hallucinogens are compounds that alter normal thought processes, perceptions of the world, personal awareness, and psychological moods. Commonly encountered examples include marijuana, PCP (phencyclidine), LSD (lysergic acid diethylamide), mescaline, and ecstasy (MDMA or methylenedioxy-methamphetamine). But by far, the most commonly used member of this group is marijuana.

Marijuana (also called cannabis since it derives from the plant *Cannabis sativa*) is the most common of all illicit drugs used worldwide, according to the UN. Estimates suggest that over half of all adults have tried marijuana at some time in their lives, Figure 13.4.12. Controversy remains intense surrounding the legalization of medicinal and recreational marijuana use, with strong advocates on both sides of the debate. A number of states and countries of the world have either reduced or eliminated criminal penalties relating to possession and use of marijuana. Nonetheless, it is still legally classified in most places as a substance of abuse with restrictions upon possession and use.

Marijuana contains a psychoactive drug that is quickly metabolized by the body into a number of other chemicals, many of which are psychoactive themselves. Tetrahydrocannabinol (THC) is the primary active ingredient in marijuana (Figure 13.4.13), although marijuana is actually a complex mixture of many compounds, including other cannabinoids. Typically, the leaves (Figure

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**Figure 13.4.15.** Various forms of Cannabis derived products: Clockwise from upper left; dried marijuana flowers and leaves, keif formed from extracted trichoime plant parts, hashish, marijuana cigarettes, the resin from a water-pipe used to smoke marijuana, and concentrated hashish oil [Photos credits: Marijuana - hometestingblog.testcountry.com/?p=8808; Keif - www.expandumwealth.com/category/medicinal-marijuana/; Hashish – at2me.blogspot.com/2008/08/history-of-hashish.html; Hashish Oil - hometestingblog.testcountry.com/?p=8808; Marijuana Resin - en.wikipedia.org/wiki/File:Resin.jpg; marijuana cigarettes - www.bikertown.com/products-page/marijuana-products/marijuana-cigarettes/].
13.4.14) and dried flowers of the plant are harvested for processing and contain the highest concentrations of THC, ranging in concentration from 5 to 20% THC. Cannabis is used in a variety of forms (Figure 13.4.15), but most commonly the dried plant matter is simply smoked. The dried female flower parts of Cannabis (specifically the trichomes, Figure 13.4.16) can be processed into a more potent powder form, called keif, that is pressed into cakes or blocks called hashish. The hashish can be further processed through a solvent extraction process to yield a red oil, called hashish oil. The trichomes are often useful in identifying the dried plant material.

Hashish can contain between 15 and 70% THC while hashish oil can hold up to 90% THC. As with marijuana, these hashish products are usually smoked, but many other methods of use are encountered including vaporization, burning as incense, and cooking into food (“hash cookies”).

Cannabis is a hearty weed that grows well in many climates. The plants grow to between five and fifteen feet tall and continue to develop as long as they receive more than 12 hours of sunlight daily – less than that and the plants begins to flower. Since cannabis plants are also used in hemp production (primarily for rope making), varieties of cannabis have been developed that minimize the THC content in these strains, allowing them to be used commercially in ropes and not be subject to international drug restrictions. Cannabis has been cultivated specifically for drug use by humans for millennia, with confirmed use dating back to at least 3,000 BCE in regions of Asia and the Middle East.

Countries in Europe and the western hemisphere began to outlaw the possession and consumption of cannabis, however, only in the early twentieth century, with the first laws in the United States probably dating to about 1906.

THC begins to have psychoactive effects in Cannabis (THC) use (en.wikipedia.org/wiki/File:Bodily_effects_of_cannabis.png).

Figure 13.4.17. Symptoms from Cannabis (THC) use

Figure 13.4.16. Trichomes of Cannabis sativa (marijuana) where THC is concentrated (Sciencephoto.com Photo No. B745.432)

Figure 13.4.18. Effects of drugs on spiders (drugs fed to the spiders through doped flies): (from left to right) marijuana, benzedrine, caffeine, and chloral hydrate (Sciencephoto.com Photo No. Z430/525),

\[\text{Bodily effects of Cannabis}\]

- **Eyes:**
  - Reddening
  - Decreased intra-ocular pressure

- **Mouth:**
  - Dryness

- **Skin:**
  - Sensation of heat or cold

- **Heart:**
  - Increased heart rate

- **Muscles:**
  - Relaxation

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on the body at about the 10 mg/Kg level. Symptoms of low-level use include lowered blood pressure, increased heart rate, impairment of memory and learning processes, increase in appetite, and mood shifts (Figure 13.4.17 and 13.4.18). THC rapidly crosses the blood-brain barrier and binds to nerve synapses in the brain (synapses are the junctions between nerve cells that complete the electrical connections in the nervous system). This changes the nerve signal pathways in the brain itself causing euphoric feelings.

THC and its metabolites (especially THC-COOH) can be directly measured by GC/MS in urine, sweat, blood and other body fluids. The half-life of THC in the body is quite long – about 10 days, one of the longest for all illicit drugs. This means that marijuana use can be detected for weeks and even several months after use. When used only once, the THC and metabolites generally clear the body to detectable levels within about a week. Daily use, however, may mean that cannabis use may be detected for as long as three months in urine. THC can be tentatively identified in the field by the Duquenois-Levine color test.

Although less common now than in the past, LSD (Lysergic acid diethylamide) continues to be a widely abused drug (structure of LSD shown in Figure 13.4.19). LSD was first prepared in the laboratory in 1938 from ergotamine derived from the Ergot fungus and is still usually synthesized from natural sources of lysergic acid. It is a “fragile” molecule that decomposes in light and air but is stable for long periods when kept dry and dark or in solution.

LSD produces altered mental processes, a distorted sense of time and space, hallucinations, and synesthesias (when stimulation of one sensory form leads to stimulation of another sensation – such as when hearing a sound generates a particular vision sensation). LSD is a very potent psychoactive compound, with the typical dose ranging from about 100 to 500 micrograms and an LD₅₀ value of about 0.2 mg/Kg. LSD is usually taken orally – one of the most common forms involves chewing a piece of blotter paper that has been soaked with an LSD-containing solution (Figure 13.4.20). The body quickly develops a tolerance for the drug, contributing to its relative low risk for physiological dependence – it becomes more difficult to achieve the same hallucinogenic effect with continued use. Symptoms of use include pupil dilation, decreased appetite, weakness, nausea, increased heart rate, sweating, and tremors, among others (Figure 13.4.21). Long term problems connected with LSD use include psychosis and continuing hallucinations (“flashbacks”), which can arise even from a single dose.
The LSD molecule binds to many important types of receptors in the brain, including all dopamine and adrenal receptors, along with most serotonin receptors. This is believed to excite activity on the cerebral cortex of the brain, the part of the brain responsible for memory, consciousness, perception, and thought. Since the dose of LSD required for an individual is so small (ca. 0.200 mg), LSD is more easily prepared, transported, and sold than most other drugs. LSD and its metabolites are readily detected in blood, urine and other body fluids, although they are rapidly broken down by light and air. LSD is also fluorescent and glows bluish-white under ultraviolet irradiation.

A variety of other hallucinogens, both synthetic and those derived from natural sources, are commonly available. Phencyclidine (PCP or “angel dust”) was developed initially as a synthetic medicinal pharmaceutical but was found to be too dangerous for use as an anesthetic due to a tendency to cause adverse side effects (“bad trips”). While not manufactured commercially today, its synthesis is still performed in small illegal laboratories from readily available starting materials. Low doses of the drug produce feelings of euphoria and decreased inhibition. Larger doses can lead to anxiety attacks, violence, auditory hallucinations, and psychosis.

Natural hallucinogens have been used by cultures around the world since the beginning of recorded history. Mescaline (peyote) and psilocybin, isolated from the peyote cactus (Figure 13.4.22) and many species of mushrooms (Figure 13.4.23), respectively, have been used in religious observances worldwide to intensify the experiences. These hallucinogens are significantly less potent than LSD and are relatively rarely abused due to their lower potency, increases in body tolerance, and limitations in easily available sources.

MDMA (also known as “Ecstasy”), a synthetic drug, produces feeling of euphoria and decreased anxiety, as do many other hallucinogens. MDMA is a very
A common recreational drug and works by releasing serotonin, dopamine and other body chemicals to achieve feelings of well-being. The half-life of MDMA in the body is about 8 hours and is rapidly metabolized and eliminated from the system.

**Depressants:** These compounds act to depress the functioning of the central nervous system, bringing about calmness and sleep. Many common drugs fall into this category and include tranquilizers, barbiturates and alcohol – the by far the single most commonly used depressant (see next section). These drugs are often called tranquilizers, sedatives, and “downers”. In moderate dosages, these compounds may produce symptoms similar to alcohol intoxication (alcohol itself is classified as a depressant).

Barbiturates are derivatives of barbituric acid and have the potential both for significant physiological and psychological dependence. Still in medical use today, these compounds are prescribed for anesthesia, sedation and treatment of seizures. Phenobarbital, secobarbital (Seconal), pentobarbital (Nembutal), and Amobarbital (Amytal) are probably the most readily available of these drugs but, according to the DEA, are not likely to be heavily abused due to their mode of action and use primarily in hospitals. Some of these barbiturates have been called “truth drugs” since they have been used to reduce inhibitions to such a level that a person provides information they would otherwise not disclose.

The use of barbituates has largely been supplanted by another class of chemicals called benzodiazepines, such as Valium, Halcion, and Xanax (Figure 13.4.24). These compounds are among the most commonly prescribed medications currently in the US – about one of every five prescriptions written - and are used therapeutically to control seizures, reduce anxiety, and...
relieve muscle pains and spasms. In high dosages, these compounds act as hypnotic compounds, inducing sleep. These compounds are generally not heavily abused, despite their ready availability, with those who do abuse them obtaining the drug through multiple prescriptions from different doctors. The exceptions are adolescents, with access to the drug at home or from street sources, along with heroin and cocaine abusers.

Chloral hydrate, first synthesized in the 1830’s, is a strong sedative. In fiction and reality, this compound is the famous “knock-out drops” or “Mickey Finn” since it is very soluble in water and alcohol and is not illegal in all countries. Its medicinal use today is rather limited, largely replaced by other depressants.

A growing health concern, especially among the young, is the use of inhaled volatile gases, such as solvents, propellants, glue, hair sprays, spray paints, cleaning fluids, glue, and similar compounds. While some of these compounds act in other ways, many of them serve as depressants. This includes “glue sniffing” and “huffing” methods of administering chemicals rapidly into the body through the lungs. Solvents are placed into plastic bags or soaked into rags before being inhaled. Unfortunately these readily available solvents are absorbed very quickly into the bloodstream. This activity leads to severe medical problems, such as permanent liver, kidney, heart, and brain damage that can lead to sudden death.

**Club Drugs:** Several depressants, along with a few drugs from other classes, are specifically being used clandestinely to reduce a person’s natural inhibitions and to bring about amnesia of what happened while under the influence of the drug. These compounds are often part of drug-facilitated sexual assault cases (DFSA) and include rohypnol, GHB, ketamine, MDMA (ecstasy – actually a hallucinogen), Figure 13.4.25.

![Club drugs are easily obtained, readily concealed, and quickly added to an unsuspecting person’s food or drink, Figure 13.4.26.](news.gather.com/viewArticle.action?articleId=281474978587682).

![A variety of color-change test kits are now on the market to detect the presence of date-rape drugs in drinks](news.gather.com/viewArticle.action?articleId=281474978587682).

embarrassed to come forward to report the crime, feeling guilty and somehow responsible for the events.

One of the most common of the club drugs is Rohypnol (flunitrazepam) – a member of the benzodiazepine depressant family. Rohypnol is ten times more powerful than valium. It acts quickly to impair a victim’s judgment, typically within 20 to 30 minutes of administering the drug and its effect lasts for hours. It is called by a variety of street names including “forget-me pill”, “roofies”, “Mind eraser”, “Ropies”, and dozens of others. Commercial “at-home” kits are now available to help detect the presence of club drugs in a person’s drink or food (Figure 13.4.27).

Rohypnol is manufactured and prescribed outside the US as a sleeping aid but it is quite addictive and dangerous when the dosage is not controlled (as it rarely is in date-rape settings). When mixed with alcohol, a very common method of delivering the drug, combined effects can rapidly lead to respiratory depression, aspiration, coma, and death.

Another very common club drug is MDMA or “ecstasy”, a hallucinogen mentioned earlier. This drug is also highly addictive and extended use can have severe biological effects including increased blood pressure and heart rate, muscle spasms, kidney failure, and significantly increased chance of heart attack and stroke. Abuse of this drug is one of the major causes of cardiac arrest in otherwise healthy young people.

**Stimulants:** Stimulants have essentially the opposite effect of depressants, and work, as the name implies, by increasing a person’s alertness and activity. Common stimulants include cocaine, nicotine, caffeine, and the large family of amphetamine-related compounds. The use of some of these compounds, such as nicotine and caffeine, to increase alertness is quite common and generally accepted in society while the use of others, such as cocaine, are illegal in most places in the world. Like some other classes of drugs, stimulants often bring a feeling of well-being, reduced appetite, and increased levels of “energy”.

Cocaine (“officially” called benzoylmethylecgonine) is a very powerful stimulant.
that acts upon the central nervous system. It is derived from the leaves of the coca plant and was first isolated in 1855. Initially used as an anesthetic, one of the first ever produced (Figure 13.4.29), it eventually found its way in 1886 into a formulation with caffeine in wine. Later the wine was dropped, sugar was added as a sweetener, and the drink was named Coca-Cola. The drink was advertised as employing "the valuable tonic and nerve stimulant properties of the coca plant and cola nuts." After 1906, however, the cocaine was removed from the drink to comply with US laws.

Cocaine functions by interfering with the reabsorption of neurotransmitters, such as dopamine and serotonin, by the body and results in a buildup of these compounds leading to an overstimulation of the neurons. This buildup leads to a longer exposure of the nervous system to these neurotransmitters, especially in the pleasure centers of the brain, resulting in a feeling of euphoria, well-being, and abundant energy. Cocaine is very addictive and

![Figure 13.4.31. Cocaine](www.telegraph.co.uk/newsv/uknews/law-and-order/5311477/Drugs-busts-force-wholesale-cocaine-prices-to-record-levels-says-Soca-head.html).

![Figure 13.4.32. Crack Cocaine](sciencephoto.com No M372/171).

![Figure 13.4.33. Chemical structures of some common amphetamines. Note the chemical similarities to several hallucinogenic and/or club drugs (right column) (www.toxlab.co.uk/amphets.htm).](http://denr.sd.gov/des/wm/hw/hwmeth.aspx).

![Figure 13.4.34. Clandestine methamphetamine laboratory – a dangerous operation!](http://denr.sd.gov/des/wm/hw/hwmeth.aspx).
can also cause acute cardiovascular (heart) and cerebrovascular (brain) emergencies. Physical effects can include constricted blood vessels, dilated pupils, increased heart rate and others. Because of this, there is at least a 24-fold increase in the risk of acute myocardial infarction one hour after cocaine use with the risk independent of the size of the dose taken – any dose increases substantially the risk. Cocaine is also a vasoconstrictor, reducing blood flow through blood vessels – leading to changes in skin and other bodily functions (Figure 13.4.30). Cocaine use provides “highs” that are often short-lived, leading the user into more frequent use of the drug to regain the feelings of exhilaration.

Cocaine is a very addictive drug with tolerance built up by the body resulting in more drug required to achieve the same relative effect.

Cocaine is still extracted from coca leaves using organic solvents and is chemically converted into its hydrochloride salt, although it is found in a number of different “forms” on the street. The hydrochloride form is readily water-soluble and can be directly injected or “snorted” (Figure 13.4.31) to introduce it rapidly into the blood stream. Crack cocaine (Figure 13.4.32) is the “freebase” form of the drug (not the hydrochloride salt) that can then be heated or smoked – the name “crack” comes from the sound often heard as the solid drug is heated. Cocaine is, however, sensitive to pyrolysis so that smoking the drug decreases the amount of active drug delivered. Street samples of cocaine are often diluted with other compounds, most commonly lidocaine, sugar, phenacetin, and caffeine.

Amphetamines, often called “speed” or “uppers”, are commonly prescribed for medical problems including appetite suppression and as stimulants. A variety of amphetamines are known, such as those shown in Figure 13.4.33. These compounds cause the body to release reserves of the neurotransmitters dopamine and noradrenaline that act quickly on the central nervous and sympathetic system to produce feelings of exhilaration, self-assurance, motivation, and enhanced focus. Amphetamines tend to cause prolonged “highs” resulting from the blockage of dopamine re-uptake and inhibition of the enzymes that metabolize dopamine – both of these effects work to keep the dopamine around longer and the effect lasting longer. After the drug does wear off, however, a severe depression and deep fatigue usually results, primarily due to depletion of
neurotransmitter reserves caused by their rapid release by the drug’s action in the first place. It takes time for the body to build the reserves back up, during which time the person feels very poorly. This would be akin to spending all one’s money on payday at a fancy restaurant, only to starve afterwards until the next payday arrives.

Amphetamines are one of the most societally problematic drugs due to the increases in violent and anti-social behavior promoted by the drug’s use. The compound is synthesized in dangerous “home” laboratories (“meth labs”) by inexperienced, amateur chemists (Figure 13.4.34). Addiction drives users into depression, weight loss, insomnia, psychosis, and other behavioral problems, accompanied by a greatly increased risk of cardiovascular and cerebrovascular problems. Amphetamine use is also associated with a rapid increase in the body’s tolerance of the drug.

**Steroids:** Steroids are organic ring molecules that promote muscle growth and repair, regulate metabolism and immune function, and control blood properties (e.g., volume, electrolyte balance, etc.). Steroids include both naturally occurring compounds in the human body, such as hormones (e.g., androgens, progesterones, testosterones, estrogens, etc.) and cholesterol, as well as chemicals derived from other sources, such as anabolic steroids and corticosteroids. Their structures are all built upon a basic five-ring pattern, Figure 13.4.35, differing only by the chemical groups attached to this framework.

Some steroids, such as anabolic steroids, are controlled substances that can be legally prescribed for a variety of medical problems including cancer, hormone deficiency, and AIDS. These synthetic steroids mimic the action of male sex hormones that increase protein synthesis and lead to a buildup of tissue mass and muscle. The use of performance-enhancing steroids has been banned by most athletic organizations but the problem remains significant. The National Institute on Drug Abuse reported that 3.4% of all high school seniors have used steroids at least once in the preceding year. Professional athletes seem to be especially susceptible to steroid use, with an increasing number of high profile cases occurring each year. These steroids work by allowing athletes to train harder and longer, and to recover from these workouts faster, resulting in a rapid enhancement of their natural abilities.

Steroid use appears to be addictive and can lead to significant health risks (Figure 13.4.36 ) including increased risk for cancer, severe mood swings, increases in violent and aggressive behavior, renal failure (kidneys) and severe acne (Figure 13.4.37). In males, anabolic steroids essentially shut down male hormone production in the body, resulting in sexual dysfunction, testicular atrophy (shrinkage and dysfunction), hair loss, and enlargement of breasts in males. In females, anabolic steroids promote the development of typically “male” features.
– growth of facial hair, increase in pattern baldness, cessation of menstrual cycles, deepening of the voice, and muscle growth. Since the liver is the primary organ for the removal of these compounds, taking large doses of steroids can result in liver inflammation, hepatitis, cirrhosis, tumors and irreversible liver failure.

**Drug Laws**

Drug use and trafficking is clearly a global problem, with many different approaches taken to deal with the problem. Most countries have laws governing the manufacture, sale, distribution, and use of certain drugs. These laws vary greatly between nations based upon prevailing social, cultural, and religious norms. Between 1989 and 1999, sixty-six countries developed national drug policies; many more continue to work on legislation. The United Nations Office on Drugs and Crime (UNODC) continues its engagement in defining and controlling world-wide manufacture, sale and use of drugs for recognized medical applications, with a focus on criminal law enforcement when these and other drugs are used illicitly. In Europe, drug use is usually considered more of a health issue than a criminal issue although the trafficking, sale, or use of chemicals that lead to harm and dependency typically carry criminal penalties. While there is a great deal of variation from country to country, the focus in Europe is on: (1) police enforcement limiting the supply of illicit drugs by arresting dealers and stemming importation, (2) educators teaching anti-drug information, and (3) doctors dealing with addiction and chemical dependency problems.

In the United States, the Controlled Substance Act (CSA) Title II of the larger Comprehensive Drug Abuse Prevention and Control Act of 1970, established the legal foundation for the government’s goal of fighting the national drug abuse problem – the “War on Drugs”. Importantly, it pulled together a number of laws that control the manufacture and distribution of many types of drugs. The CSA provides criminal guidelines for holding different

![Drug Enforcement Administration](www.justice.gov/dea/index.htm)

**Figure 13.4.38.** In the US, the Drug Enforcement Administration of the Department of Justice is charged with overseeing the Controlled Substance Act (CSA) (www.justice.gov/dea/index.htm).

**Types of Drugs:**

- **Narcotics** – bring relief from pain and induce sleep. (often incorrectly used as reference to any socially unacceptable drug). Narcotics are analgesic - relieve pain by depressing nervous system (opium, morphine, heroin, codeine, opiates - oxycontin, methadone);
- **Hallucinogens** - alter normal thoughts, perceptions and moods (PCP, LSD, mescaline, MDMA, ecstasy);
- **Depressants** - depress functions of central nervous system, reduce anxiety, and aid in bringing about sleep (alcohol, barbituates, tranquilizers);
- **Stimulants** - increase alertness, mental activity and focus (cocaine, amphetamines);
- **Club/Date-Rape Drugs** - reduce inhibitions and awareness (roophynol, esctacy, MDMA, GHB, ketamine).
- **Steroids** - promote muscle growth and repair (androgen, testosterone, anabolic steroids).
amounts of chemicals defined as *controlled substances*, with an attempt to distinguish users from those who distribute the drug. In the United States alone, there are an estimated 1.8 million drug arrests each year, currently about 40% of these are related to marijuana use.

The CSA law classifies all drugs into five groups, called *schedules*, which arrange drugs based primarily upon their accepted medical usages and potential for abuse (with some exceptions for particular substances). A summary of the features of these schedules is given in Table 13.4.1.

Schedule I drugs, those that are deemed the most dangerous, carry a very high potential for abuse, lack any current accepted medical use, and do not have an accepted safe method for using the drug – even while under careful professional medical supervision. No prescriptions can be written for these substances and their manufacture is tightly overseen by the DEA (Drug Enforcement Administration – Figure 13.4.33). Drugs in this class include heroin, marijuana, LSD, the date-rape drug GHB, the hallucinogens psilocybin and mescaline, and a variety of potent pain relievers and amphetamines.

<table>
<thead>
<tr>
<th>Schedule I</th>
<th>Schedule II</th>
<th>Schedule III</th>
<th>Schedule IV</th>
<th>Schedule V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for dependence and Abuse</td>
<td>High</td>
<td>High</td>
<td>Lower than Schedule I or II drugs (moderate)</td>
<td>Low</td>
</tr>
<tr>
<td>Medical use</td>
<td>No currently accepted medical use for treatment</td>
<td>Current accepted medical use but with severe restrictions on prescribing</td>
<td>Current accepted medical use in treatment</td>
<td>Current accepted medical use in treatment</td>
</tr>
<tr>
<td>Restrictions</td>
<td>Illegal in any quantities</td>
<td>Requires special reporting and administration</td>
<td>Prescription required</td>
<td>Prescription required</td>
</tr>
<tr>
<td>Examples</td>
<td>Heroin, LSD, Marijuana, Methaqualone, GHB</td>
<td>Morphine, PCP, cocaine, methadone, methamphetamine</td>
<td>Codeine, hydrocodone, some barbiturates, ketamine, anabolic steroids</td>
<td>Librium, Darvon, Valium</td>
</tr>
<tr>
<td>Sentences</td>
<td>Very Severe, especially when accompanied by violence – includes life imprisonment</td>
<td>Severe when not used within strict guidelines of medical oversight</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Schedule II drugs are those that also have a high potential for abuse and dependence but have at least some generally accepted medical applications (generally accepted by the medical community and confirmed by the Department of Justice). These medications, when prescribed by a physician, carry severe restrictions of when and how they might be used. Morphine, a Schedule II drug, is most often prescribed and administered in a hospital setting where strict oversight is possible and access to the drug by personnel is tightly monitored. Other drugs in this schedule include cocaine, methadone, oxycontin, a variety of less potent and medium acting amphetamines, high concentration codeine, phencyclidine, and Ritalin (often prescribed for attention deficit disorder, ADD, in children).

Schedule III drugs have a lower potential for abuse and addiction than compounds in either Schedule I or II and have well-accepted medical uses. These drugs are still highly regulated but are
prescribable by a physician and available from a pharmacist, although the number of refills of these prescriptions are controlled. Drugs in this group include anabolic steroids, the common date-rape drug ketamine, hydrocodone and codeine compounded with a pain reliever (such as ibuprofen or acetaminophen), and a variety of intermediate-acting barbiturates.

Schedule IV drugs are those that carry a relatively low potential for abuse and have a medically accepted application. These drugs also have a low potential for either psychological or physiological dependence. This category contains many common prescriptions that may be refilled up to five times within a six-month period and includes many long-acting barbiturates, moderate analgesics, stimulants, and anti-psychotic drugs.

Schedule V drugs are those that have a low potential for abuse and dependence and have well established medical uses. These drugs can only be distributed for medical purposes and include a number of over-the-counter medications like cough suppressants and anti-diarrheal medications.

While there have been a number of tests of the constitutionality of the CSA, it has thus far been upheld by the Supreme Court. The classification of drugs into a particular drug schedule is subject to legislation. For example, the placement of the date-rape drug GHB on Schedule I was legislated in 2000 although when used as a medication under the trade name Xyrem it remains a Schedule III drug (one of several multiply-listed drugs).