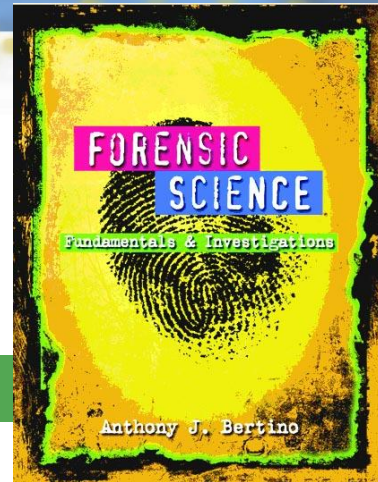


Chapter 9 *Drug Identification and Toxicology*

By the end of this chapter you will be able to:



- A. Identify the five types of controlled substances
- B. Relate signs and symptoms of overdose with a specific class of drugs or toxins
- C. Describe the role of various types of toxins in causing death
- D. Discuss agents that may be used in bioterrorism
- E. Define and describe the goals and practice of toxicology



How Much Do You Know About Drug I.D. and Toxicology...?

True or False...?

1. All toxins are illegal
2. Saliva-based drug tests are just as accurate as urine-based drug tests
3. Hair tests can show the presence of a drug 3 months after consumption
4. Mercury was used in medication until 1984.
5. 23% of murders are committed using poisons
6. Dogs' sense of smell is 40 times greater than humans'
7. The small intestine is the organ in humans that detoxifies the body's wastes

Introduction



- A. Toxicology – the study of **poisons & drugs** used for medicinal, recreational, or criminal purposes.
- B. Exposure to drugs & toxins can be:
 - 1. **Ingested** through the gastrointestinal system
 - 2. **Inhaled** into the lungs
 - 3. **Injected** into the bloodstream
 - 4. **Absorbed** into the skin

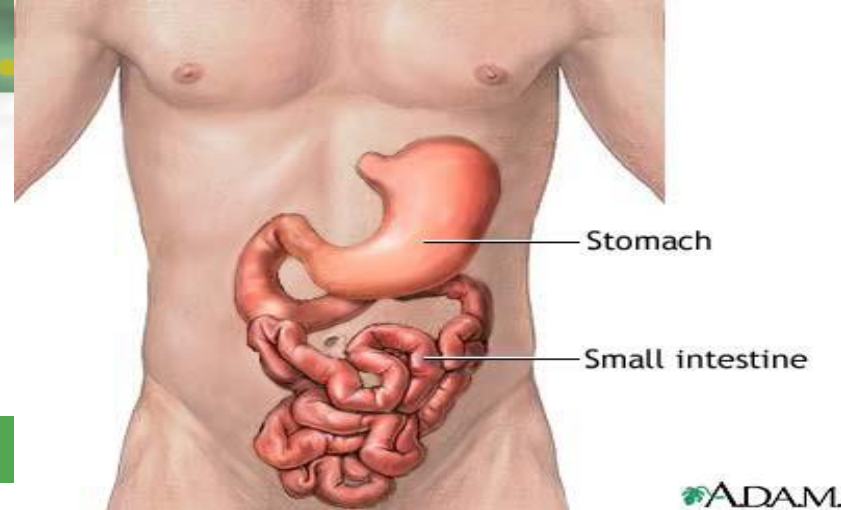
Introduction

C. Toxicity – the degree to which a substance is poisonous or can cause injury. Toxicity depends on:

1. Dose – how much is taken/absorbed
2. Duration – frequency/length of exposure
3. Nature of exposure – ingested, inhaled, absorbed
4. Interaction with other drugs – alcohol, prescription drugs



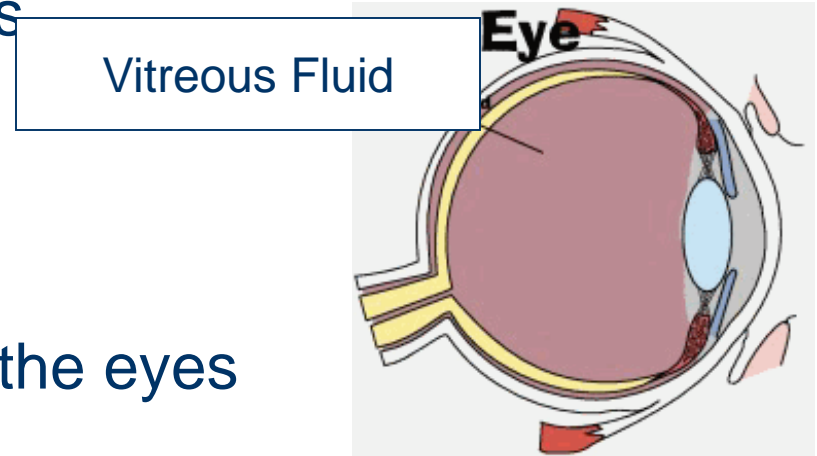
Introduction



D. Forensic toxicology - helps determine the relationships between **exposure** to a drug and the **resulting effects** (toxic or lethal)

E. **Bodily Fluids & tissues** can be analyzed to detect exposure to drugs & toxins

1. Stomach contents
2. Skin and Hair
3. Internal Organs
4. Vitreous humor fluid of the eyes



Introduction

F. Other toxic agents may include heavy metals, solvents & vapors, radiation & radioactive materials, pesticides, & plant/animal toxins.

G. Toxic substances are also classified by **HOW** people are exposed to them:

1. **Intentionally**—by treating illness or relieving pain
2. **Accidentally**— by harmful combinations or overdoses
3. **Deliberately**— homicide (killing others) or suicide (oneself)

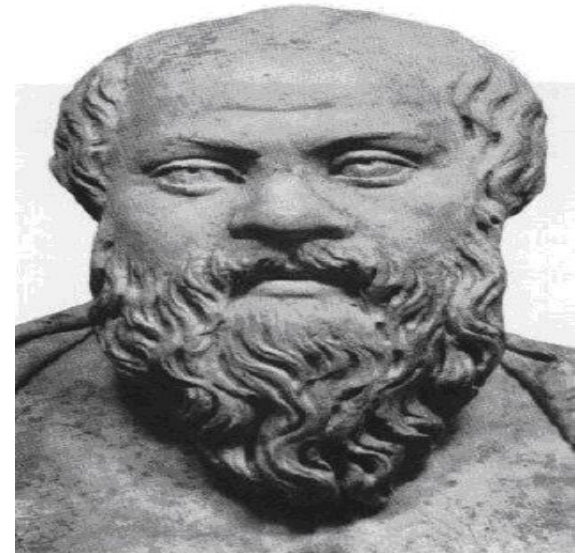


History, Murder, Overdose, & Crime

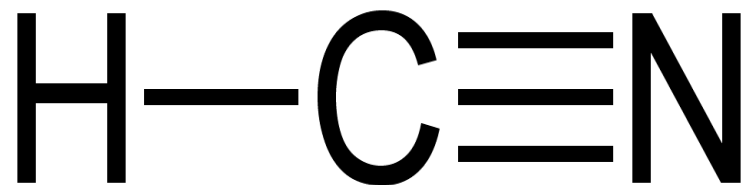


A. History of Toxins & Notable Poisonings

1. The Greek philosopher Socrates was one of the earliest reported victims of poisoning (399 B.C.)
2. In the 17th Century, toxic doses of poisons were given to rich and royal families to settle disputes



History, Murder, Overdose, & Crime



As

3. Arsenic and Cyanide were most commonly used because they are extremely toxic in small doses.
4. In the 1800's chemical analysis was developed to identify toxins in human tissues.



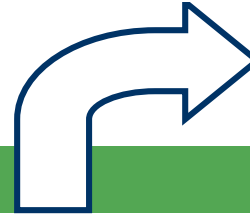
History, Murder, Overdose, & Crime

5. **Nazi leaders** Heinrich Himmler & Hermann Goering ingested cyanide capsules in 1945
6. **Jonestown cult members** consumed cyanide-laced punch in 1978 killing ~900 people



History, Murder, Overdose, & Crime

RICIN



7. Bulgarian dissident Georgi Markov was killed by **ricin** in **1978**

8. Russian ex-spy Alexander Litvinenko was mysteriously **exposed to radiation** in 2006 (polonium-210)- he died.



9. President of Ukraine: Viktor Yushchenko dioxin poisoning in 2004

History, Murder, Overdose, & Crime

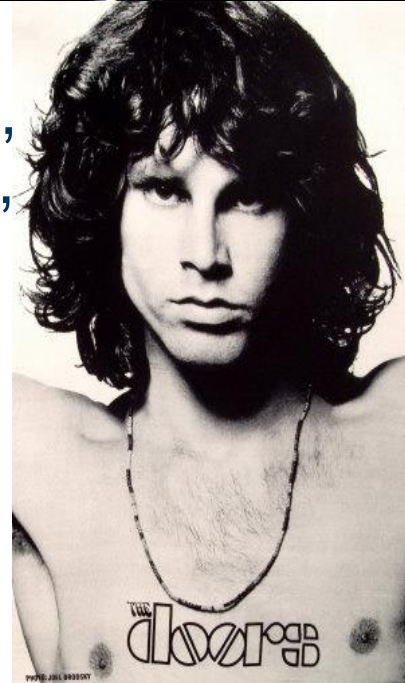


- B. Less than $\frac{1}{2}$ of 1% of all homicides results from poisoning.
- C. Commonly used poisons include **arsenic, cyanide and strychnine**, as well as an assortment of other industrial chemicals such as **fertilizers**.
- D. Acute Poisoning – **high doses** over a short period of time causing immediate symptoms such as cyanide ingestion
- E. Chronic Poisoning – **lower doses** over long periods of time producing gradual symptoms such as lead & mercury poisoning.

History, Murder, Overdose, & Crime

F. **Accidental drug overdoses** or lethal drug combinations are more common— John Belushi, Chris Farley, Anna Nicole Smith, River Phoenix, Heath Ledger, Jim Morrison, Jimmi Hendrix

G. More than **50% federal and 20% of the state prison populations** consist of drug offenders.





Controlled Substances

- A. Controlled Substances –drugs whose manufacture, distribution, possession and use are restricted because of the effects and potential for abuse
- B. There are 5 classes of controlled substances:

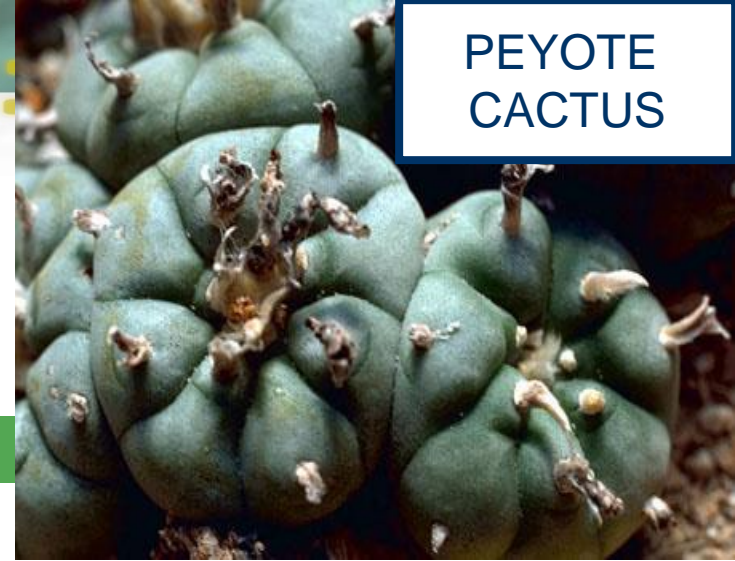
1. Hallucinogens
2. Narcotics
3. Stimulants
4. Anabolic Steroids
5. Depressants

Drug Schedules



Hallucinogens

MARIJUANA



- A. Hallucinogens - often derived from **plants** and **affect the user's perceptions**, thinking, self-awareness, and emotions.
- B. **Naturally grown** – mescaline (cactus – peyote), marijuana, and certain mushrooms.
- C. **Chemically manufactured** – LSD, MDMA (ecstasy), PCP (angel dust).

MUSHROOMS

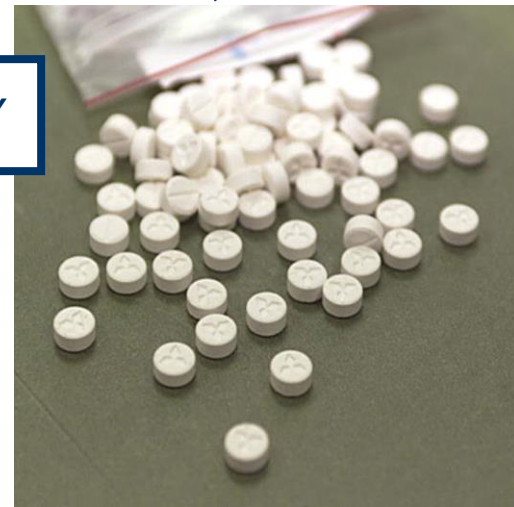


Hallucinogens

D. The **effect and intensity** of response to these drugs varies from person to person.

E. Overdoses cause **increased heart rate**, increased blood pressure, panic attacks, anxiety, or psychosis.

ECSTASY





Narcotics

Narcotics reduce pain and can be very addictive!

Drug	Characteristics of Drug Overdose
Opium	Difficulty breathing, low blood pressure, weakness, dizziness, confusion, loss of consciousness, coma, cold clammy skin, small pupils
Heroin Codeine Morphine	Difficulty breathing, low blood pressure, coma, spasms of the stomach or intestines, constipation, nausea, vomiting, sleepiness, blue fingernails and lips, death
Methadone	Difficulty breathing, drowsiness, coma, low blood pressure, muscle twitches, blue fingernails and lips
Oxycodone	Slow, difficult breathing, seizures, dizziness, weakness, loss of consciousness, coma, confusion, tiredness, cold clammy skin and small pupils



Narcotics



A. Narcotics – reduce pain by **suppressing** the nervous system's ability to relay messages to the brain.

B. Include opium and its derivatives – **heroin and codeine**.

C. Examples - Vicodin, Lortab, Methadone, Morphine, Percocet, OxyContin, Tylenol 3

OPIUM PLANT



Heroin Addict

Narcotics



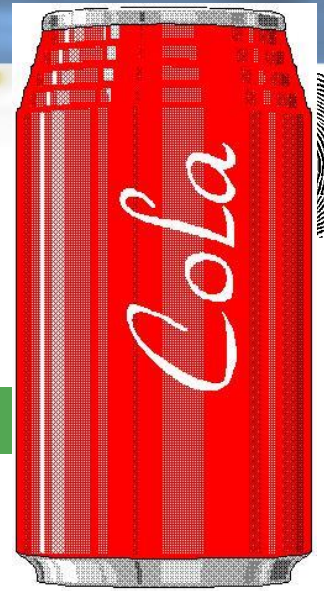
D. Overdose symptoms include difficulty **breathing**, low **blood pressure**, weakness, dizziness, confusion, muscle twitches, coma, blue fingernails/lips

E. These drugs are **very habit forming** and are often abused.



Stimulants

- A. Stimulants - increase feelings of energy and alertness while suppressing appetite.
- B. Abused to boost endurance & productivity
- C. Highly addictive
- D. Depression often results as the drug wears off

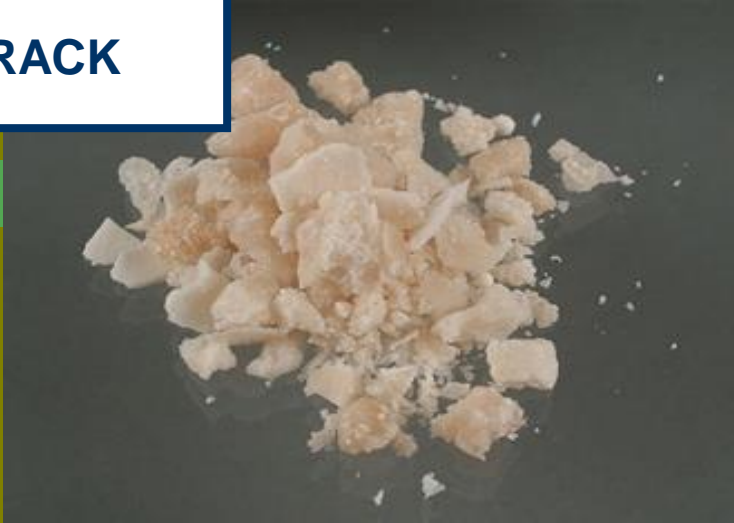


Stimulants

COCAINE



CRACK



CRYSTAL METH



E. Examples –
amphetamines,
methamphetamines,
cocaine (crack)

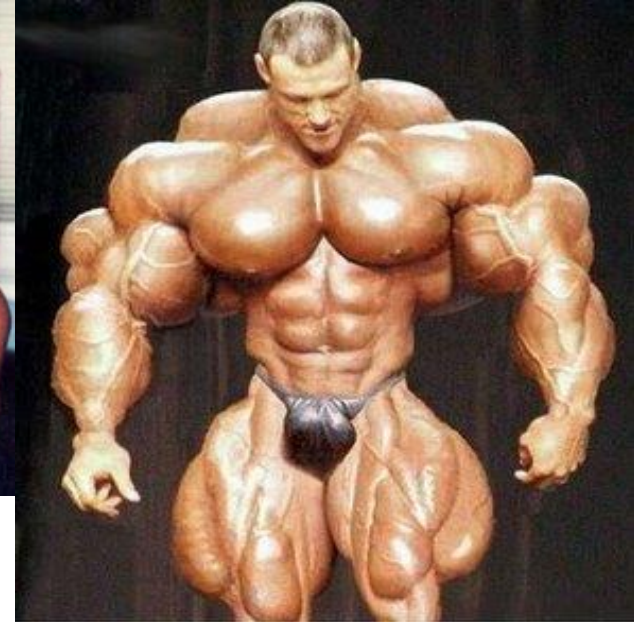
Note: methamphetamines
are more potent than
amphetamines

Stimulants

F. Overdose symptoms include high blood pressure, heart rate, agitation, confusion, stroke, seizures.



Anabolic Steroids



- A. Anabolic Steroids – promote cell and tissue growth & division increasing bone mass and body muscle
- B. Produced in a lab and have a chemical structure similar to testosterone.
- C. Used to treat low testosterone levels, delayed puberty, impotence, and muscle wasting caused by diseases & disorders.



Anabolic Steroids

BARRY BONDS
Professional Baseball



MARION JONES
Olympian
Track & Field

- D. Popular with **weightlifters**, **bodybuilders**, and other athletes.
- E. Side effects include **acne**, increased **body hair** & **baldness**, high blood pressure, high **cholesterol**, impaired **fertility**, blood **clots**, kidney/liver **cancers**, heart **attacks**

Depressants



- A. Depressants – relieve anxiety and produce sleep
- B. Act on the central nervous system and increase the activity of a neurotransmitter called GABA.
- C. Increased GABA production results in a calming feeling, drowsiness and slowed brain activity.
- D. Examples include barbiturates & benzodiazepines such as Valium or Xanax



HEATH LEDGER died of an
accidental prescription
drug overdose

Depressants

- E. Side effects include **slurred** speech, loss of **coordination**, and a state of intoxication similar to alcohol.
- F. Overdose symptoms include **slow heart rate & breathing** leading to coma and death
- G. Mixing depressants with alcohol and other drugs **increases their effects &** can create lethal combinations



Combined effects of oxycodone, hydrocodone, diazepam, temazepam, alprazolam and doxylamine became lethal.

Alcohols



- A. All alcohols are **toxic to the body**
- B. Some are **indirectly** toxic – only poisonous once metabolized by the body
- Ex. **Methanol** is not directly poisonous but is converted to **formaldehyde in the liver** and becomes very toxic
- C. **Ethanol** (grain alcohol) is found in many **beverages**
 - 1. Produced by the **fermentation** of sugar in fruits, grains & vegetables
 - 2. Pure ethanol is **tasteless** and can **damage human tissue**



Alcohols

The following contain EQUAL amounts of Alcohol

D. The body converts ethanol to **acetaldehyde** and then to **acetic acid**.

1. Too much acetaldehyde in the blood produces **dehydration & hangover** symptoms like headache, nausea & weakness

E. Chronic abuse of alcohol can cause **liver damage** & severe behavior modifications such as **rage and depression**



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Organic Toxins



Wasp Stinger
with venom

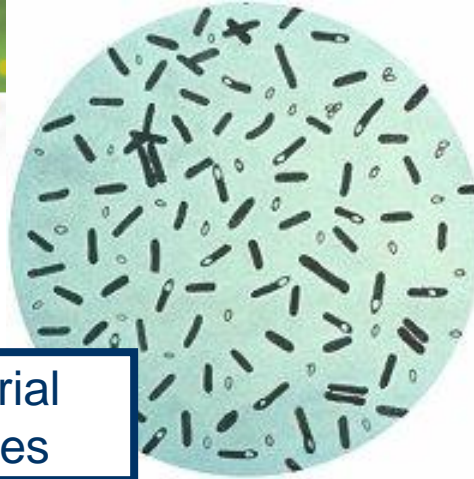


- A. Organic toxins are **poisonous substances** produced by **living organisms**
- B. They are proteins absorbed by another creature that **interfere with metabolism**
- C. Usually absorbed through the **skin or intestine**
- D. Examples include **bee stings or snakebites**
- E. Venom – a toxin secreted by an animal that can be **transferred to a human**



Bacterial Toxins

Bacterial Spores



Clostridium botulinum

A. Botulism – a **neurotoxin** produced by the bacteria *Clostridium Botulinm*

1. The most poisonous **biological substance** known to humans
2. **Paralyzes muscles** by blocking neurotransmitters
3. Causes **irreversible damage** to nerve endings.
4. Very small amounts are **extremely deadly**.



Bacterial Toxins

5. Can be ingested from contaminated food – canned vegetables, cured pork/ham, smoked/raw fish & honey/corn syrup
6. Can be inhaled through bacterial spores that release the toxin in the body
7. Botox - purified botulinum toxin - has been safely used in medicine and cosmetics



Before



After



Bacterial Toxins

B. Tetanus - a **neurotoxin** produced from the bacteria *Costridium tetani*

1. Bacteria release a **poison** that blocks nerve signals **from the spinal cord to the muscles**
2. Causes severe **muscle spasms** that can **tear muscles and fracture bones**
3. Sometimes called **Lockjaw** because symptoms begin in the jaw and interfere with breathing
4. Worldwide ~ **1 million** deaths/year; U.S. ~ **5** deaths/year in persons who have **not been vaccinated**





Pesticides & Heavy Metals

Pesticides mostly are used to protect plants or food crops.

Substance	Characteristics of Drug Overdose
Pesticides (e.g., DDT, aldrin, dieldrin)	Interferes with the movement of nerve impulses and muscular contractions. Anxiety, seizures, twitching, rapid heart beat, muscle weakness, sweating, salivation, diarrhea, tearing, coma, and death
Lead	Nausea, abdominal pain, insomnia, headache, weight loss, constipation, anemia, kidney problem, vomiting, blue discoloration along the gum line, seizure, coma, and death.
Mercury	Acute poisoning from inhalation causes flu-like symptoms, muscle aches, and stomach upset. Chronic poisoning causes irritability, personality changes, headache, memory and balance problems, abdominal pain, nausea and vomiting, damage to the gums, mouth, and teeth. Long-term exposure can cause death.



Pesticides and Heavy Metals

Metal compounds can damage many organs in the body.

Substance	Characteristics of Drug Overdose
Arsenic	<p>Within 30 minutes of ingestion produces abdominal pain, severe nausea, vomiting, diarrhea, muscle cramps, convulsions, kidney failure, delirium, and death.</p> <p>Chronic exposure produces skin lesions, headache, personality changes, nausea, vomiting, diarrhea, convulsions, and coma.</p>
Cyanide	<p>Overdose can be fatal 6-8 minutes after ingestion. Rapidly causes weakness, confusion, coma, and pink skin from high blood oxygen saturation. Produces an almond-like odor.</p>
Strychnine	<p>Enters the body by inhalation or absorption through eyes or mouth. Produces, within minutes, body spasms, temperature rises, violent convulsions, and death.</p>

Pesticides & Heavy Metals

PESTICIDES



- A. Pesticides - used for controlling insects, mice, weeds, fungi, bacteria, and viruses that threaten food or crops
 - 1. Measured by **duration to exposure** and accumulates over time
- B. Metal compounds are very **poisonous** and have been used for **suicide** and **homicide**
 - 1. May enter the body by **ingestion, inhalation or absorption**
 - 2. Metals are stored in **soft tissues** and can harm **organs**



Auschwitz Concentration
Camp Gas Chamber - Poland



Lethal Injection



Pesticides & Heavy Metals



C. Other lethal agents produce death by **inhibiting enzyme activity** & interfering with the production of ATP - the energy needed for cellular function

1. Hydrogen cyanide - **used in gas chambers**
2. Carbon Monoxide - **from non-ventilated car exhaust**
3. Potassium Chloride - **used in lethal injections** - stops the heart by ceasing electrical impulses

Bioterrorism Agents

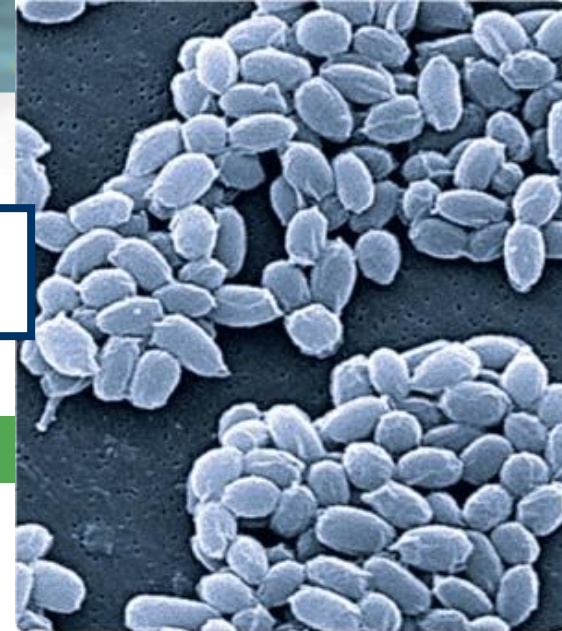


Hazmat investigates
a Ricin scare

- A. Ricin – a waste product from manufacturing castor oil
1. A poisonous protein in the castor bean
 2. Lethal in extremely small amounts
 3. Can be inhaled as a mist or a powder, ingested as food or drink or injected into the body.
 4. Prevents cells from making necessary proteins & can cause death within a few hours.

Bioterrorism Agents

Anthrax Spores



B. Anthrax – caused by the bacterium *Bacillus anthracis* which forms spores

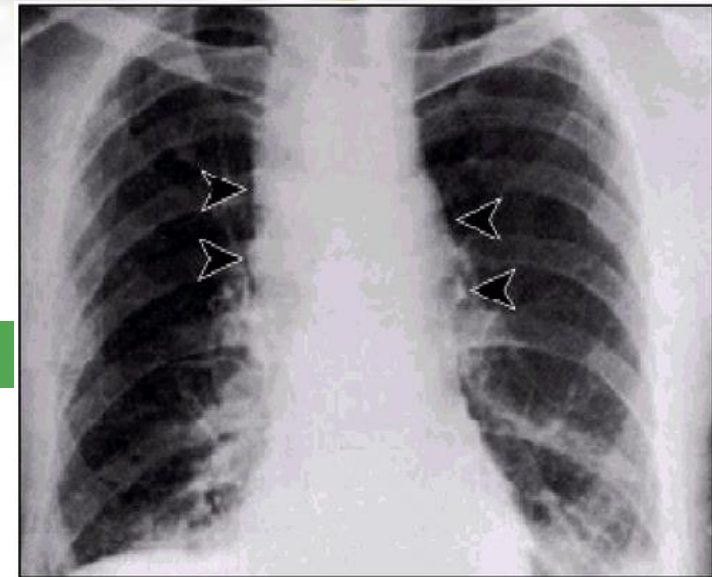
1. Spores can remain dormant and inactive until encountering favorable conditions
2. Can be spread to humans from infected animals.

Anthrax Cutaneous Lesion



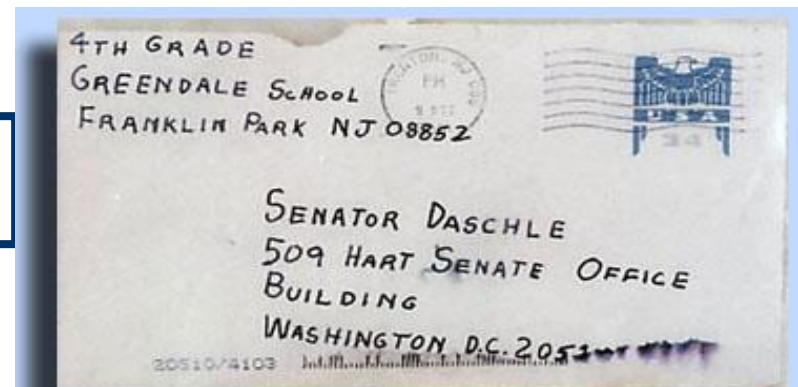
Bioterrorism Agents

3. Can be inhaled causing breathing problems (usually fatal) ingestion (25% to 60% fatal) or absorption via the skin (20% fatal)
4. In 2001, anthrax caused 22 infections when spread through the U.S. postal system of which half resulted in death.



Inhaled Anthrax
X-Ray

Letter to U.S. Senate
Containing Anthrax



Summary



- A. Forensic toxicology seeks to identify **poisons or drugs in criminals and victims.**
- B. Toxicology is important in studying cases of **drug overdose and sporting violations.**
- C. **Controlled substances** fall into five main groups.
- D. Poisons can be produced by **living organisms.**
- E. **Pesticides and heavy metals** are common poisons.
- F. **Bioterrorism agents** include ricin and anthrax.