#2200 Effects of Drugs

The objective of this kit is to develop in the student an understanding of what a drug is and how it affects a living organism. The student will use safe, commonly encountered materials that are provided in the kit and a readily available laboratory organism, *Daphnia sp.* for these investigations. This kit allows a student to study the effect of lactic acid, nicotine, adrenaline, alcohol, aspirin, and caffeine on the central nervous system. Enough material is provided for a class of 30 students working in pairs. Three to four class periods will be required to complete the investigations.

Contents:

Microscope Slides (72)
Plastic Cups (15 - 30 ml)
Pipets (15)
Grease Pack (1)
Nylon Washers (15)
Crustacean Ringers Soln. (2 - 120 ml bottles)
Aspirin Solution (1 - 30 ml bottle)
Nicotine Sulfate Solution (1 - 30 ml bottle)
Caffeine Solution (1 - 30 ml bottle)
Ethyl Alcohol Solution (1 - 30 ml bottle)
Lactic Acid Solution (1 - 30 ml bottle)
Adrenaline Chloride Solution (1 - 30 ml bottle)

Teacher's Manual (1)
Student Instructions Master (1)

Additional Required Materials:

Daphnia sp. cultures
Microscopes
Distilled Water
Hydromethylcellulose solution (optional)

WARNING: **This product contains NICOTINE and ASPIRIN, chemicals known to cause reproductive toxicity.**

Refills are available for the kit.
The Science First part number is:
2200-SOL "Effects of Drugs Solutions"

Introduction

The use and abuse of drugs are subjects of immense social importance. We frequently read about scientific breakthroughs, blatant quackery, huge drug busts, and the tragedies of a teenage junkie. Young people are asked to form opinions and make real decisions about drugs and how they fit into a person's life. Most of the basis for these judgments is peer pressure and mass media presentation of what drugs and drug abuse are all about.

This kit aims to develop in the student an understanding of what a drug is and how it affects a living organism. The student uses safe, commonly encountered materials and a readily available laboratory organism, *Daphnia sp.* for these investigations. Working with a living organism, rather than a written description, the student can see first hand the profound effects that a simple material, such as nicotine, can have. The student also develops the ability to handle laboratory organisms carefully and with respect.

The materials in the kit are ready for use, and require only that the *Daphnia* culture be purchased ahead of time. The student will need access to microscopes of 40x to 100x to perform the activities. The materials provided are sufficient for a class of 30 students working in pairs.

This kit is intended for use by junior high and high school students studying general science, health or biology. Opportunities are present throughout the kit to relate the activities to discussion of human health and drug use. The nature and contents of these discussions must depend on local opinion regarding drugs and their use. You should review ahead of time what topics will be discussed in class.

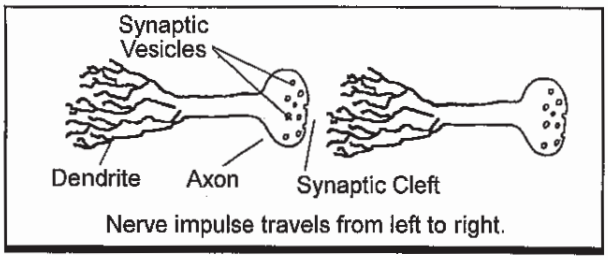
Background Information

Any chemical that alters the functioning of the human body is a drug. Many harmful chemicals such as LSD, heroin, cocaine, marijuana, and many seemingly harmless substances such as nicotine, aspirin and caffeine are drugs. To understand the activity of any of these drugs, we must first establish the concept of baseline, the normal activity of the organism, and then examine how drugs affect the activity of the organism.

Systems - Baseline

It is impossible to fully describe normal behavior in this discussion. For the purposes of the investigations of this kit, we will focus our attention on some key attributes of the circulatory, nervous and muscular systems. These systems, particularly the nervous system, are most immediately affected by most common drugs. Many medicinal drugs, such as insulin, act on the digestive, endocrine and excretory systems; and most on several systems at once.

The nervous system acts as a regulator for all bodily functions - speech, respiration, heart rate, motor activity, etc. An important aspect of the nervous systems is the ability to transmit impulses quickly from one nerve cell (neuron) to another, and from neurons to muscle cells. This transmission occurs across a specialized junction called a synapse. A diagram of two neurons is at right. A nerve transmission travels down a neuron, from the axon of one towards the dendrite of another. When the impulse reaches the end of the axon, called the presynaptic bulb, it stimulates the movement



Nerve impulse travels from left to right.

of synaptic vesicles which contain a neurotransmitter toward the synaptic cleft (the most commonly encountered neurotransmitter is Acetylcholine, or ACH). Here the vesicle fuses with the membrane of the presynaptic bulb and releases the neurotransmitter. The transmitter travels across the cleft and, upon reaching the dendrite, is received by the receptor sites of the dendrite. An enzyme specific for the neurotransmitter (for ACH the specific enzyme is acetylcholinesterase - ACHe) deactivates and removes it and the neurotransmitter is then resorbed by the presynaptic bulb. A similar situation occurs at the neuromuscular junction, except a muscle cell replaces the dendrite. Many drugs affect the nervous system at this site, by either inhibiting production of the neurotransmitter or its complimentary enzyme. Respiration and circulation are regulated by the involuntary nervous system. Changes in these two systems can be shown by the response known as "fight or flight". Activation of the sympathetic nervous system in times of stress, being startled for example, leaves a person wide eyed, flushed, breathing heavily and shaking. This results from a sudden release of adrenaline and noradrenaline from the adrenal medulla. This leads to an increase in the heart beat rate; it causes the peripheral blood vessels to clamp down and direct blood to the muscles and away from the digestive organs; and it causes an increase in respiration and an increase in cellular metabolism, all of which helps prepare the organism to either fight or flee.

Effects of Drugs

Drugs exert their effects primarily by changing the balance of bodily functions. While some drugs act solely on the respiratory or circulatory systems, most drugs involve the nervous system at some point.
Some drugs imitate the effect of neurotransmitters. These drugs cause impulses to be received by the dendrite even though none was initiated at the axon. LSD and other hallucinogenic drugs over stimulate those nerves which connect memory and emotion centers of the brain. This causes one to lose the distinction between what is real and what is fantasy.

Tranquilizers appear to over stimulate relaxation pathways of the parasympathetic areas, particularly the limbic system. Barbiturates and other depressants act by reducing nerve activity in the brain s arousal system, the reticular formation. Barbiturates may also reduce the activity of memory and perception centers, thus reducing the nerve impulses which constitute being awake.

Anesthetics, analgesics, and opiates (heroin, codeine) have very diverse effects, but act in similar ways. The brain's ability to perceive stimuli, particularly pain messages, is reduced. This inhibition of pain impulses along the pathway prevents them from reaching the limbic system. In the case of opiates, a small dosage induces a state of calmness, but a large dose may result in death.

Alcohol acts as a depressant, not as a stimulant as many people believe. Alcohol inhibits normal control mechanisms within the brain. Alcohol depresses the ability of the brain to react to stimuli, thus leading to poor reflex responses, i.e. the ability to drive, walk, and talk.

The Role of the Liver

The effect of any drug depends on its effective dosage in the bloodstream. The liver acts as a detoxifier - it breaks down any foreign chemical in the body. Thus the effective dose of a drug depends on how much the liver can handle in a given period of time. For example, an average adult liver can metabolize about 8 grams (8 ml or 1/4 ounce) of alcohol per hour. Any amount over this level will remain in the blood and is available to act on the brain.

As the body is exposed to several drugs at once, the ability of the liver to metabolize one over the other is compromised. An example is alcohol and barbiturates. Two or three sleeping pills taken after several strong drinks can have the same effect as several doses taken without alcohol. This synergism is an important consideration in any situation involving drugs.

Over a period of time, constant drug exposure can lead to changes in the way the body responds. Drug metabolism increases with increased exposure and results in tolerance to drugs. A smoker needs to smoke more and more cigarettes to experience the same light-headed feelings as when he first started. The same is true for the chronic drug abuser. An increased dosage is necessary to produce the same high.

The uses and abuses of drugs in our society require much consideration, particularly by those who must make decisions for themselves. The problems of drug abuse and its tragedies are well documented. The challenge now is to educate young people to consider the effects of all drugs on their bodies, and to make responsible decisions for their own lives.

Use of "The Effects of Drugs" in the Classroom

In this kit, the students will be looking at the effects of chemicals on the central nervous system. The chemicals they will be using are listed below:

Lactic Acid is the result of cellular metabolism. Lactic acid is most noticeable when exercising vigorously. It is felt as a burning feeling in the large muscles. Its effect on the nervous system results in an increased heart rate, since the heart utilizes the lactic acid for increased contractions when stressed.

Nicotine excites the autonomic nervous system and mimics the effects of acetylcholine. This results in a clamping down of the blood vessels of the digestive organs and in the limbs. Nicotine also increases gastrointestinal activity.

Adrenaline, sometimes called *epinephrine*, is produced by the adrenal medulla which is located just above the kidneys in the abdomen. Adrenaline has many functions, particularly in the fight or flight response.
Caffeine affects many systems in addition to the central nervous system. It increases cellular metabolism, and the formation of glucose. It affects the central nervous system by increasing heart rate, clamping down blood vessels, and reduces the threshold for neuron excitation.

Aspirin is an anti-inflammatory agent. In other words, it "takes down" the swelling due to minor bumps and bruises. Aspirin also interferes with the synthesis (production) of prostaglandins, which enhance inflammatory effects, regulating the perception of pain.

Ethyl Alcohol interferes with gluconeogenesis, the process by which Lactic acid can be converted to glucose for necessary energy needs. Although alcohol can be used as a source of energy, it provides no vitamins or minerals, is stored as fat, and interferes with a person's ability to properly see at night (prevents the synthesis of rhodopsin from vitamin A).

The objectives for the use of this kit include:

- For each drug tested, the student should be able to describe the effects on the organism in the same ways used to describe the baseline.
- The student should be able to describe the test organism's behavior in both qualitative and quantitative terms. These descriptions are based upon comparison against the baseline measurements.
- The students should be able to relate the effects of the test drug on the test organism to their effects on man. Depending on the age and sophistication of the group, this should lead to a discussion of the role of drugs in society.

- The student should be able to handle living experimental material carefully and in such a way that the organism may be observed over an extended period of time.

- The students should come away from the exercise with a greater understanding about drug use and drug actions. Drug use and abuse does not refer simply to the popular news items such as marijuana, heroin or cocaine. Alcohol, nicotine, caffeine, aspirin and other commonly used materials are also considered drugs.

The activities require 3 to 4 class periods for completion. Depending upon the sophistication level of the students, class discussion may extend the activities for an additional period.

Preparation of Materials

About one week before you plan the activities, you should make arrangements to obtain *Daphnia* cultures. (These tests may also be run on brine shrimp, if you happen to have them in the lab) These small aquatic crustaceans are very useful as laboratory subjects. They are available from aquarium supply shops, may be collected in spring and summer from fresh water ponds, or can be ordered from biological supply houses. The students will need to use microscopes with a magnification of 40x to 100x. One microscope will be needed for each team. For these experiments, a mirror is preferred over direct lighting as the heat produced will harm the organism. If mirrors are not available, use the lowest power setting possible. Make sure the microscopes are clean and in good working order.

The materials in the kit are ready to use. If you wish to have the students test "unknown" drugs, make them up the day before in the unlabelled dropper bottles. Use 3-5 drops of liquid materials or .10 gram of solid for one dropper bottle. For most solids, this will be about enough powder to cover a capital O. Depressants such as barbiturates or stimulants such as D-amphetamine sulfate are good examples for this experiment.

Guide to Student Activities

The introduction in the Student Manual serves to give a brief background to the study of drugs. You may wish to discuss the common meanings of "drug" before handing out the student instructions. Many useful lead-ins for later discussion can be generated here. Part I focuses on establishing the baseline, or normal behavior pattern for the *Daphnia.* Encourage the students to make as many observations as possible on the normal movements and appearance of the organism. If the students comment that the *Daphnia* is swimming too quickly for observation, have them remove some water with some cotton fibers, or add a drop of **hydromethylcellulose** solution.

To aid in the recording of the heart rates, have the student making the count make a mark on paper for each 10 beats while the other student watches the time. If you wish, have the students record the results on the board and use the class average as the baseline reading for the later work.

In Part II the students test the effects of each of the test drugs. Encourage the students to work as quickly as possible to avoid prolonged exposure of the drug to the *Daphnia.* If the *Daphnia* do not return to baseline after resting in the clear Ringers solution, return them to the stock solution and get a new animal. Again, encourage the students to make as many observations as possible. Try to locate several females for the brood sack release response upon application of the adrenaline solution. (Female *Daphnia* are much larger than the males. The brood sack contains the eggs of the female and should be easily visible to the student.) You might point out that nicotine is used to control small insects such as aphids. This indicates the poisonous nature of the drug.

The dose response experiment is similar in principle and design to those used in industry for testing drugs. The

students may or may not be able to recognize the threshold nature of some of the drugs. Encourage the students to view their data in terms of the dose response curves shown in the student instructions. You might discuss the biological reasons for each of the curves.

Further Areas of Interest

After the initial activities are completed, you may want to have the students pursue some of the following exercises:

1. Expose the *Daphnia* to a constant low level of the drug. Use one of the medicine cups covered with a glass slide or Saran Wrap as a cover. Add one of the drug solutions at its critical level, as determined in Part III. Use the medicine cups as a graduated cylinder and assume that the pipets deliver 20 drops per ml.

   Try to determine if the *Daphnia* become acclimated to the drug, if their responses return to normal, and if they still respond to an elevation of the drug level.

2. Have the students investigate the manufacture and testing of drugs. The Food and Drug Administration and various drug companies are possible sources of information. Have the students write directly to the public relations department of drug manufacturing firms. Addresses are usually located on drug containers. Drugs such as Laetrile and saccharin have attracted a great deal of attention recently, particularly in test designs used to monitor the drug's effects.

3. If appropriate, investigate the social and psychological effects of drugs in the news today. These include crack, ice, marijuana, alcohol and heroin. Local community health groups, law enforcement agencies and hospitals may be willing to provide information and speakers. The scope of such discussions must be determined by local willingness to consider drug related topics.

THE EFFECTS OF DRUGS #2200 Student Instructions (ANNOTATED)

When people hear the word "drugs", they often think of medicine and narcotics or other mind-altering substances. In fact, any chemical which changes the functioning of our bodies can be considered a drug. Most chemicals which are considered to be drugs work in very low concentrations. For this reason, even small changes in the amount or dosage can have a serious effect on the person taking the drug.
In these experiments, you will investigate the way in which some common drugs affect living organisms. Some of these drugs are common ones that you have heard of before, such as caffeine, nicotine and alcohol. Others, such as adrenaline and lactic acid, may not be familiar to you. Handle the drug samples carefully, and wash your hands when you are finished with the experiments. Follow your teacher's instructions for use and disposal of the laboratory materials. Treat all chemicals with respect.

Part I: Establishing a Baseline.

You will use the organism *Daphnia* to examine the effects of drugs. (You may be using *artemis,* instead. These are also known as brine shrimp, and are very similar to *Daphnia.)* This organism is a small aquatic crustacean, related to shrimp and lobsters. It lives in fresh water ponds and slow moving streams.
Daphnia are sometimes referred to as water fleas.

To observe the behavior of *Daphnia,* you will need to use a microscope. If you aren't familiar with using a microscope, review basic skills with your teacher before handling *Daphnia.*

An observation chamber for *Daphnia* may be made as follows: Using your finger, rub a small amount of grease

on one side of the flat nylon washer. Place the washer, grease side down, on a glass microscope slide, and press gently to form a tight seal. Add a few drops of Ringers solution to the central chamber.
Using a pipet, pick up a single *Daphnia* from the stock culture. Wait until the *Daphnia* swims close to the opening of the pipet, and then gently squeeze out a drop into the observation chamber. Place a coverslip on top to prevent evaporation of the liquid.

Examine the *Daphnia* under the microscope using the low power objective, and a low light. Make sure that the light source is not too intense, as it may heat up and harm or kill the *Daphnia.*

Make a drawing of the *Daphnia,* labelling the eye, heart, and legs:

Work with your partner and time the heartbeat by counting the number of beats in 30 seconds. Do this three times; record the average of the three trials:

Trial Number	Beats in 30 seconds	Beats per Minute
#1	*143*	*286*
#2	*161*	*322*
#3	*157*	*314*
	Average Beats/Minute	*307*

Class average, beats/min: _____

Describe the activity of *Daphnia:*

(Rapid beating of the legs. A meandering motion through the water with smooth turns. Some movement of the antennae. Students may observe contractile movements of the digestive system.)

Most drugs exhibit their effects on the circulatory and nervous systems. While we can't see exactly what is

happening in the nervous system, the type and level of activity will give a good indication. We will use the heart rate as a measure of changes in the circulatory system.

Part II: Testing Drug Solutions

You will be working with six different drug solutions and any "unknowns" supplied by your teacher. Before using any of these drugs, read the instructions carefully; these apply to all of the testing.

1. Place a single *Daphnia* in the observation chamber as before.

2. Add a single drop of drug solution to the chamber.

3. Observe the *Daphnia* for 2 minutes, taking turns with your partner. Record any changes in the *Daphnia's* behavior.

4. After 2 minutes of exposure, count the number of heart beats in 30 seconds. Repeat for a total of three counts. Record the results on the data table.

5. Carefully pick up the *Daphnia* and transfer it to a medicine cup containing 5 ml of Ringers Solution. Empty and rinse out the observation chamber with distilled water. After 2 minutes, transfer the *Daphnia* back to the observation chamber. Add a few drops of Ringers Solution. This complete process should not take more than 6 minutes.

6. Repeat steps (2) through (5) for the next drug to be tested. Record all your observations on the data table:

Part III: Dose Response

Some drugs must reach a critical level before they have any effect on an organism. In the experiment you will find out what happens when *Daphnia* is exposed to different concentrations of a drug. Your teacher will tell you which drug you will be working with. If your teacher has made up the drug solutions already, go to step 1 below:

Drug Dilutions:

1. Label four cups 1/10 strength, 1/100 strength, 1/1000 strength, and 1/10,000 strength.

2. Add four drops of the full strength solution to the 1/10 cup. Add 36 drops of Ringers Solution. Swirl to mix.

3. In the 1/100 cup, add 9 drops of Ringers solution. Add 1 drop of the mixture from step 2. Swirl to mix.

4. For the 1/1000 and 1/10,000 dilutions, the same proportions are used: 9 parts Ringers Solution to 1 part drug dilution from the previous step.

Step 1.

Using a clean pipet, pick up a *Daphnia* from the stock culture and place it in the 1/10,000 cup for 30 seconds. Transfer the *Daphnia* and some of the 1/10,000 solution and place it in the observation chamber. Record your observations on the data table.

Step 2.

Transfer the *Daphnia* from the slide to the 1/1000 cup. Try to transfer as little of the fluid as possible. While the *Daphnia* is in the new solution, dump out the remaining liquid from the observation chamber.

Step 3.

After 30 seconds in the 1/1000 cup, transfer the *Daphnia* and a few drops of solution to the observation chamber. Again, record you observations.

Step 4.

Continue this process for the 1/100 and 1/10 cups. Do not use the drug solution at full strength as it will probably kill the organism.

Dose Response Table

Does there seem to be a critical level for this drug? That is, is there a point below which you don't observe any effect (the threshold level), or above which the effect is constant?

(See Data Table)

Many drugs have a critical point. Others show a fairly constant response. Shown below are some hypothetical dose response curves. Does the drug you tested fit one of these curves?

Hypothetical dose response curves

Discussion Questions

1. When a new drug is tested for humans, a scientist wants to find out if the drug has any harmful side effects. What type of studies should be done?

2. Do any commonly used drugs fit into one of the dose response curves above?

3. Can you relate your observations on the drugs you tested to their effect on humans?

SAFETY INSTRUCTIONS: IMPORTANT

NOTICE TO TEACHERS REGARDING LABORATORY REAGENTS

Perhaps the best general rule regarding the safe handling of laboratory chemicals is to treat all of them as being potentially dangerous. This means that none of them should be taken internally, and that any external contact should be washed thoroughly. In fact, most of the chemicals provided in The Science Source kits are diluted enough that they are not hazardous. The following lists indicate appropriate antidotes for the hazardous chemicals. Check this list for the chemicals provided in the kit:

I. **Concentrated Acids & Bases** - **Do not** induce vomiting, dilute with water, then milk or egg white, call a physician immediately.

1. 25 % Acetic Acid
2. 3M Hydrochloric Acid
3. Concentrated Sulfuric Acid

II **Dilute Acids & Bases** - **Dilute** with water, then milk.

1. 1 M, 0.5M, 0.1 M Hydrochloric Acid
2. Oxalic Acid
3. Sodium Hydroxide
4. Ammonium Hydroxide

III **Miscellaneous Chemicals** - Dilute immediately with water. Induce vomiting with warm salt water, or warm baking soda solution.

1. Ammonium Chloride
2. Ammonium Oxalate
3. Barium Chloride
4. Biuret Reagent
5. Bromthymol Blue
6. Calcium Chloride
7. Ethanol (Denatured Alcohol)
8. Ferric Ammonium Sulfate
9. Hydrogen Peroxide
10. Janus Green B
11. Lead Nitrate
12. Lugol's Solution
13. Magnesium Reagent (Titan Yellow, Alcohol)
14. Mercuric Nitrate
15. Methylene Blue
16. Ninhydrin
17. Phosphorus Reagent (Ammonium Molybdate, Nitric Acid)
18. Potassium Ferricyanide
19. Potassium Permanganate
20. Silver Nitrate
21. Sodium Carbonate
22. Sodium Thiosulfate
23. Sudan IV

IV. **Organic Solvents** - **Do not** induce vomiting. Dilute with water and milk. Call a physician immediately.

Isopropyl Alcohol

THE EFFECTS OF DRUGS #2200 Student Instructions

When people hear the word "drugs", they often think of medicine and narcotics or other mind-altering substances. In fact, any chemical which changes the functioning of our bodies can be considered a drug. Most chemicals which are considered to be drugs work in very low concentrations. For this reason, even small changes in the amount or dosage can have a serious effect on the person taking the drug.
In these experiments, you will investigate the way in which some common drugs affect living organisms. Some of these drugs are common ones that you have heard of before, such as caffeine, nicotine and alcohol. Others, such as adrenaline and lactic acid, may not be familiar to you. Handle the drug samples carefully, and wash your hands when you are finished with the experiments. Follow your teacher's instructions for use and disposal of the laboratory materials. Treat all chemicals with respect.

Part I: Establishing a Baseline.

You will use the organism *Daphnia* to examine the effects of drugs. (You may be using *artemis,* instead. These are also known as brine shrimp, and are very similar to *Daphnia.)* This organism is a small aquatic crustacean, related to shrimp and lobsters. It lives in fresh water ponds and slow moving streams.
Daphnia are sometimes referred to as water fleas.

To observe the behavior of *Daphnia,* you will need to use a microscope. If you aren't familiar with using a microscope, review basic skills with your teacher before handling *Daphnia.*

An observation chamber for *Daphnia* may be made as follows: Using your finger, rub a small amount of grease on one side of the flat nylon washer. Place the washer, grease side down, on a glass microscope slide, and press gently to form a tight seal. Add a few drops of Ringers solution to the central chamber.
Using a pipet, pick up a single *Daphnia* from the stock culture. Wait until the *Daphnia* swims close to the opening of the pipet, and then gently squeeze out a drop into the observation chamber. Place a coverslip on top to prevent evaporation of the liquid.

Examine the *Daphnia* under the microscope using the low power objective, and a low light. Make sure that the light source is not too intense, as it may heat up and harm or kill the *Daphnia.* The general structure of a Daphnia is shown below. Based on your observations, make a drawing of the *Daphnia,* labelling the eye, heart, and legs:

Work with your partner and time the heartbeat by counting the number of beats in 30 seconds. Do this three times; record the average of the three trials:

Trial Number	Beats in 30 seconds	Beats per Minute
#1		
#2		
#3		
	Average Beats/Minute	

Class average, beats/min: _____

Describe the activity of *Daphnia:*

Most drugs exhibit their effects on the circulatory and nervous systems. While we can't see exactly what is happening in the nervous system, the type and level of activity will give a good indication. We will use the heart rate as a measure of changes in the circulatory system.

Part II: Testing Drug Solutions

You will be working with six different drug solutions and any "unknowns" supplied by your teacher. Before using any of these drugs, read the instructions carefully; these apply to all of the testing.

1. Place a single *Daphnia* in the observation chamber as before.
2. Add a single drop of drug solution to the chamber.
3. Observe the *Daphnia* for 2 minutes, taking turns with your partner. Record any changes in the *Daphnia's* behavior.
4. After 2 minutes of exposure, count the number of heart beats in 30 seconds. Repeat for a total of three counts. Record the results on the data table.
5. Carefully pick up the *Daphnia* and transfer it to a medicine cup containing 5 ml of Ringers Solution. Empty and rinse out the observation chamber with distilled water. After 2 minutes, transfer the *Daphnia* back to the observation chamber. Add a few drops of Ringers Solution. This complete process should not take more than 6 minutes.
6. Repeat steps (2) through (5) for the next drug to be tested. Record all your observations on the data table.

Part III: Dose Response

Some drugs must reach a critical level before they have any effect on an organism. In the experiment you will find out what happens when *Daphnia* is exposed to different concentrations of a drug. Your teacher will tell you which drug you will be working with. If your teacher has made up the drug solutions already, go to step 1 below:

Drug Dilutions:

1. Label four cups 1/10 strength, 1/100 strength, 1/1000 strength, and 1/10,000 strength.
2. Add four drops of the full strength solution to the 1/10 cup. Add 36 drops of Ringers Solution. Swirl to mix.
3. In the 1/100 cup, add 9 drops of Ringers solution. Add 1 drop of the mixture from step 2. Swirl to mix.
4. For the 1/1000 and 1/10,000 dilutions, the same proportions are used: 9 parts Ringers Solution to 1 part drug dilution from the previous step.

Step 1.

Using a clean pipet, pick up a *Daphnia* from the stock culture and place it in the 1/10,000 cup for 30 seconds. Transfer the *Daphnia* and some of the 1/10,000 solution and place it in the observation chamber. Record your observations on the data table.

Step 2.

Transfer the *Daphnia* from the slide to the 1/1000 cup. Try to transfer as little of the fluid as possible. While the *Daphnia* is in the new solution, dump out the remaining liquid from the observation chamber.

Step 3.

After 30 seconds in the 1/1000 cup, transfer the *Daphnia* and a few drops of solution to the observation chamber. Again, record you observations.

Step 4.

Continue this process for the 1/100 and 1/10 cups. Do not use the drug solution at full strength as it will probably kill the organism.

Dose Response Table

Does there seem to be a critical level for this drug? That is, is there a point below which you don't observe any effect (the threshold level), or above which the effect is constant?

Many drugs have a critical point. Others show a fairly constant response. Shown below are some hypothetical dose response curves. Does the drug you tested fit one of these curves?

Hypothetical dose response curves

Discussion Questions

1. When a new drug is tested for humans, a scientist wants to find out if the drug has any harmful side effects. What type of studies should be done?

2. Do any commonly used drugs fit into one of the dose response curves above?

3. Can you relate your observations on the drugs you tested to their effect on humans?