What is IPM?
IPM is pest management that uses multiple control tactics to keep pest populations in check. IPM takes social and environmental consequences of each tactic into account. For a detailed explanation of the IPM process, see *Coming to a Store Near You* on page 1.

Why should your students learn about IPM?
Although more pesticides are used on farms than in homes, excessive exposure to pesticides usually occurs in homes. As a result, it is important for students to learn how to safely implement IPM at home.

IPM is a perfect opportunity for students to learn and practice problem-solving and reasoning skills. It is an applied use of math, biology, ecology, economics, and chemistry knowledge. It is quickly becoming a major field of study and work in the United States.

In the agricultural science curriculum, IPM is a critical component; IPM is being adopted in almost all areas of agriculture, from crop and livestock production to food processing, shipping and storage.

Classroom IPM
Because IPM is gaining increased acceptance, local growers or organizations using IPM may be available as resources to teachers. They may be willing to host a field trip or appear as guest speakers in your classroom. Also, IPM is being used by some school districts because of concern for children's exposure to chemical pesticides. This provides a great opportunity for students to get involved in a real life IPM project. Have the maintenance person in charge of your building's IPM program come in and talk to your class about the IPM program for the school. Give students the opportunity to participate in scouting activities. Create a student IPM patrol in which students keep an eye out for pest-encouraging situations (like food in the classrooms) and work to eliminate pest feeding and breeding grounds in the school. Both students and maintenance staff will benefit from such an arrangement—giving students real-world, hands-on experiences, and giving maintenance staff extra scouting eyes and buy-in into their IPM program. Another important opportunity with IPM is the interdisciplinary nature of the subject. IPM involves science, economics, communication, history, biology, ecology, and business. IPM is a chance for teachers from a variety of disciplines to work together to create a cohesive, meaningful unit of study for their students.

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"IPM involves science, economics, communication, history, biology, ecology, and business..."
IPM In An Interdisciplinary Unit

1. Choose a site for your IPM studies. The school building and grounds or a local grower’s field, barns, or greenhouses are potential sites.

2. During biology, agriscience, ecology, or even math classes, you might take students to the chosen site to survey the pest and beneficial populations. You might use various traps, nets, and observations to determine population levels for each type of pest found.

3. Repeated measures over the course of several weeks could give students a body of data to manipulate in math class (See Biomath in Pests Have Enemies Too, or Oh Deer! in Project WILD). Students could calculate the rate of change of each population, graph population trends, calculate predator/prey ratios, and map pest locations (perhaps using isolocines to indicate pest density at each location) (See The Thunderstorm in Project WET for an isolocine activity).

4. The same data could be used in biology or ecology classes in discussions of predator/prey interactions, habitat requirements, and life cycles (See Natural Enemies Card Game below, Population Dynamics in Pests Have Enemies Too or Who Fits Here? and Deadly Links in Project WILD). Questions raised by the data gathered could lead into student-designed scientific experiments to test hypotheses.

5. In history class, students could study the history of pest management, and how we have arrived at the IPM concept.

6. In chemistry, students could study the action and structure of the many chemical pesticides we use in pest management. They could discuss the modes of action of chemical pesticides and could compare them with natural chemical controls such as garlic and pepper sprays (See Deadly Links in Project WILD).
Not quite ready to jump in completely?

Here are some stand-alone IPM activities you might like to try:

**NATURAL ENEMIES CARD GAME**

(Food Web Dominoes) (adapted from Pests Have Enemies Too; see resources on next page)

1. Make cardboard “dominoes” with the following pairs of organisms on them:
   - lady beetle/grass
   - corn/soybean
   - wheat/roset
   - alfalfa/grass
   - rose chafer beetle/hickory tree
   - potato/cattails
   - milkweed/ants
   - citrus tree/oak tree
   - monarch caterpillar/parasitic wasp
   - tomato/potato
   - raccoon/walleye
   - coyote/elm tree
   - carrot/white grub
   - apple tree/aphid
   - underground root borer/mushroom
   - crayfish/largemouth bass
   - deer/parasitic fly
   - algae/red fox
   - wolf/possum
   - mosquito/grasshopper
   - bat/grackle
   - tomato hornworm/honeybee
   - soybean mosaic virus/field mouse
   - cow/wildflower
   - citrus wild virus/cow tick
   - corn borer/cotton
   - stalk borer parasite/praying mantis
   - prickly pear cactus/hummingbird
   - bird louse/soybean pod borer
   - Colorado potato beetle/grasshopper fungus
   - frog/prickly pear moth
   - dragonfly/caterpillar hunter beetle

2. Distribute cards evenly to students. On the floor, wall, or bulletin board, the teacher should tape one card. Student volunteers then add one card at a time so that the organism on one half of a card feeds upon or is fed upon by the organism on the card half it is touching. Students may need to look up information about the organisms on their cards. As each student adds a card, he or she must explain why that play is justified. Encourage students to use terms like parasite, predator, pathogen (disease), host, herbivore, carnivore, and natural enemy.

3. Continue to play until all cards are placed, or until no more can be placed.

4. Before the cards are disturbed, select an organism that is in play and ask the class to assume that it has become a pest. Which organisms in play are potential natural enemies of this pest? Suggest to the students that even though the enemies may not be touching the pest in the game, they could be manipulated by humans for possible use as a biological control agent.

5. Discuss how the numbers of a given predator, parasite, or disease organism affect the numbers of the organism consumed. This relationship is the basis for the biological control of pests. As a class, develop a working definition of biological control, emphasizing that it involves the use of natural enemies by humans to help control or manage pests. Through biological control we increase the numbers and kinds of a pest’s natural enemies so that the pest’s numbers decrease.

WHEN IS A PEST NOT A PEST?

(adapted from Pests Have Enemies Too; see resources on next page)

1. Discuss the definition of the word “pest.” Highlight the relative and anthropocentric nature of the term. Point out that whether an organism is a pest depends upon where it is and how it is related to the other organisms in its habitat.

2. Provide students with a list of organisms that may or may not be pests, depending upon where they are and what they are doing. Some suggested organisms are: maple seedling, clover, raccoon, algae, deer, rabbits, dandelions, pond weeds, termites, maggots, fleas, fruit flies, bees, mosquitoes, and house flies. Ask students to think of a situation in which each of these organisms is a pest and a situation in which each is not a pest. For example, mosquitoes are considered pests when they are biting people, but are highly beneficial as food for fish and bats.

3. Discuss students’ answers. Should potential pests be treated the same wherever they occur? Are there criteria that we might use to determine when an organism is a pest?
IPM CHARADES

1. Divide the class into groups of 3. Give each group a list of IPM vocabulary words. Suggested terms include: predator, prey, pest, parasite, biological control, scouting, beneficial, pesticide, quarantine, and mechanical control. Provide resource information on IPM (see resource list to right), and give students time to look up definitions to each of these terms.

2. Write each term on a separate slip of paper. Randomly hand one slip of paper to each group. The group needs to come up with a short, silent “skit” to illustrate the term to the rest of the class.

3. Groups present their “skits” to the rest of the class. Those not presenting should try to guess which vocabulary term the presenting group is acting out, in a Charade-like game.

IPM Resources for Teachers

Here's a small sampling of the information available to help you teach IPM.

INTERNET RESOURCES

See Bug Bytes

OTHER RESOURCES


Pests Have Enemies Too: Teaching Young Scientists About Biological Control, by Michael R. Jeffords and Audrey S. Hodgins. Illinois Natural History Survey, Special Publication 18, July 1995. Illinois Dept of Natural Resources, 607 E. Peabody Drive, Champaign, IL 61820 Phone: (217) 333-6880. Also available free through APHIS—NBCI web site (see BugBytes)


Project WILD. Western Regional Environmental Education Council. Available free with training. In PA, contact Theresa Alberici, PA Game Commission, (717) 783-4872. In MI, contact Michigan State University, (517) 355-1712.

Suppliers of Beneficial Organisms in North America (listing of 142 suppliers of over 130 species of beneficial organisms). Available free from: California Environmental Protection Agency, Department of Pesticide Regulation, Environmental Monitoring and Pest Management Branch, 1020 N Street, Room 161 Sacramento, CA 95814-5624. Phone: (916) 324-4100. Also available at http://www.cdpr.ca.gov

Written by Robinne Weiss, PSU Department of Entomology
DANGEROUS LIAISONS:

Insects & Human History

As entomologists, we often emphasize the positive aspects of insects—their roles as recyclers, pollinators and biocontrol agents, to name a few. But any study of insects' interactions with humans would be incomplete without a look at insects as carriers of disease. These insects have had profound impacts, not just on individuals, but on the whole face of human history.

Black Plague
Probably the most infamous insect-vectored disease, the Black Plague (a.k.a. Bubonic plague) killed nearly two-thirds of the European people in the mid-1300s. It took 500 years for the European population to return to pre-plague levels. Bubonic plague is caused by a bacterium, *Yersinia pestis*, which can attack over 100 types of animals. The bacterium is carried in the guts of fleas. Generally, these fleas infest rodents such as rats, but if rats and humans are living in close proximity, hungry fleas may be just as happy with a meal of human blood. This is when problems start. If the flea is carrying the plague bacterium, a bitten person will generally become ill in 3 to 4 days after the bite. Mortality is nearly 100% if the disease is untreated, and can occur within 24 hours after the onset of symptoms.

Bubonic plague is still around but does not reach epidemic levels because modern sanitation and antibiotics have made fleas and plague bacteria rare. In the western United States, plague is sometimes carried by fleas on prairie dogs.

African Sleeping Sickness
African sleeping sickness is a deadly disease found in 36 countries of sub-Saharan Africa. It is caused by a parasitic trypanosome (a protozoan) which is transmitted to humans and cattle through the bite of the tsetse fly. The trypanosome invades all the infected person's organs, starting in the blood and ending in the nervous system. Untreated, mortality is 100%. At the beginning of the 20th century, Africa was ravaged by an epidemic of sleeping sickness which killed half a million people. An intensive eradication campaign was begun in response to the epidemic. People living in outbreak areas were treated with the drug pentamidine, which can prevent a person from contracting sleeping sickness for up to cont'd on next page.
There were over 1.3 million cases and 10,000 deaths from malaria in the Union Army during the course of the war."

Typhus
Before World War II, diseases were one of the major causes of death in war. Often, more soldiers died of disease than from wounds obtained on the battlefield. Typhus is caused by a microorganism called Rickettsia. It is transmitted by the body louse, and was one of the most deadly diseases that spread throughout armies. Poor sanitation and close living quarters in army encampments helped to spread lice and typhus.

Many of the symptoms of typhus are similar to those of malaria, such as a continued high fever, headaches, and mental confusion. Under epidemic conditions, mortality is close to 100%. During World War I, 2-3 million Russians alone died from typhus. During World War II, newly discovered chemical insecticides such as DDT were used to control typhus, saving thousands of lives.

Lice get typhus by biting an infected person, but they do not transmit the disease through their bite. The bacteria-like disease lives in the gut of the louse, eventually rupturing the gut and killing the louse. Typhus is transmitted only when infected lice are crushed—when you pick an infected louse off and crush it, you can contract typhus through your skin or mucous membranes. Fortunately, the incidence of body lice and typhus are very low in the United States thanks to louse eradication campaigns and modern antibiotics.

Malaria
Another historically important insect transmitted disease is malaria—a protozoan in the genus Plasmodium. Originally found in most tropical and temperate areas of the world, it has played a role in many wars, including the United States Civil War. There were over 1.3 million cases and 10,000 deaths from malaria in the Union Army during the course of the war. In the Confederate Army, the situation must have been worse, because the Union blockade made anti-malarial drugs difficult to obtain in the South.

Malaria also played a role in the history of the Panama Canal. French efforts to build the canal failed due to a number of reasons, one of which was the prevalence of malaria and yellow fever. Thousands of workers died from these diseases. Malaria, which tends to debilitate its victims rather than kill them outright, infected 83% of the canal work force. When the United States took over the canal project, one of the first efforts undertaken was to eradicate these diseases. Swamps and pools of standing water were drained to eliminate mosquito breeding grounds. Bodies of water that could not be drained were treated with oil to suffocate mosquito larvae. And sick canal workers were placed in screened isolation rooms to keep mosquitoes from picking up the disease. The effort cost $400,000 a year, but by 1906 both diseases were under control, and canal construction was able to proceed unhindered.
OBJECTIVE: To help children develop a better understanding of head lice and how infestations start and can be avoided.

MATERIALS:
- fact sheet about lice and explanation of different removal methods
- red and white beads (about 50 of each color)

VOCABULARY:
- epidemic - when disease infects many people throughout an area
- louse - singular form of lice, a parasite that sucks blood from animals; also describes a person
- lousy - being infested with lice or describes something bad or worthless
- nit - a louse egg
- nit-pick - to remove lice; today means to be concerned with petty details
- nitty-gritty - the specific details of something
- nitwit - a stupid or silly person
- resistance - when an animal such as an insect evolves immunity to the effects of a chemical that used to be lethal

DISCUSSION PRIOR TO ACTIVITY:

1. Remind the children that anyone can get lice. It does not matter who you are, where you live or what clothes you wear.

2. Explain that lice are parasitic insects that have adapted to sucking blood. Many animals have lice and different lice live on different animals. The lice that humans can have only live on humans.

3. Discuss the life cycle of lice from egg to adult. The eggs are called nits. It takes 7-10 days for nits to hatch. A louse can live for 30 days and a female can lay up to 100 nits. It is actually not the lice that make us itchy, but an allergic reaction to their feces.

4. Ask the children if they know how lice move from one person to the next. Sharing combs, hats, and clothes are a few of the easiest ways.

5. Describe the different methods of louse removal. Manual removal with small toothed combs specifically designed to remove both lice and nits is one method. Another is insecticidal shampoos that use chemicals to kill the lice. Lice need to be removed not only from heads, but also from clothes, bed sheets, and stuffed animals. Washable items should be washed with hot water and dried in a hot clothes dryer. Stuffed animals should be placed in an airtight bag for two weeks. Carpets should be vacuumed well.

6. Ask the children what “resistance” means? Explain that many insects that are continually exposed to non-lethal doses of insecticides evolve resistance to the insecticides. The individuals which survive the insecticide reproduce, and their offspring also carry this resistance, creating a whole new population of pests resistant to insecticides.

ACTIVITY:

1. Give each student a red or white bead. About half of the class should have red and half white. Record how many red and white beads were given out.

2. Explain to the students that the beads are lice. Do not tell them what the difference is between the red and white beads.

3. Students then must decide if they will manually remove the lice, which takes a long time and can be painful, or use a shampoo and risk making lice resistant to insecticides. Record who chose which method.

4. Those who chose the shampoo and have red beads have resistant lice; their lice live. Those who chose the shampoo and have white beads have non-resistant lice and their lice die.

Continued on back page.
5. Those who chose manual removal can have either type of beads and their lice will be removed and die.

6. Collect beads from the students who manually removed their lice and those who chose the shampoo and had white beads.

7. Give 10 more red beads to the students who chose the shampoo and had red beads. This represents their lice reproducing. They now must give each student sitting next to them one of their beads. This represents louse transmission.

8. Discuss how many students had red beads in the beginning versus how many have red beads now. Why has this happened? How can we get rid of the lice now? Run the game again to see if you can improve louse control.

9. Discuss with the class why more non-toxic methods of louse removal need to be developed.

For further information on head lice contact:
The National Pediculosis Association at www.headlice.org
Dr. Greene at www.drgreene.com/971124.html#alternative_treatments

Here are three classroom activities developed by teachers and published on the Internet. With a little creativity and some background material, the possibilities for great educational activities on this topic are endless. Check out the resource list at the end of this article for some inspirational information sources.

1. There is a fun Hands-on Epidemic Simulation about the black plague developed by Cory Wisnia at Mendocino Middle School in California (http://www.mcn.org/ed/CUR/cw/Plague_Sim.html). In this simulation, students play the role of travelers in the time of the plague outbreaks in Europe. Students travel from town to town and draw colored beans out of a bag at each town to see if they contract the plague or cholera, another disease prevalent in Europe at the time. Students create a log book of their journeys and send "postcards" home to describe their travels.

An appropriate activity for grades 7 and up, Diseases of Africa, involves students in research and problem solving on a disease of their choice (http://www.ofps.dpi.state.nc.us/OPFS/tc/TNT/mlp0032.htm). Working in small groups, students research their disease, then develop and present a plan for treating it. You may choose to allow them to select only insect-vector diseases in order to emphasize this concept.

An activity for grades 4 and 5, The Harmful Effects of Insects in Our Lives, was originally published in School Library Media Activities Monthly (vol. 6, pg 10, June 1990; http://ericir.syr.edu/Virtual/Lessons/SLMAM/Into_Curriculum/Science/insects.html). Using library resources, students research different harmful insects. For each insect, they create a card with a statement about the damage the insect does. These cards are then used as part of a game in which students classify the harm done as spreading disease, damaging trees or wood, or damaging plants or stored products.

For further information on head lice contact:
The National Pediculosis Association at www.headlice.org
Dr. Greene at www.drgreene.com/971124.html#alternative_treatments

1. Robinne Weiss and Rachel Parson

Resources (see BugBytes for worldwide web resources):