ABSORPTION AND EFFECTS OF PESTICIDES

A. APPLICATORS:

Subject A: Should know the routes of entry of pesticides into the body.

Subject B: May need to know the difference between acute and long term effects.

Subject C: May need to know that pesticides are registered.

B. SUPERVISORS:

Subject A: Should know the routes of entry of pesticides into the body.

Subject B: Should know what is an acute effect, and may need to know about accumulation of dose or effect. Should understand relationship between exposure to pesticides and cancer.

Subject C: May need to know that pesticides are registered.

C. SANITARIANS, AGRICULTURAL EXTENSION OFFICERS AND REGISTRATION PERSONNEL

Subject A: Should know the routes of entry of pesticides into the body.

Subject B: Should know what is an acute and long term effect, about accumulation of dose or effect, and the facts concerning pesticides and cancer.

Subject C: Should know about registration, the Code of Conduct, and distribution of pesticides.

D. OTHER HEALTH AND MEDICAL PERSONNEL

Subject A: Should know the routes of entry of pesticides into the body.

Subject B: Should know what is an acute and long term effect, about accumulation of dose or effect, and the facts concerning pesticides and cancer.

Subject C: Should know that pesticides are registered.

Module No. II A 1
Level: BASIC

Section: II Absorption and effects of pesticides
Subject: A Absorption: Routes of entry
Number: 1 Through the skin

Main points:

PESTICIDES MUST BE ABSORBED INTO THE BODY BEFORE THEY CAN CAUSE ANY DANGER TO HEALTH.

THERE ARE FOUR ROUTES OF ENTRY OF PESTICIDES INTO THE BODY.

MANY PESTICIDE FORMULATIONS CAN BE ABSORBED THOUGH THE INTACT SKIN.
FOR THOSE WHO HANDLE OR APPLY PESTICIDES, THIS IS THE COMMONEST ROUTE OF ABSORPTION.

Subsidiary points:

1. The absorption of most pesticides does not leave any mark on the skin to show that it has taken place.

2. Formulations of most pesticides can be absorbed through intact skin as long as they are in contact with the skin. Contact occurs when dust clings to the skin, when liquid splashes on to the skin, when the skin is immersed in liquid, or when spray mist or rebound spray lands on the skin and dries on it.

3. The pesticide is absorbed more rapidly if:
   - the formulation is a liquid or is oily,
   - the formulation is concentrated,
   - the skin is warm or sweaty.

4. Absorption slows or stops as soon as the pesticide is washed off the skin, depending on how well the washing is carried out. Solvents should not be used for washing. Only water should be used, and this is more efficient if used with soap.

For discussion:

If you apply pesticides, how can your skin become contaminated?

Other information:

1. A few pesticides or their solvents are not absorbed through intact skin but are irritant to the skin or corrosive to the nails.

2. See also Module II A 4.

Suggested visual aid: A diagram of the body outline with arrows pointing to the face and forearm (and legs if relevant).

Module No. II A 2
Level: BASIC

Section: **II** **Absorption and effects of pesticides**
Subject: **A** **Absorption: Routes of entry**
Number: **2** **Through the mouth**

Main points:

PESTICIDES TAKEN THROUGH THE MOUTH ARE ABSORBED IN THE STOMACH AND IN THE GUT

Those who handle pesticides can absorb them if they eat, drink, or smoke at work without first washing their hands.

Workers and members of any families may take pesticides through the mouth if:

- they drink from any unlabelled container or bottle into which pesticide has been decanted. The pesticide is drunk in mistake for water or other drinks, and the amount swallowed can be dangerous, even if the mistake is soon realised from the taste.
- used or 'empty' pesticide containers are left around where children might play with them.

For discussion:

Are there any other ways in which family members might take in pesticides by mouth? Which of these are likely to cause absorption of high doses of pesticides?

Other information:

1. Uncovered food can sometimes be contaminated during indoor residual spraying in public health operations, but the dosage will be relatively low.

2. If food is contaminated by a leaking container during transportation or storage, dosage may be high.

3. The group should be reminded that the dosage absorbed is what determines the effect.

Suggested visual aid: A diagram of the body outline with an arrow pointing to the mouth.

Module No. II A 3
Level: BASIC

Section: II **Absorption and effects of pesticides**
Subject: A **Absorption: Routes of entry**
Number: 3 **Through the lungs**

Main point:

PESTICIDE GETS INTO THE LUNGS IF GAS OR VAPOUR IS INHALED.

ONCE TAKEN INTO THE LUNGS IT MAY BE RAPIDLY ABSORBED.

Light dust and aerosols can also enter the lungs,

but only the smallest particles reach the alveoli.

Subsidiary points:

1. Absorption from the lung when mists are inhaled is negligible, since the droplets of moisture are too large to pass directly into the lungs. Instead, they are trapped on the moist lining of the nose and throat, and may be absorbed from these as if through the skin, or swallowed.

2. As with the other routes of entry, how much pesticide is absorbed (the dose) depends on its concentration in the fog, vapour, or dust.

3. Some pesticides have a strong smell (e.g. malathion), but in most formulations, any smell comes from the solvents. In either case, smell is not a reliable indication of the concentration of any pesticide in a gas, vapour, or mist.

Other information:

Only particles of diameter 1-8 micrometers (thousandths of a millimetre) can pass into the lungs without being trapped in the nose or mouth, throat, or trachea. Non-reflecting particles of this size are too small to be seen.

Suggested visual aid: A diagram of the body outline with an arrow pointing to the chest area and to the nose.

Module No. II A 4
Level: BASIC

Section: II **Absorption and effects of pesticides**
Subject: A **Absorption: Routes of entry**
Number: 4 **Through broken skin**

Main point:

THE ABSORPTION OF PESTICIDE THROUGH WOUNDS, CRACKED SKIN AND RASHES ON EXPOSED SKIN IS GREATER THAN THAT THROUGH THE SAME AREA OF INTACT SKIN.

Wounds and rashes should be covered with waterproof dressing as long as the worker continues to be exposed to a pesticide.

Subsidiary point:

A waterproof dressing should be removed or changed for a permeable dressing after work each day, and reapplied if work continues on the next day.

Other information:

This route of absorption is sometimes referred to as 'inoculation'.

Suggested visual aid: A diagram of the body outline with an arrow pointing to a shaded area on a forearm.

Module No. II B 1
Level: INTERMEDIATE

Section: II Absorption and effects of pesticides
Subject: B General effects of pesticides
Number: 1 Acute and long term effects.

Main points:

The routes of absorption are not equally efficient in determining how much of the amount entering the body is absorbed. Absorption in the lungs is the most efficient. Absorption through the skin may be the most important, but some pesticides (such as DDT and the pyrethroids) are hardly absorbed through the skin at all, except in oily formulations. In occupational exposure, intake through the mouth is less important, but once it occurs, absorption is difficult to prevent or slow. The effects of the absorbed dose are independent of the route of absorption. By any route, the amount of the chemical absorbed is the DOSE, and once it is absorbed, its effect is independent of the route of absorption.

AS SOON AS ANY TOXIC CHEMICAL IS ABSORBED, THE BODY OFTEN BEGINS TO BREAK IT DOWN BY ONE OR SEVERAL AVAILABLE MECHANISMS, IN ORDER TO RENDER IT HARMLESS.

AN ACUTE EFFECT OCCURS WHEN THE LEVEL OF A TOXIC CHEMICAL IN THE BODY REACHES A CERTAIN THRESHOLD, AND IT CONTINUES UNTIL THE LEVEL FALLS.

THE EFFECT OCCURS SOON AFTER THE THRESHOLD HAS BEEN PASSED.

A LONG TERM EFFECT ONLY APPEARS SOME TIME AFTER ABSORPTION OF A SINGLE OR MULTIPLE DOSES OF A CHEMICAL WITH CHRONIC TOXICITY.

Subsidiary points:

1. Many pesticides are acutely toxic, and have no chronic toxicity in humans. These are rapidly excreted or are rapidly broken down after absorption into less toxic compounds. Acute effects can be persistent as long as exposure continues, and the level remains above the threshold.

2. A few pesticides, which are little used, produce long term effects from a single dose. These include thallium, which is a rodenticide, and the organic mercurials which are sometimes used as fungicides for the treatment of seeds for planting. The latter causes permanent paralysis and brain damage if the treated seeds are eaten.

3. The threshold dose for a long term effect may be lower than that for an acute effect.

Suggested visual aid: Text, using words in capital letters above.

Module No. II B 2
Level: INTERMEDIATE

Section: II **Absorption and effects of pesticides**
Subject: B **General effects of pesticides**
Number: 2 **Storage: accumulation of dose and effect**

Main points:

SOME PESTICIDES ARE STORED IN BODY TISSUES.

Example: A few organochlorines are stored in fat.

STORAGE IS NOT CUMULATIVE: IT IS RELATED TO ABSORPTION. IF THIS DIMINISHES, SO DOES THE LEVEL OF STORAGE.

WHILE STORED, THE CHEMICAL DOES NOT CIRCULATE, AND THEREFORE DOES NOT CONTRIBUTE TO THE LEVEL AT WHICH AN EFFECT OCCURS.

WHEN THE RATE OF EXCRETION OR INACTIVATION OF ANY CHEMICAL IS LESS THAN THE RATE OF ABSORPTION, ACCUMULATION OF THE CHEMICAL IN THE CIRCULATION CAN OCCUR, AND THE THRESHOLD DOSE TO CAUSE AN EFFECT MAY BE EXCEEDED AFTER REPEATED DOSES.

ACCUMULATION OF EFFECT CAN OCCUR WHEN THE EFFECT CAUSED LASTS LONGER THAN THE EXCRETION OF THE CHEMICAL. REPEATED DOSES AT A LEVEL WHICH CAUSES A SMALL EFFECT WITHOUT SYMPTOMS CAN PRODUCE A SYMPTOMATIC EFFECT AS THE EFFECTS OF EACH DOSE ACCUMULATE TO PASS THE THRESHOLD AT WHICH SYMPTOMS APPEAR.

ACCUMULATION OF EFFECT IS MORE IMPORTANT THAN ACCUMULATION OF DOSE, ESPECIALLY WITH ORGANOPHOSPHORUS PESTICIDES.

Subsidiary point:

Storage in fat of DDT and related compounds has caused some concern, and was one of the factors that led to restriction or banning of the compound. It was certainly of significance in some animal species, especially birds, but there is no evidence that any adverse effects have appeared in humans during the 50 years that DDT has been used.

Suggested visual aid: Text, if required.

Module No. II B 3
Level: ADVANCED

Section: II **Absorption and effects of pesticides**
Subject: B **General effects of pesticides**
Number: 3 **Relationship of dose to exposure and effect**

Main points:

FOR ANY TOXIC CHEMICAL, EXPOSURE IS RELATED TO DOSE, AND DOSE TO EFFECT, AND THEREFORE EXPOSURE IS RELATED TO EFFECT, THROUGH THE DOSE.

IF THERE IS NO EXPOSURE, THERE CAN BE NO EFFECT.

IF EXPOSURE IS HIGH, BUT ABSORPTION IS LOW, THERE WILL BE NO EFFECT IF THE THRESHOLD DOSE IS NOT REACHED.

IF EXPOSURE IS VERY LOW, ABSORPTION WILL ALSO BE LOW, AND THE DOSE WILL ONLY REACH THE THRESHOLD LEVEL IF THE THRESHOLD IS LOW.

THESE SIMPLE PRINCIPLES ARE THE BASIS OF PREVENTION OF ANY ADVERSE EFFECTS FROM EXPOSURE TO TOXIC CHEMICALS.

IF THEY ARE APPLIED, ANY CHEMICAL, HOWEVER TOXIC, CAN BE HANDLED SAFELY.

Subsidiary points:

1. Those who are most likely to be exposed to pesticides are those who manufacture them, those who transport them, and those who apply them as part of their work. Most of this course is about how the exposure of the latter group can be diminished by various protective measures to avoid or lower absorption.

2. In ordinary circumstances, exposure of the public will be slight. They should have no access to hazardous pesticides, and experience has shown that occasional exposure to drift or other minor accidental exposures do not result in significant absorption. Massive pesticide contamination of food has caused serious poisoning among the public. The handling and storage of all pesticide formulations need great care, particularly in transportation.

Suggested visual aid: Text, if indicated.

Module No. II B 4
Level: INTERMEDIATE

Section: **II** **Absorption and effects of pesticides**
Subject: **B** **General effects of pesticides**
Number: **4** **Pesticides and cancer**

Main points:

AUTHORITIES REGISTERING PESTICIDES REQUIRE TESTS ON ANIMALS TO BE CARRIED OUT TO ASSESS THE POTENTIAL OF EACH PESTICIDE TO CAUSE CANCER. THEY REGULARLY REVIEW RESULTS, AIDED BY THE ADVICE OF INTERNATIONAL EXPERTS.

THE ONLY PESTICIDES THAT HAVE BEEN SHOWN DEFINITELY TO PRODUCE CANCERS IN HUMANS ARE THE INORGANIC SALTS OF ARSENIC.

Subsidiary points:

1. Carcinogenicity tests are usually carried out on rodents which are exposed to a pesticide for a lifetime.

2. Humans do not always react to chemicals in the same way as rodents, and the tests do not exclude the possibility that some compounds which do not produce cancers in animals might do so in man, and vice versa.

3. It may take up to 20 years after exposure to a chemical before cancers appear in humans. Most pesticides have been in use for longer than this period. Exposed human populations have been studied closely, especially in manufacturing and formulating plants. These studies have not produced evidence that pesticides at present in use have caused cancers in humans.

Suggested visual aid: Text, if indicated.

Module No. II C 1
Level: BASIC

Section: II **Absorption and effects of pesticides**
Subject: C **Control of pesticides**
Number: 1 **Registration of pesticides**

Main points:

PESTS DESTROY UP TO ONE THIRD OF THE WORLD'S FOOD CROPS DURING GROWTH, HARVESTING AND STORAGE, AND CAUSE MILLIONS OF CASES OF HUMAN AND ANIMAL DISEASE EVERY YEAR.
PESTICIDES ARE STILL NECESSARY TO REDUCE THESE UNTOWARD EFFECTS.

PESTICIDES VARY IN TOXICITY, AND THIS INFLUENCES THE HAZARD THAT THEY PRESENT TO NON-TARGET ORGANISMS, INCLUDING HUMANS.
THE SPECIFICITY OF PESTICIDES ALSO VARIES, BUT IN GENERAL IS LOW.
THEREFORE, THE USE OF PESTICIDES MUST BE CONTROLLED TO PROTECT THE WHOLE ENVIRONMENT.

MOST COUNTRIES HAVE FOUND THAT THE ONLY WAY TO DO THIS IS TO REGISTER PESTICIDES TO CONTROL THEIR USE.

THE GOAL IS TO PROVIDE SOCIETY WITH ADEQUATE PROTECTION FROM ADVERSE EFFECTS WHILE NOT DENYING IT ACCESS TO BENEFITS FROM THE USE OF PESTICIDES.

THIS INVOLVES DECIDING HOW EACH PESTICIDE FORMULATION SHALL BE DISTRIBUTED, LABELLED AND USED WITH MAXIMUM EFFICIENCY AND MINIMUM HAZARD TO MAN AND THE ENVIRONMENT.

Subsidiary point:

Pesticide registration authorities may be independent or attached to a government ministry, usually agriculture. Regardless of how they are organized, it is essential that other ministries, including health, environmental protection, fisheries, forestry, and others should be closely associated in the registration process.

For discussion:

How are pesticides controlled in this country?

Suggested visual aid: Text, if indicated.

Module No. II C 2
Level: BASIC

Section: II **Absorption and effects of pesticides**
Subject: C **Control of pesticides**
Number: 2 **The Code of Conduct**

Main points:

NOT ALL ASPECTS OF THE SAFE AND EFFICIENT USE OF PESTICIDES CAN BE COVERED BY THE REGULATIONS MADE AS THE RESULT OF REGISTRATION OF PESTICIDES.

IN 1985, AFTER CONSULTATION WITH OTHER INTERNATIONAL AGENCIES, THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO) ISSUED THE INTERNATIONAL CODE OF CONDUCT ON THE DISTRIBUTION AND USE OF PESTICIDES

Level: INTERMEDIATE

Subsidiary points:

1. The Code of Conduct is addressed to international organizations, governments of exporting and importing countries, industry (including manufacturers, trade associations, formulators, and distributors), users, and public sector organizations such as environmental groups, consumer groups, and trade unions.

2. It deals with:

   - pesticide management
   - testing of pesticides
   - reducing health hazards
   - regulatory and technical requirements
   - availability and use
   - distribution and trade
   - information exchange
   - labelling, packaging, storage and disposal, and
   - advertising

3. Apart from the articles in the Code many of these subjects have been amplified in more detail in Guidelines issued by FAO under the Code.

4. The Code was up-dated in 1989, to include Information Exchange and Prior Informed Consent (PIC).

Other information:

Copies of the Code and the Guidelines can be obtained from FAO.

Suggested visual aid: Text, if indicated.

Module No. II C 3
level: INTERMEDIATE

Section: II Absorption and effects of pesticides
Subject: C Control of pesticides
Number: 3 Distribution of pesticides

Main points:

AN EFFECTIVE WAY OF PROTECTING WORKERS AND THE GENERAL PUBLIC FROM ADVERSE EFFECTS IN THE HANDLING OF PESTICIDES IS REGULATION OF THE DISTRIBUTION OF HAZARDOUS FORMULATIONS

NATIONAL CIRCUMSTANCES MAY DETERMINE HOW THIS IS DONE. MANY COUNTRIES USE THE WHO RECOMMENDED CLASSIFICATION OF PESTICIDES BY HAZARD AS THE BASIS FOR CONTROL.

Level: ADVANCED/REGULATORY

Subsidiary points:

1. A suggested plan is as follows according to the hazard class of the formulation:

   Class Ia (Extremely hazardous): permitted to be sold only to approved pest control organizations for specified operations. The applicators must be fully trained, and must use full protective equipment. Some countries require licensing of applicators to ensure that training has been thorough.

   Class Ib (Highly hazardous): permitted to be sold only to approved pest control organizations for permitted uses. Applicators must be trained as above.

   Class II (Moderately hazardous): permitted to be sold only through certain retailers to those who require to use the pesticides in the course of their work. For example, farmers can buy these pesticides from suppliers of agricultural chemicals in bulk. The retailer should remind the purchasers of the precaution to be taken, and each sale should be recorded in a special register.

   Class III (Slightly hazardous), and those formulations in Table 5 of the Guidelines to Classification, unlikely to present acute hazard in normal use: permitted to be sold to the general public in small packs or as ready-for-use packages.

2. The class should be clearly visible from the colour of the label, and the presence of warning symbols on containers of formulations of moderate or higher hazard.

For discussion:

What are the regulations for distribution and labelling in this country?

Suggested visual aid: Text, if indicated.