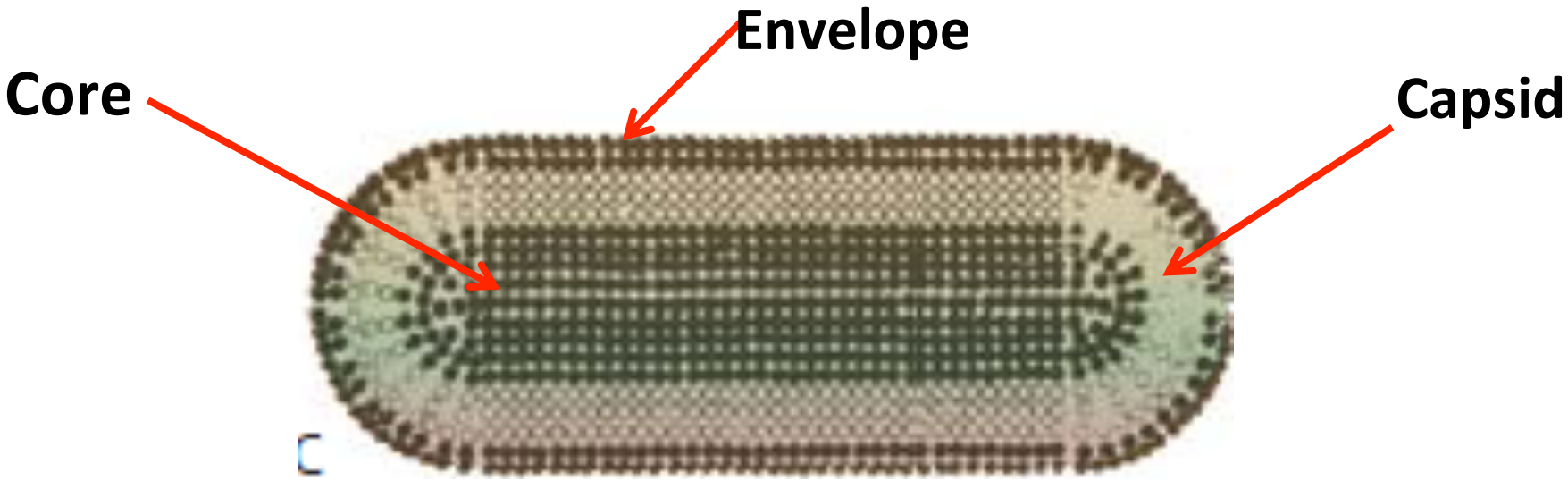
PLANT VIRUSES

Definition: A virus is a set of one or more nucleic acid template molecules, normally encased in a protective coat or coats of protein or lipoproteins, that is able to organize its own replication only within suitable host cells.

Virus: A **nucleoprotein** that multiplies only in living cells (obligate parasites) and has the ability to cause disease



VIRAL STRUCTURE

CORE

- ✓ DNA or RNA
- ✓ Contains genetic information
- ✓ Mostly RNA, except Cauliflower mosaic virus

CAPSID

- ✓ Outer protein coat
- ✓ Functions
  - Protects core
  - Shape of the virus
  - Attachment to host cell membrane

VIRAL STRUCTURE cont…

ENVELOPE

- ✓ Membrane around capsid (for enveloped viruses)
  - Virus without envelope-naked virus

- ✓ Bilayer of phospholipids and proteins, derived from host cell membrane

- ✓ Functions
  - Protection from drying (enhances transmission)
  - Attachment to host cell membrane (by means of spikes)
  - Makes virus more susceptible to chemicals that dissolve lipids

TRANSLOCATION AND DISTRIBUTION OF VIRUSES IN PLANTS

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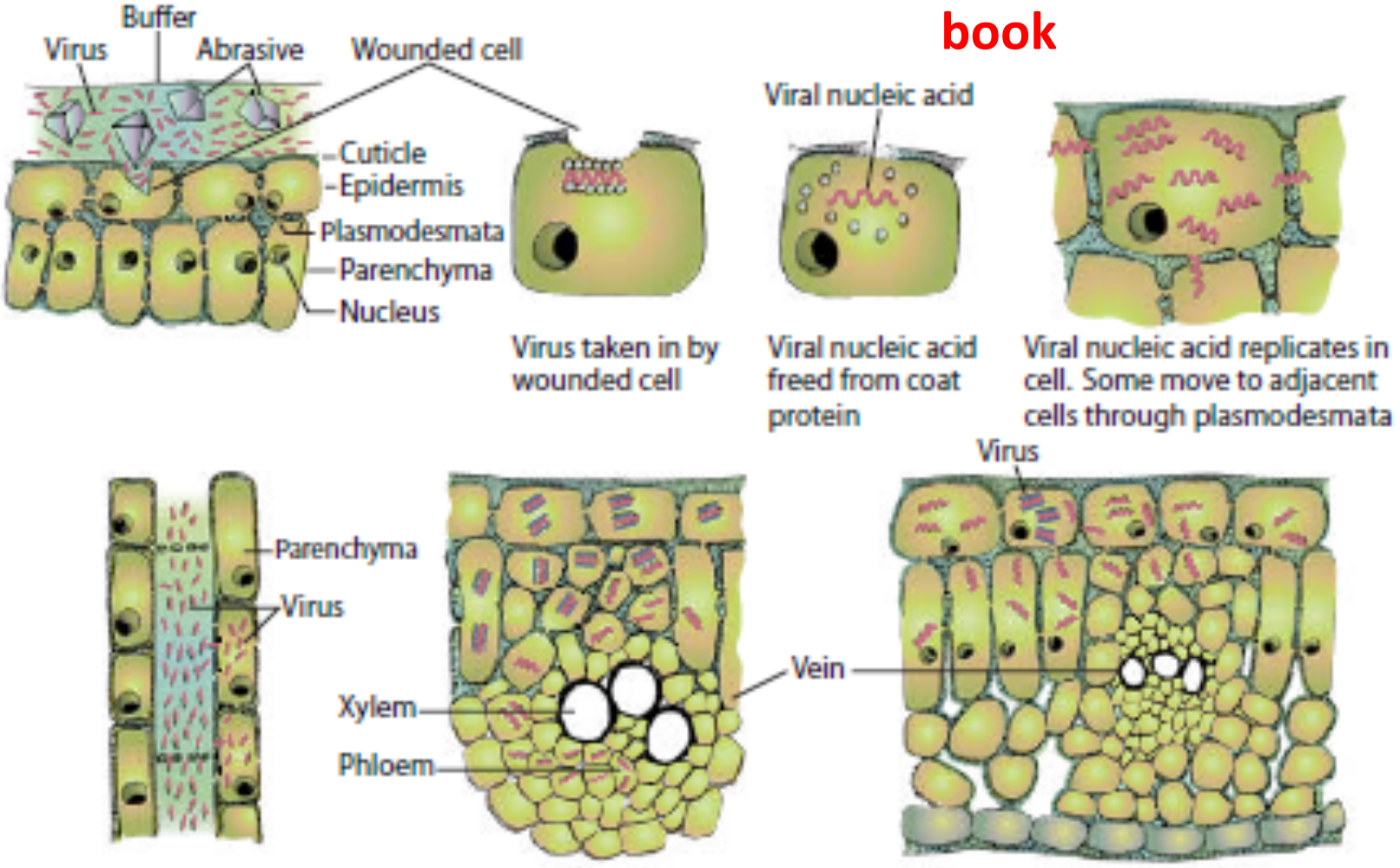

Virus taken in by wounded cell

Viral nucleic acid freed from coat protein

Viral nucleic acid replicates in cell. Some move to adjacent cells through plasmodesmata

In phloem, viral nucleic acid or virus is carried with the photosynthate throughout the plant

Viral nucleic acid or virus reaches phloem vessel through plasmodesmata of parenchyma cells

Viral nucleic acid multiplies in new cells and spreads to adjacent cells. Some of the early formed nucleic acid is coated with protein and forms virus

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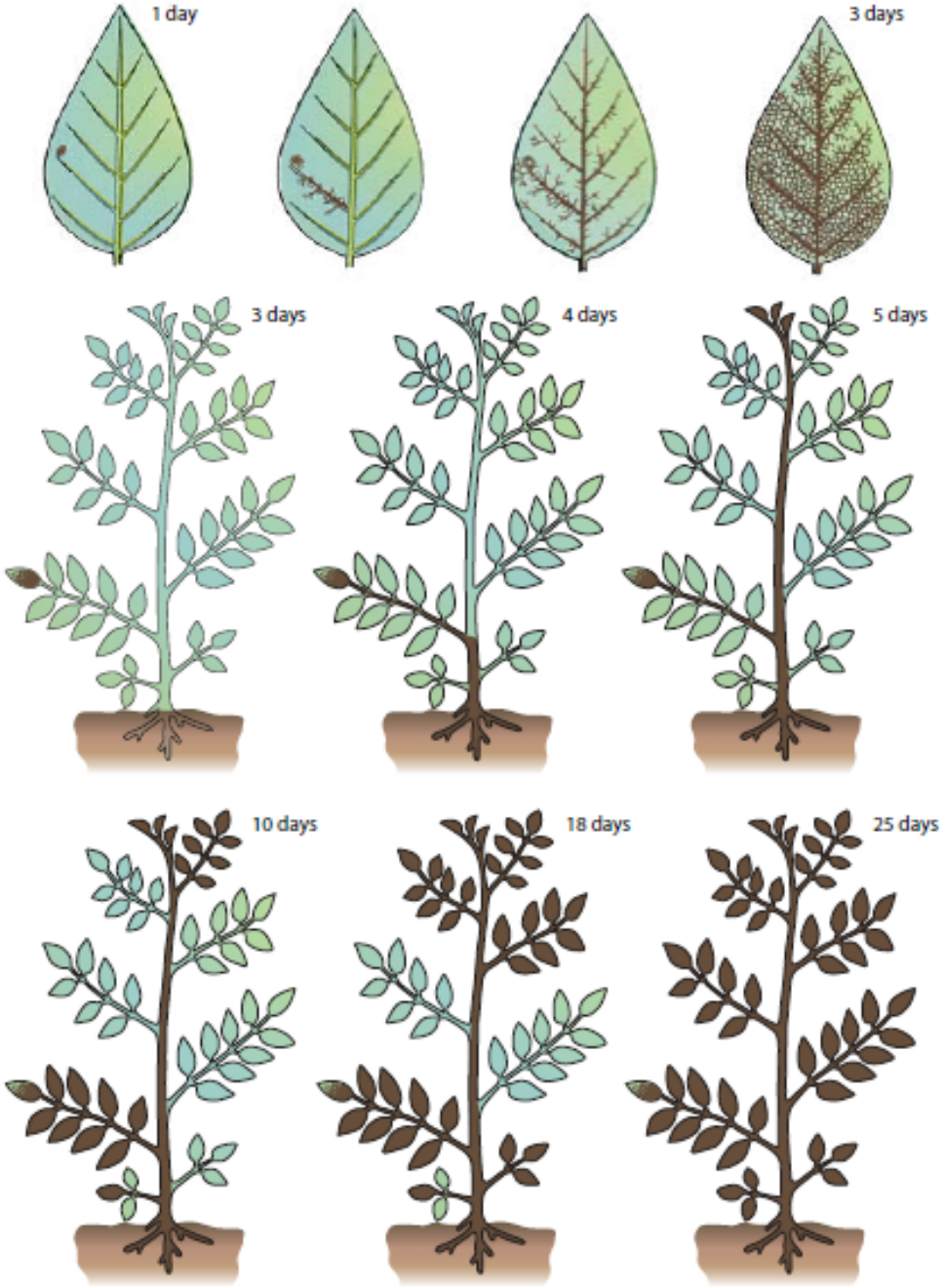


FIGURE 14-12 Schematic representation of the direction and rate of translocation of a virus in a plant. [Adapted from Samuel (1934). *Ann. Appl. Biol.* **21**, 90–11.]

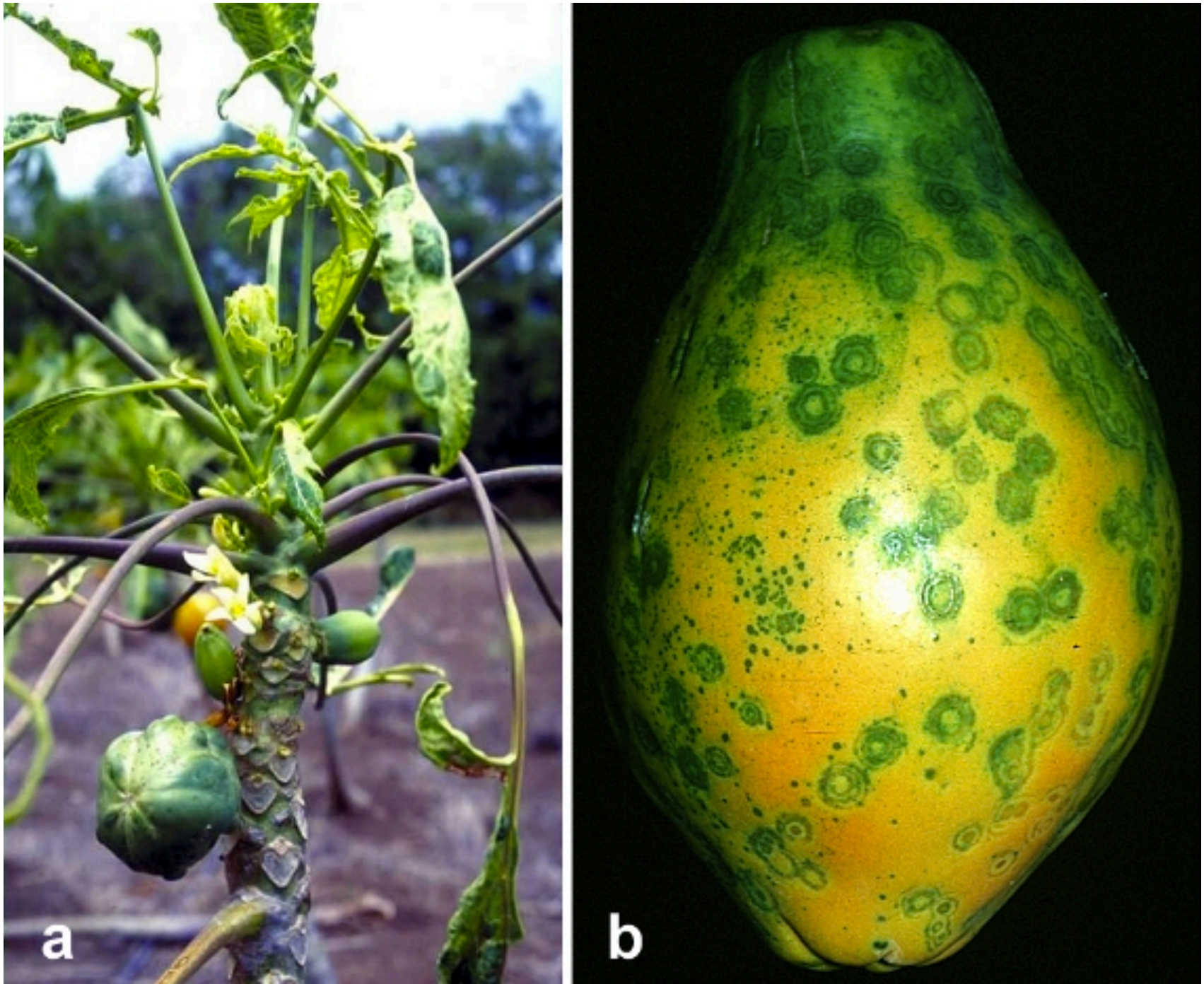
SYMPTOMS OF VIRAL INFECTION IN PLANTS

Mainly mimic genetic abnormalities

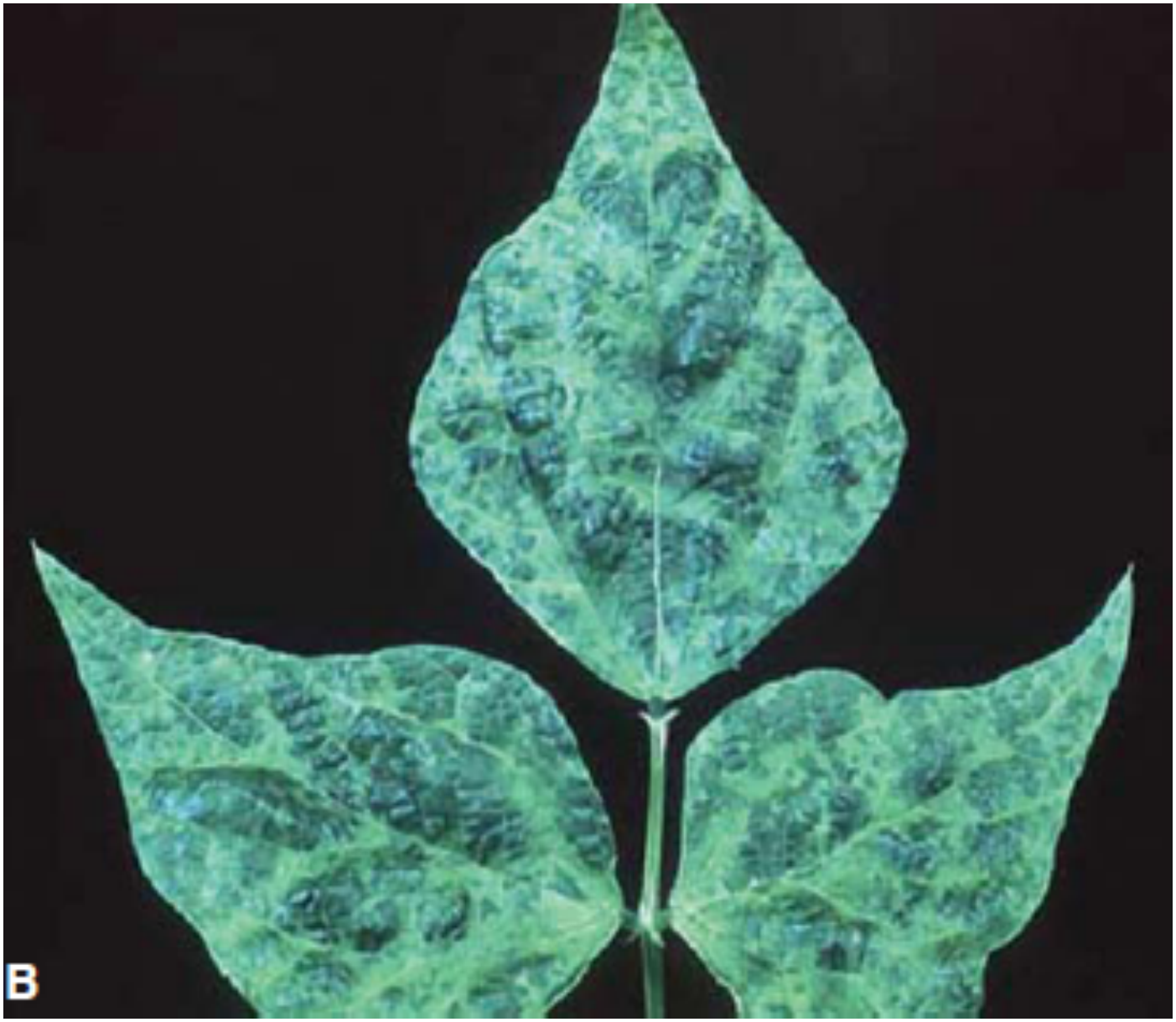
1. Vein banding
2. Mosaic
3. Yellows
4. Flecking or spotting on foliage
5. Distortions
6. Abnormal growth and death

Mosaics on tobacco leaves caused by Tobacco mosaic virus

Papaya ringspots caused by Papaya ringspot virus


a
b

Mosaics caused by Bean common mosaic virus



Malformation and mosaics formed by Watermelon mosaic virus

Maize streak caused by Maize streak virus

Banana bunchy top disease - by banana bunchy top virus

HOW TO IDENTIFY A PLANT VIRUS

- Quick leaf-dip
- Routine screening
- Test plants
- DNA/PCR-based approaches

TRANSMISSION OF PLANT VIRUSES

Understanding the mode of transmission helps us in the control of the viruses

1. Vertical transmission

2. Horizontal transmission

- Insects, Nematodes, Humans, Mechanical means, Seed

MANAGEMENT OF PLANT VIRUSES

- Curing virus-infected plants is difficult/impossible
  - On small-scale: Chemotherapy, Thermotherapy, and Meristerm-tip culture has been succesful but not on large-scale.

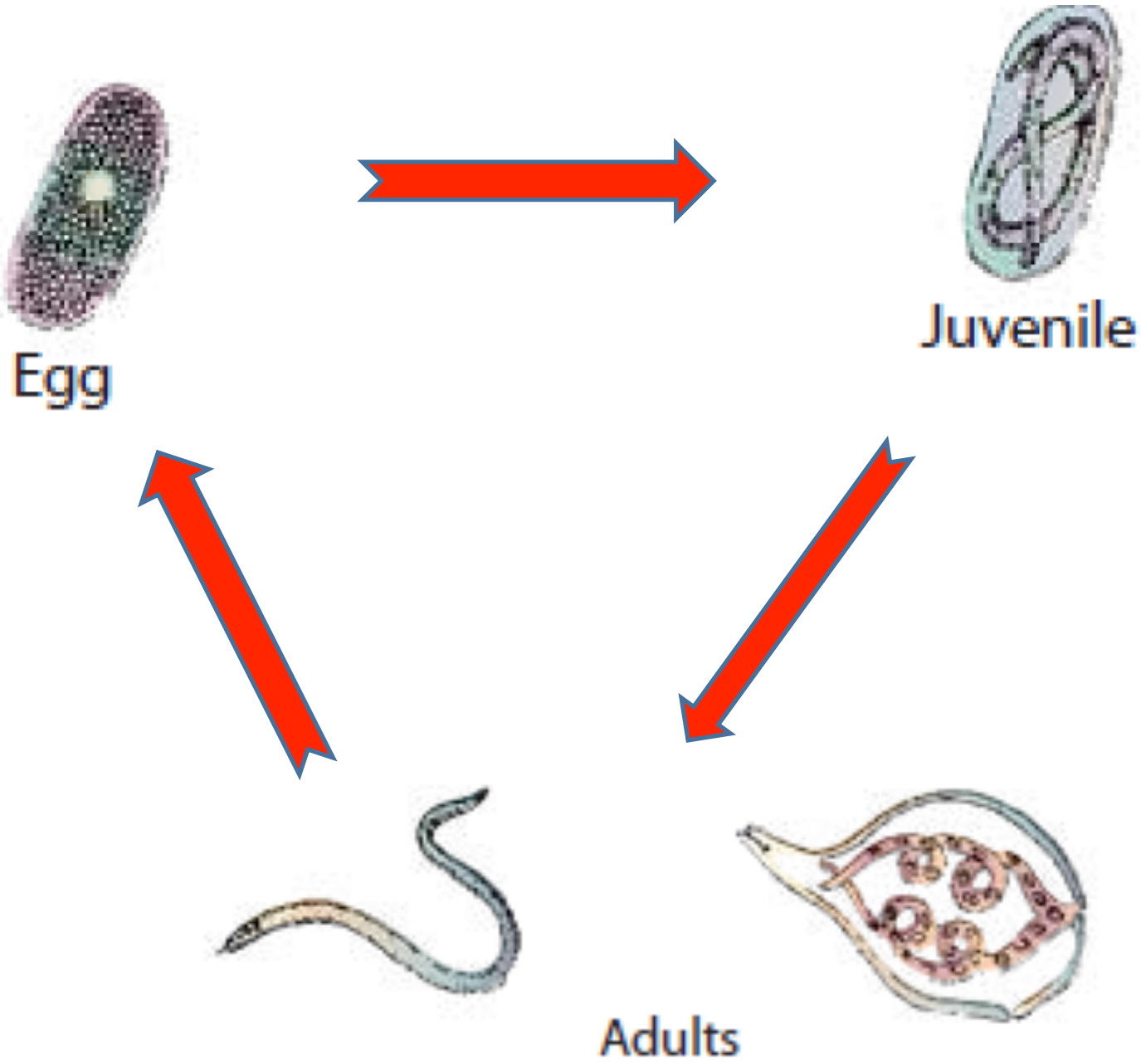
- In general: prevent, delay viral infection or ameliorate its effects:
  - Phytosanitation (quarantine, eradication, crop hygiene, virus free planting material)
  - Pesticides to control vectors
  - Mild strain protection

- Singly or in combination

NEMATODES

NEMATODES

- Generally microscopic, worm-like animals that live saprophytically in water or soil, or as parasites of plants and animals.


Egg
Juvenile
Adults

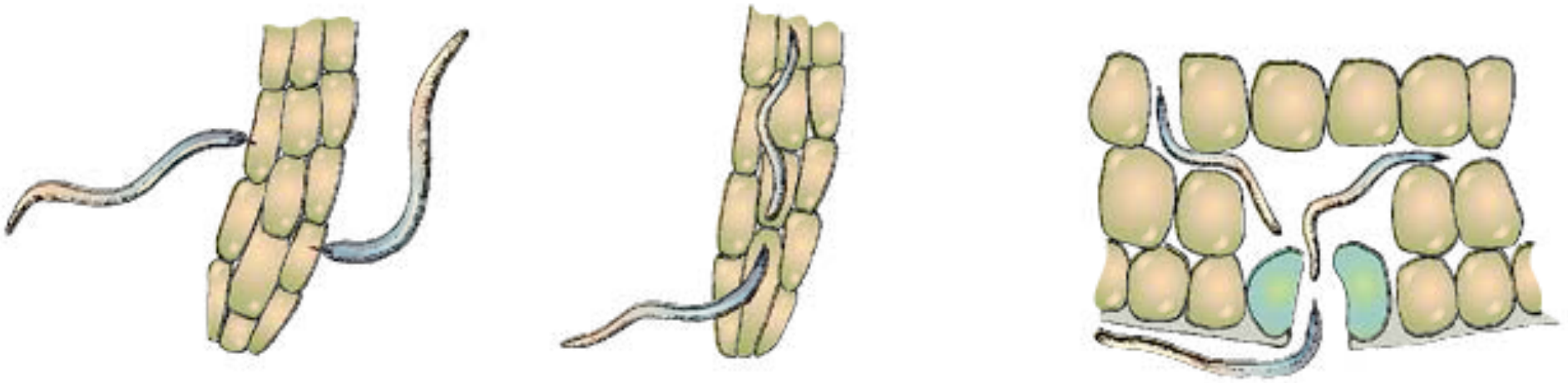


FIGURE 2-10 Methods of penetration and invasion by nematodes.

- Nematodes secrete a saliva which contains <u>enzymes</u> & <u>toxins</u>

MAJOR GROUPS OF NEMATODES

- Root knot nematodes (Genus: *Meloidogyne sp*)
- Cyst nematodes (Genera: *Heterodera* and *Globodera*)
- Burrowing nematode-Burrowing nematode disease (*Radopholus*)
- Lesion nematodes-Lesion nematode disease (*Pratylechus sp*)
- Citrus nematode (*Tylenchulus semipenetrans*)
- Stem and bulb nematode (*Ditylenchus*)
- Pine wilt disease
- Sting nematode (*Belonolaimus*)

Nematode Reproduction

1. All nematodes produce eggs. Therefore, all reproduction is sexual. Eggs develop into juveniles (one per egg) that hatch from the egg and develop into adults.

2. Most nematodes are oviparous.
   Eggs develop outside the female body.

3. Very few nematodes are viviparous.
   Eggs -- without an obvious egg shell -- complete development inside the uterus and functional juveniles emerge from the female.

Symptoms Induced by Plant-Parasitic Nematodes

Above Ground

- Reduced yield
- Stunting
- Wilting
- Chlororsis
- Lesions
- Galls

Below Ground

- Reduced root system
- Stubby Roots & “Witches Broom”
- Lesions
- Galls
- Rotting (when secondaries are present)

Symptoms (above and below ground) often are mistaken for damage from compaction, iron deficiency chlorosis and other nutrient deficiencies, drought stress, herbicide injury, or other plant diseases. Symptoms may be masked by the presence of secondary organisms that follow the nematodes

SYMPTOMS

- Often non-specific (depends on species)
  - ✓ Stunting
  - ✓Poor growth
  - ✓Wilting
  - ✓Distortion

- Nematodes secrete a saliva which contains <u>enzymes</u> & <u>toxins</u>

- Damage is done to the host by removal of nutrients & by the deleterious effects of the components of the saliva

Root galls on bean plant infected with the root-knot nematode *Meloidogyne sp.*

Root galls: tomato, carrot, potato (*Meloidogyne sp.*)

Soyabean Cyst nematode damage

Nematode damage in maize

Physical, Biological, Cultural, and Chemical Control of Nematodes

Physical

- Heat
- Electrical
- Microwave
- Irradiation
- Flooding
- Osmotic

Biological

- Organisms
- Reasons for failure

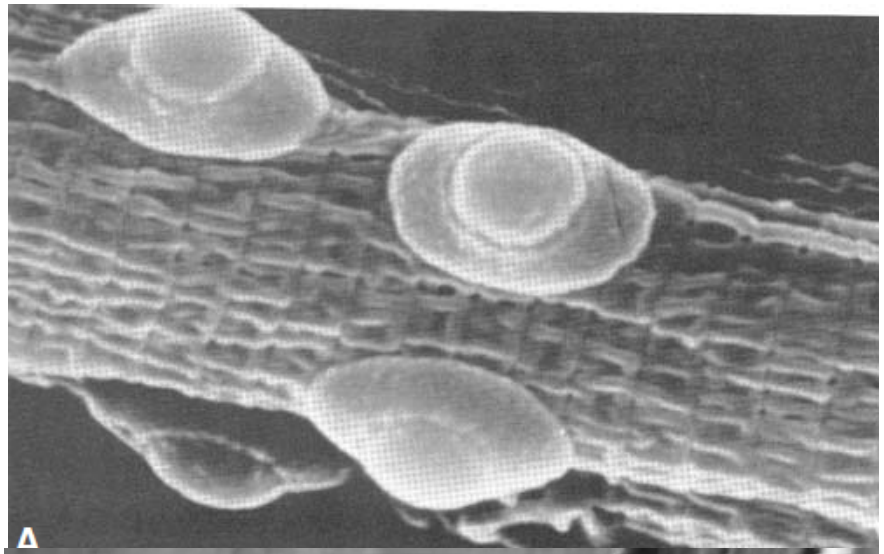
Cultural

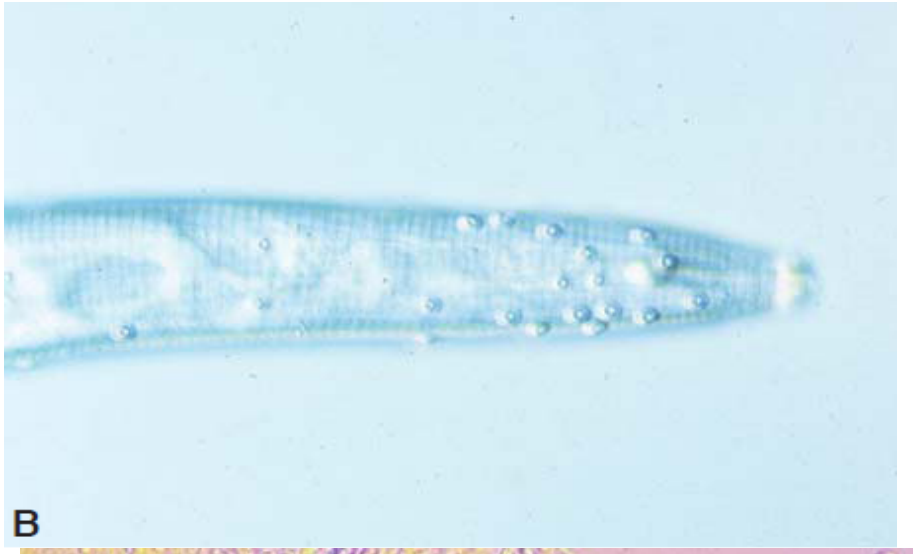
- Resistance
- Rotation
- Clean Culture
- Fallow
- Allelopathic Plants
- Legislative (Quarantines)

Chemical

- Chemicals
  - Fumigant
  - Non-Fumigant
- Application Methods and Equipment

Biological control of nematodes





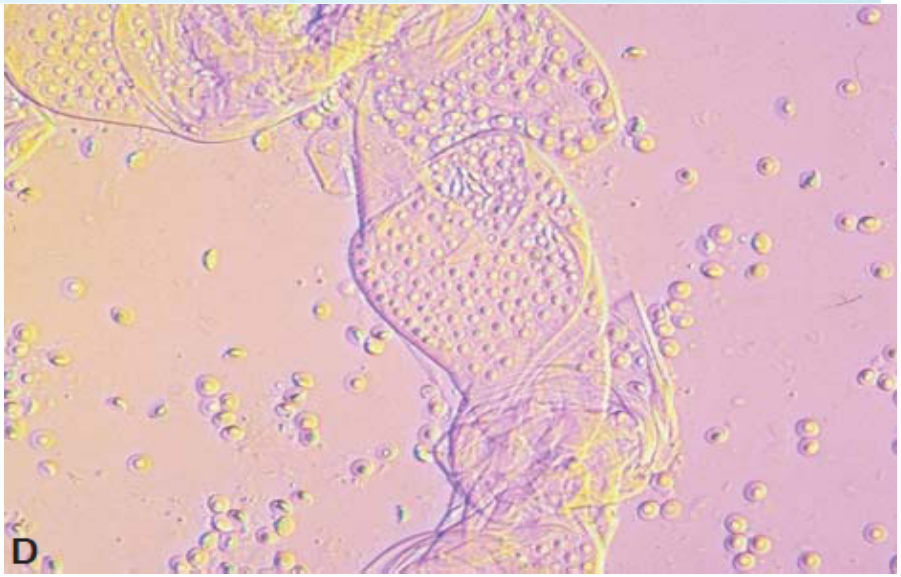


FIGURE 9-12 Biological control of nematodes. In (A, B, and C) *Meloidogyne* juveniles and (D) *Pratylenchus sp.* are attacked by the bacterium *Pasteuria penetrans* and in (E) a *Heterodera* cyst by the fungus *Verticillium lecanii*. [Photographs courtesy of (A) K. B. Nguyen, (B and D) R. M. Sayre, and (C and E) D. J. Chitwood.]

Solarisation

NON INFECTIOUS DISORDERS

- Brought about by abnormal temperatures, light, atmosphere, disturbance of water relationship, nutritional imbalance, toxic action of pesticides or other applied chemicals, or by injury from such physical causes like lightning and wind

- No parasite involved

- Symptoms may be confused with pathogenic ones

- May make plants too weak to defend themselves against pathogens

- Remember what we discussed under diagnosis of abiotic causes of disease

NON INFECTIOUS DISORDERS cont…

- Low Temperature effects
- High Temperature effects
- Soil-moisture disturbance
- Effects of Atmospheric pollution
- Lightning injury
- Nutritional disorder
- Effects of Toxic chemicals

CONTROL OF PLANT PATHOGENS AND LOSS AVOIDANCE

CONTROL OF PLANT PATHOGENS AND LOSS AVOIDANCE

CHEMICAL CONTROL

EXCLUSION

CULTURAL MEASURES (practices done during crop production)

MULTILINES AND MIXTURES (multiple varieties mixed and planted)

NON-CHEMICAL SOIL TREATMENT (e.g heat treatment)

INDUCED RESISTANCE

BIOLOGICAL CONTROL (controlling one microbe using another nonpathogenic one)

MANAGING VECTORS

HOST PLANT RESISTANCE

CHEMICAL CONTROL OF PLANT PATHOGENS

- Applicable against fungal, bacterial and nematode diseases, but not viruses (indirect via control of insects)

- Why are pesticides (fungicides, bacteriocides, nematicides) needed?
  - May be the only available control method at times
  - They may be the most economical option available

- Can be applied to the soil, seed, foliage.

- They should be used judiciously: to minimise costs, environmental damage, health hazard, and development of resistance.

- See handout for details

PREVENTING RESISTANCE TO CHEMICALS

- Consistent use of the same chemical might speed-up build-up of resistance against the chemical in pathogen populations
- To minimise the chances of this happening, it is advisable to rotate/combine chemicals from different chemical groups.
- These groups are based on mode of action (chemicals with the same mode of action are placed into one group)
- An example is the FRAC Code (Fungicide Resistance Action Committee)
- See handout for details

INTEGRATED MANAGEMENT

Integrated Disease (Pest) Management (IDM) is an effective and **environmentally sensitive** approach to disease management that relies on a **combination** of common-sense practices. IDM programs use current, comprehensive information on the **life cycles** of plant pathogens and their **interaction** with the environment. This information, in combination with available disease **control methods**, is used to manage disease by the most economical means, and with the least possible hazard to people, property, and the environment.

STAGES IN AN IDM

1. Prevention

2. Observation

3. Intervention

SIX BASIC COMPONENTS OF IDM

1. **Acceptable disease levels**
   i. Use action thresholds, apply controls only if those thresholds are crossed.
   ii. control, not eradication.

2. **Preventive cultural practices**

3. **Monitoring**

Inspection, identification, record-keeping, environment

SIX BASIC COMPONENTS OF IDM

4. Mechanical control

- ❑ Roguing

5. Biological control

- ❖ Natural enemies

6. Chemical control

- ✓ Last resort
- ✓ Used judiciously