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SEMINAR
ON

IMPORTANCE OF BIOPESTICIDES IN IPM OF FIELD CROPS

2022

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Submitted by

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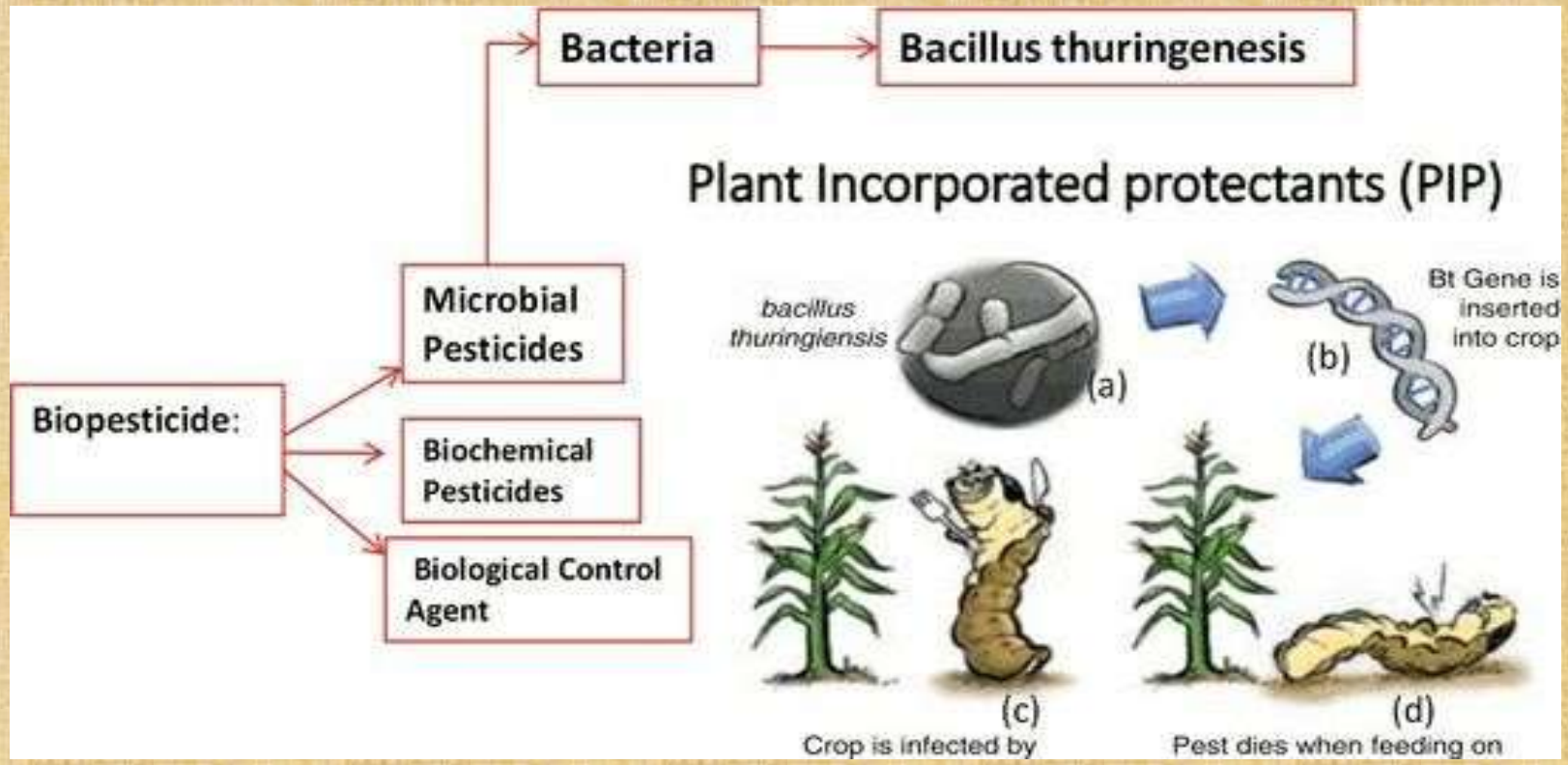
Introduction

- Bio means involving life or living organisms.
- Biopesticides is a formulation made from occurring substance that controls pest by non-toxic mechanism and in eco-friendly manner.
- Biopesticdes may be derived from animals (e. g. nematodes), plant (Crysanthemum, Neem) and micro-organisms (*Bacillus thuringiensis* , *Tricoderma*, NPV) , and include living organisms (natural eneniem) etc.
- The most commonly used biopesticides are living organisms, which are pathogenic for the pest of interested
- Biopesticide mass-produced, biologically based agents used fro the control of the plant pest.
- Therefore, an eco-friendly alternative is the need of the hour.
- However, biopesticides are generally less toxic to the user and non-targetd organisms, making them desirable and sustainable tools for pest management.
- Priority should be given to biopesticide use against pests to avoid adverse impact of chemical insecticides.

What are Biopesticides?

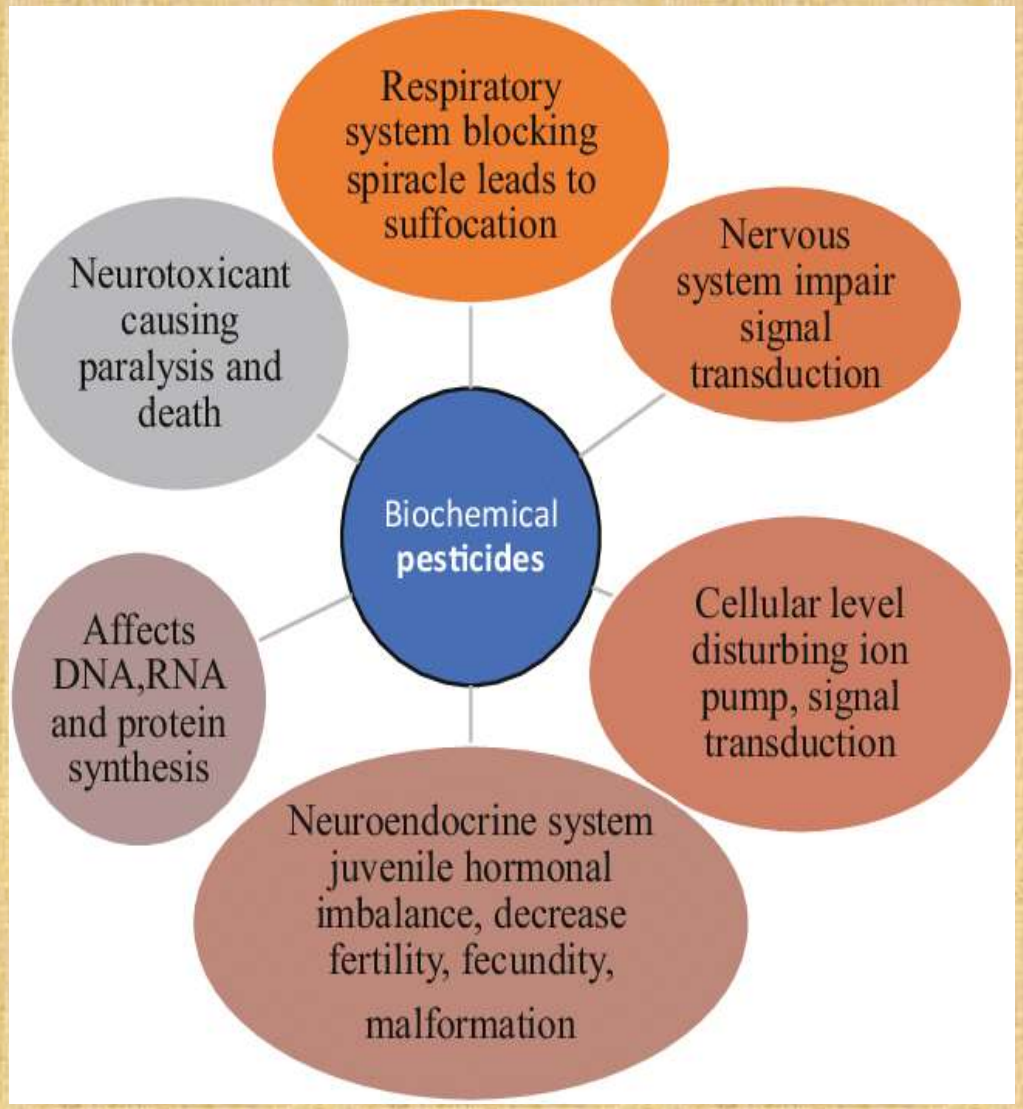
Biopesticides are certain types of pesticides derived from such natural materials which are extracted from animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered biopesticides.



Classes of Biopesticides

- Biopesticides fall into three major classes:

1. **Biochemical pesticides :-** Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Biochemical pesticides include substances that interfere with mating, such as insect sex pheromones, as well as various scented plant extracts that attract insect pests to traps.



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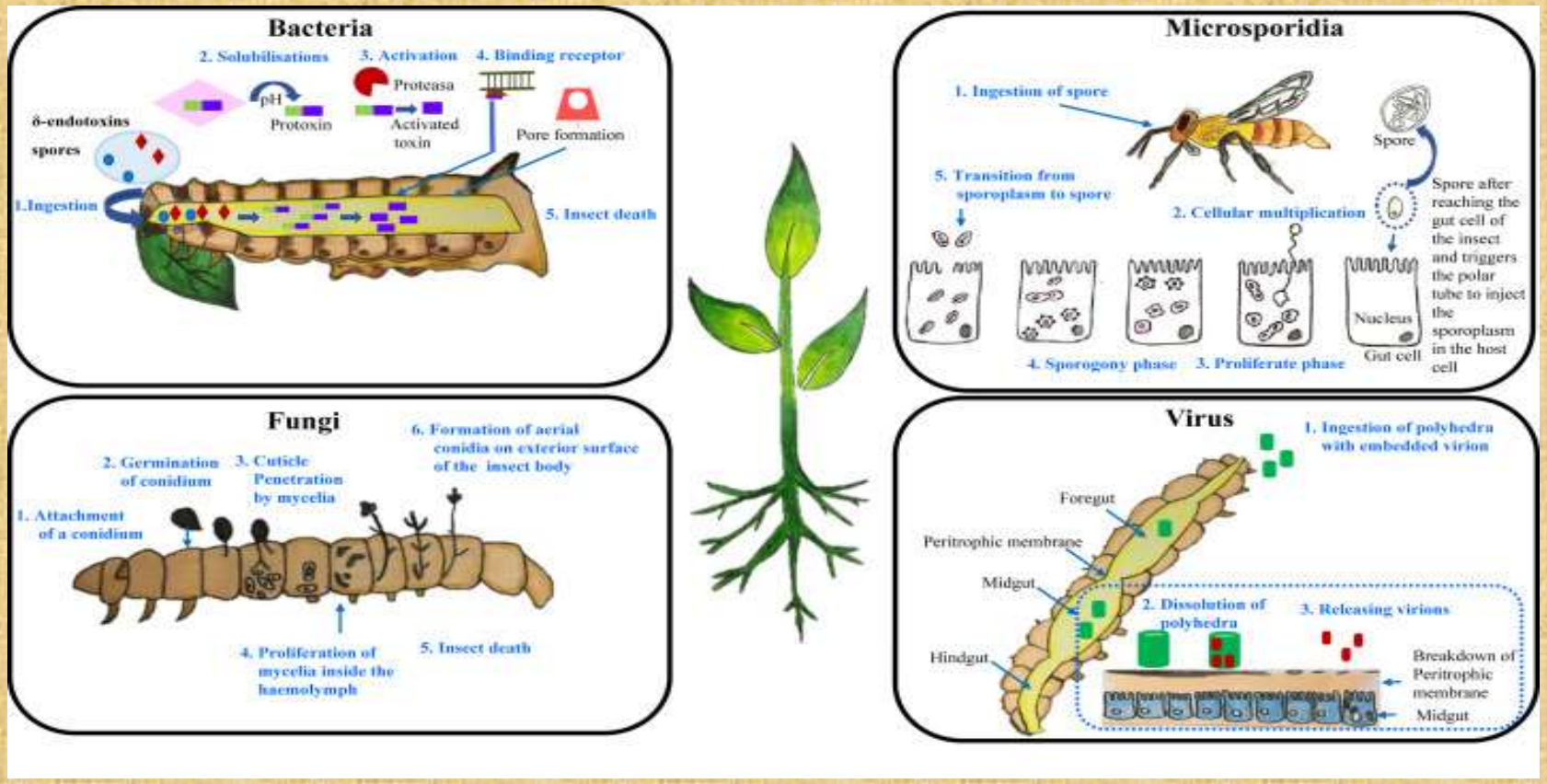
2. **Microbial pesticides :-** Microbial pesticides consist of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. For example, there are fungi that control certain weeds and other fungi that kill specific insects. The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis*, or *Bt.*



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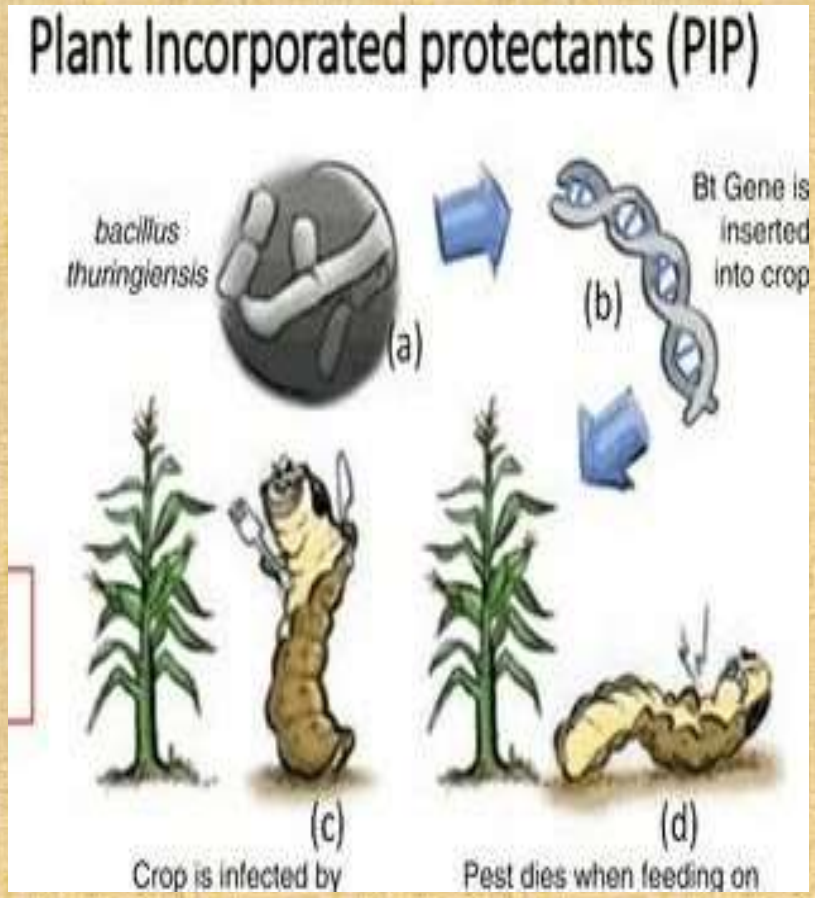
3. Plant-Incorporated-Protectants (PIP) :- Plant-Incorporated-Protectants (PIPs) are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the *Bt* pesticidal protein and introduce the gene into the plant's own genetic material.



1. Biochemical pesticides

Semiochemicals

Semiochemicals are organic compounds used by insects to convey specific chemical messages that modify behavior or physiology.

The term semiochemical is derived from the Greek word “someone” which means sign or signal.

The term Semiochemical was first proposed by Law and Regnier in 1971 (Simeon-maker or signal)

Pheromone

A substance that is secreted by an organism to the outside and cause a specific reaction in a receiving organism of the same species.

1. **Sex Pheromone :-** A chemical generally produced by the female to attract same species of males for the purpose of mating.

The following are the some of the female sex pheromones identified in insects:

Conti….

NAME OF THE INSECT	PHEROMONE
Silk worm, *Bombyx mori*	Bombykol
Gypsymoth, *Porthesia dispar*	Gyplure, disparlure
Pink bollworm, *Pectinophora gossypiella*	Gossyplure
Cabbage looper, *Trichoplusia ni*	Looplure
Tobacco cutworm, *Spodoptera litura* Gram pod borer *Helicoverpa armigera*	Helilure
Honey bee queen, *Apis* sp.	Queen's substance
Example of males producing sex pheromone	
Cotton boll weevil, *Anthonomas grandis*	Coleoptera
Cabbage looper, *Trichoplusia ni*	Lepidoptera
Mediterranean fruitfly *Ceratitis capitata*	Diptera

Conti….

2. Aggregation Pheromone :- A substance produced by the one or both sexes, and brigning both sexes together for feeding and reproduction.

PHEROMONE	INSECT
Frontalin	*Dendroctonus frontalis*
Ipsenol	*Ips confuses*
Periplanone	*Periplanata americana*
Dimethyl decanol	*Tribolium confusum*

Conti….

3. Alarm Pheromone :- A substance production by an insect to repel and disperse other insects in the area. It is usually released by an individual when it is attack.

Organs producing alarm pheromones in various insects are listed below.

INSECT	ORGANS
Aphid	Cornicles
Bug *Dysdergus* sp.	Abdominal glands
Termites	Cephalic glands
Worker bees	Sting glands
Ants	Anal, mandibular and Dufours's glands

Conti….

4. **Parapheromone :-** A substance of anthropogenic origin, not known to exist in nature but structurally related to some natural pheromone components that in some way affects the insect communication system. e. g. Methyl eugenol, Cue-lure.
5. **Propheromone :-** Refers to photolabile adduct able to protect pheromone molecules under field conditions. e. g. Tricarbonyl.

Allelochemical

A substance that is significant to organism of different from its source, for reasons other than food.

1. **Allomone :-** A substance produce or acquired by an organism that, when contacts an individual of another species, evokes in the receiver a behavioural or physiological reaction that is adaptively favourable to the emitter but not the receiver. e. g. Sting gland in bee, Reflex bleeding in aphids, Secretion from osemateria in *Papilio demoleus* (Citrus caterpillar), Formic acid in ants.
2. **Kairomone :-** A substance produce or acquired by an organism that, when contacts an individual of another species, evokes in the receiver a behavioural or physiological reaction that is adaptively favourable to the receiver but not the emitter. e. g. Haptanoic acid released by larva of potato tuber moth *Phthorimaea operculella* increases in searching by its parasitiod, µ- farnesene secreted by codling moth larva attracts its parasitoid.

Conti….

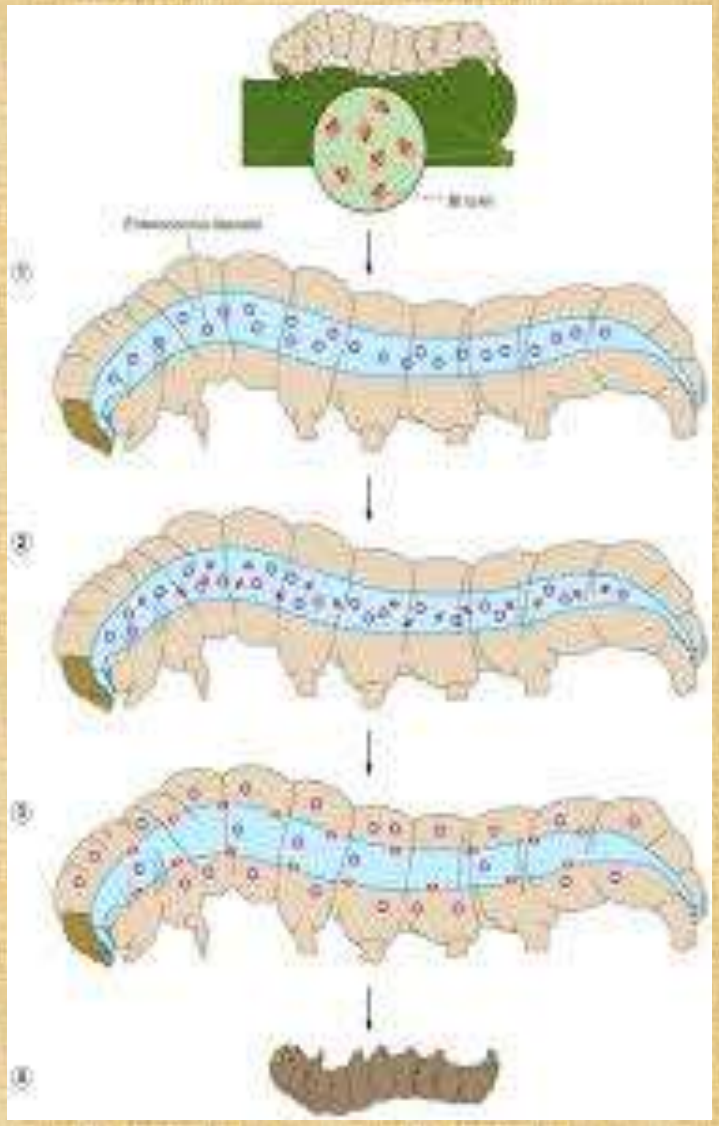
3. Synomone :- A substance produce or acquired by an organism that, when contacts an individual of another species, evokes in the receiver a behavioural or physiological reaction that is adaptively favourable to both emitter and receiver. e. g. Termites and protozoans.

4. Apneumone :- A substance emitted by a non - living material which evokes a behavioural or physiological reaction that is adaptively favourable to a receiving organism but detrimental to an organism of another species that may be found in or the living material. e. g. an ichnuemoind parasite of *Venturia canescens* in attract by the smell of the othmeal.

2. Microbial pesticides

1. Bacteria

The most widely use of insecticidal bacteria is *Bacillus thruinginesis Bt.* these are gram positive, spor forming soil bacterium that produces parasporal, proteinaecous crystal incolusion bodies during sporulation,



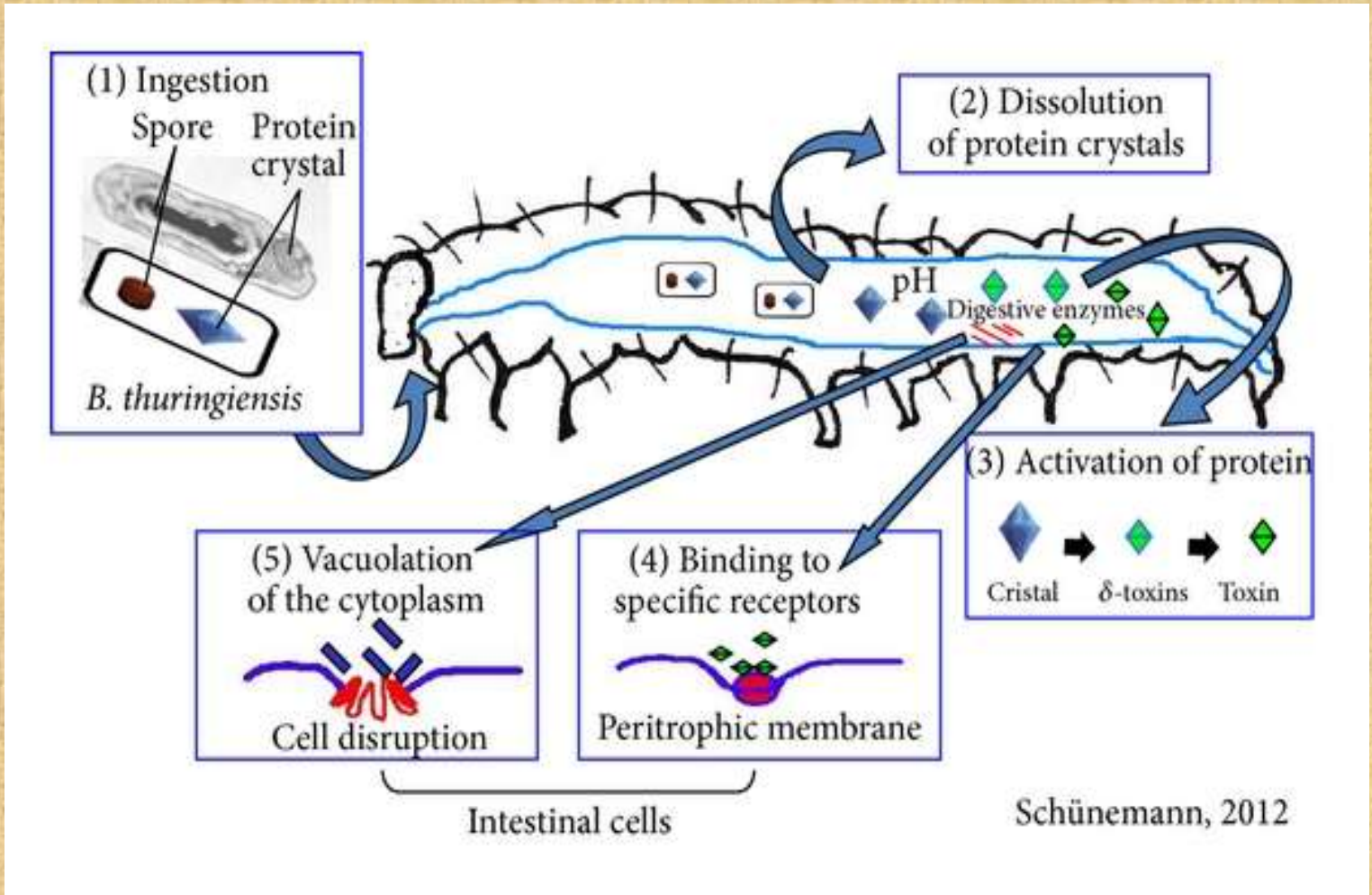
List of some important Entomopathogenic bacteria

Bt variety	**Targate pests**
Bacillus thuringiensis subspecies *kurstaki*,	Lepidopteran larvae
Bacillus thuringiensis subspecies *aizawai*	Lepidopteran larvae
Bacillus thuringiensis subspecies *israelensis*	Dipteran larvae
Bacillus thuringiensis subspecies *tenebrionesis*	Adults and larvae of Coleoptera
Bacillus thuringiensis subspecies *morrissoni*	Colorado potato beetle
Bacillus thuringiensis subspecies *japonensis*	Soil beetl
Bacillus sphaericus	Mosquito larvae
Bacillus popilliae	Japanese beetle
Serratia entomophila	White gurb

Mode of action *Bt*

- On being ingested by the susceptible host, the endospore germinate in the gut (only if the pH is below 9), producing the bacterial cell.
- The cells migrate into the haemocoel where they multiply rapidly and invade and destroy certain tissue and soon fill much of the haemocoel.
- This stage of infection is termed as septicemia.
- Prior to the death of the host, the thickwalled refractile spore are formed; the bacillus body is then called sporangium.
- After the death of the host, the spore are released into the soil.
- The genus *Clostridium* differs from the genus *Bacillus* in that it does not invade the heamocoel but multiplies in the gut itself and the host's cadaver gets mummified instead of disintegrating.

Bt infection in Insects



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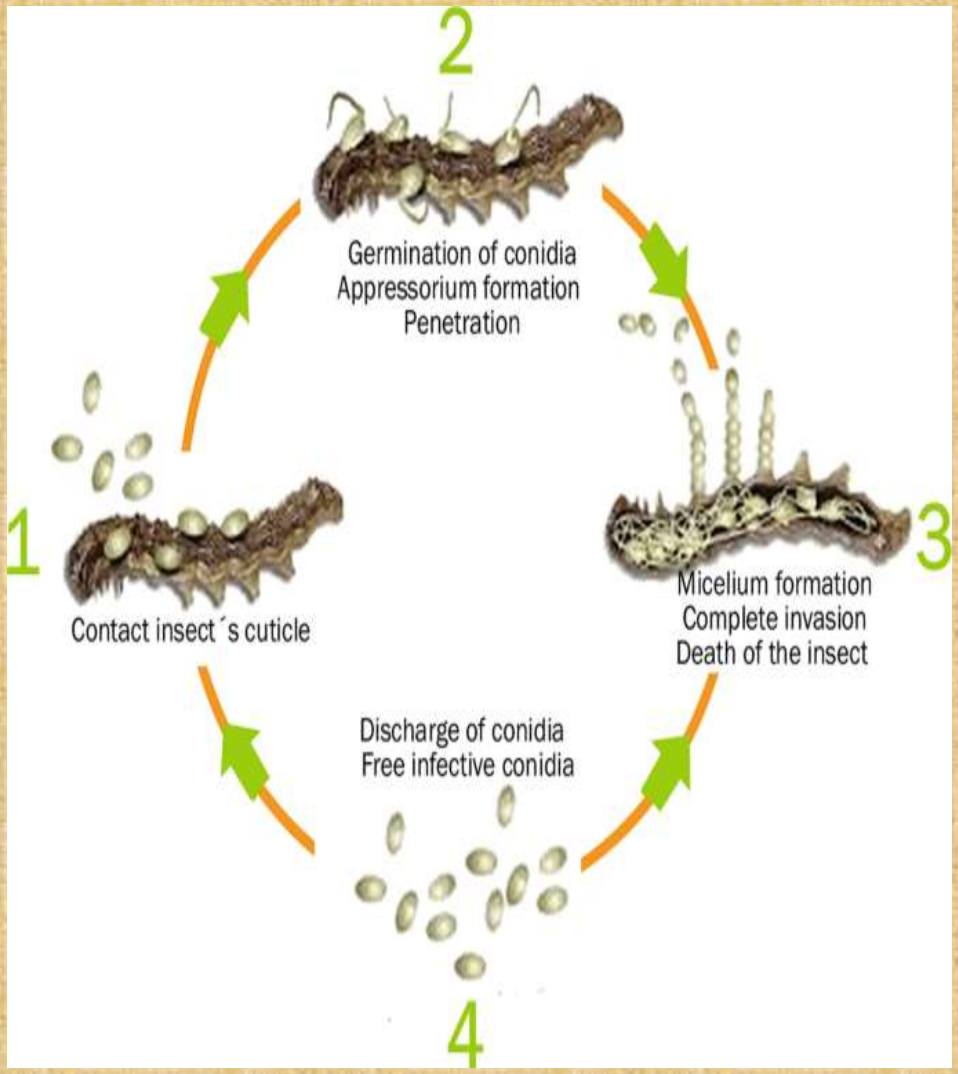
2. Fungi

Louis Pasteur was the first use of the fungus on grap vines yards to control tiny inhabiting insects. Entomopathogenic fungi are able to directly penetrate on the outer layer of host insect once it attached to the fungus penetrate in the insect bodywall with the help of hypha produces from the spores, the hypha enter the circulatory system of the insect. The cause of insect death is extensive fungal growth in the haemolymph and poisoning by fungal toxin.



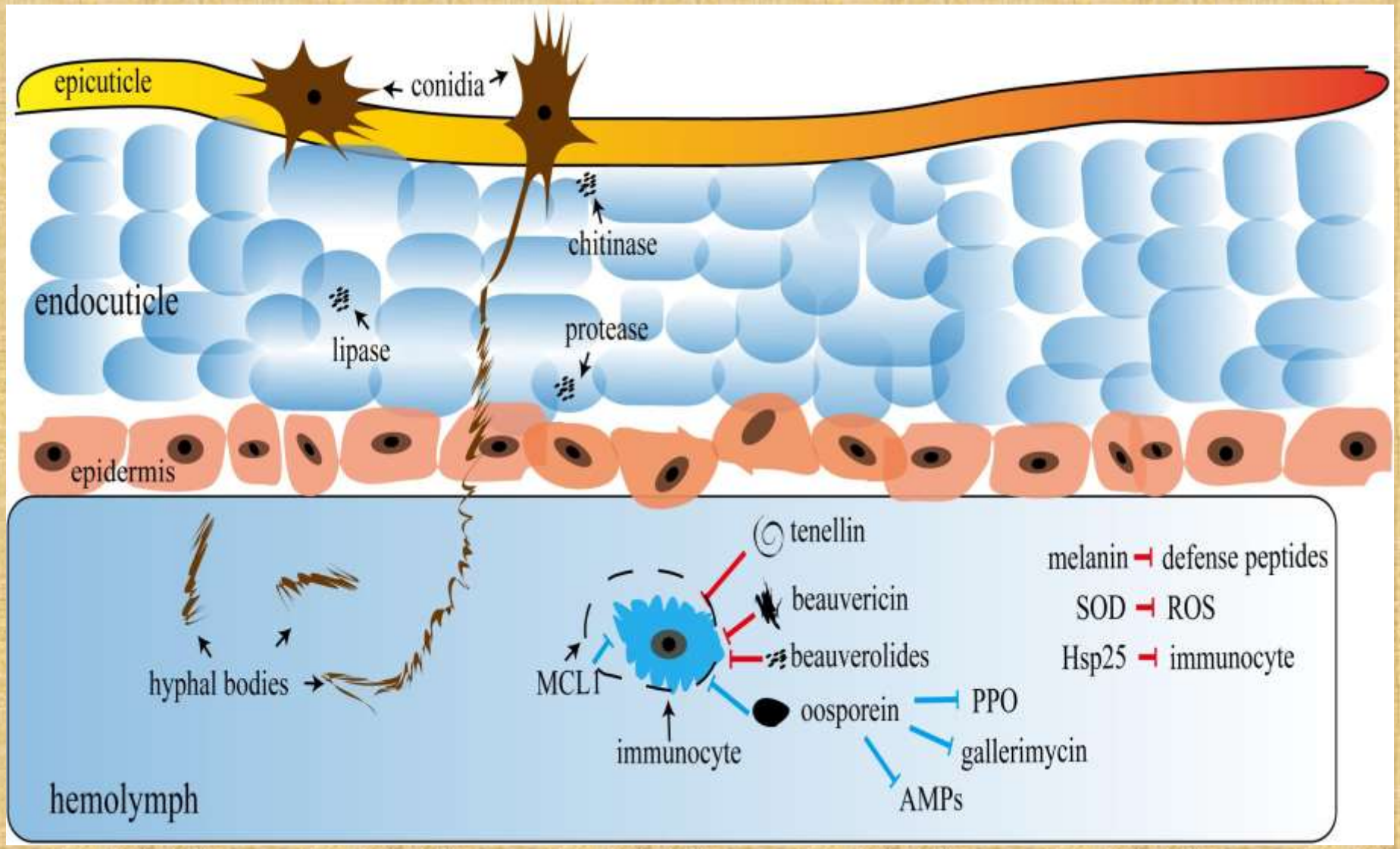
Some common fungus-containing microbial insecticides commonly used worldwide

Fungi species	Effective Host	Commercial Name
Beauveria bassiana (Bals. Criv) Vuill.	Whiteflies, aphids, thrips	Mycotrol
Beauveria bassiana	Sucking insects	Naturalis
Metarhizium anisopliae	Termite	BioBlast
Lecanicillium lecanii	Aphids	Vertalec
Lecanicillium lecanii	Whiteflies	Mycotal
Paecilomyces fumosoroseus	Whiteflies, thrips	PFR-97
Beauveria brongniartii	Manas larvae	Engerlingpilz
Metarhizium anisopliae	Grasshoppers	Green Muscle
Beauveria bassiana	Manas larvae	Betel
Metarhizium anisopliae	Whiteflies, thrips, aphids and caterpillars	MET52 EC
Metarhizium anisopliae	Whiteflies, thrips, aphids and caterpillars	Whiteflies, thrips, aphids and caterpillars

Mode of action of Fungi

- The action mechanisms of entomopathogenic fungi; firstly, the fungus spores settle on the insect cuticle, then the spores germinate and enter the cuticle by forming appressorium.
- Hyphae develop in hypodermis and they continue to multiply in insect body and blood cells and cause the death of the insect.
- Permanent sexual and asexual periods occur with asexual spores that can spread by saprophytic development on these dead individuals (Glare and Milner, 1991).
- For example, *Beauveria bassiana* and *Metarhizium anisopliae* secrete toxin in artificial environments.
- These substances can cause insect death even before spread and form spores in tissue of parasitic fungus.
- In most cases, the digestion of fungal propagules can cause death due to toxic effect rather than mycosis (Charnley, 2003).

Mode of Action of fungal spore in insect bodywall



SOURCE :- GOOGLE

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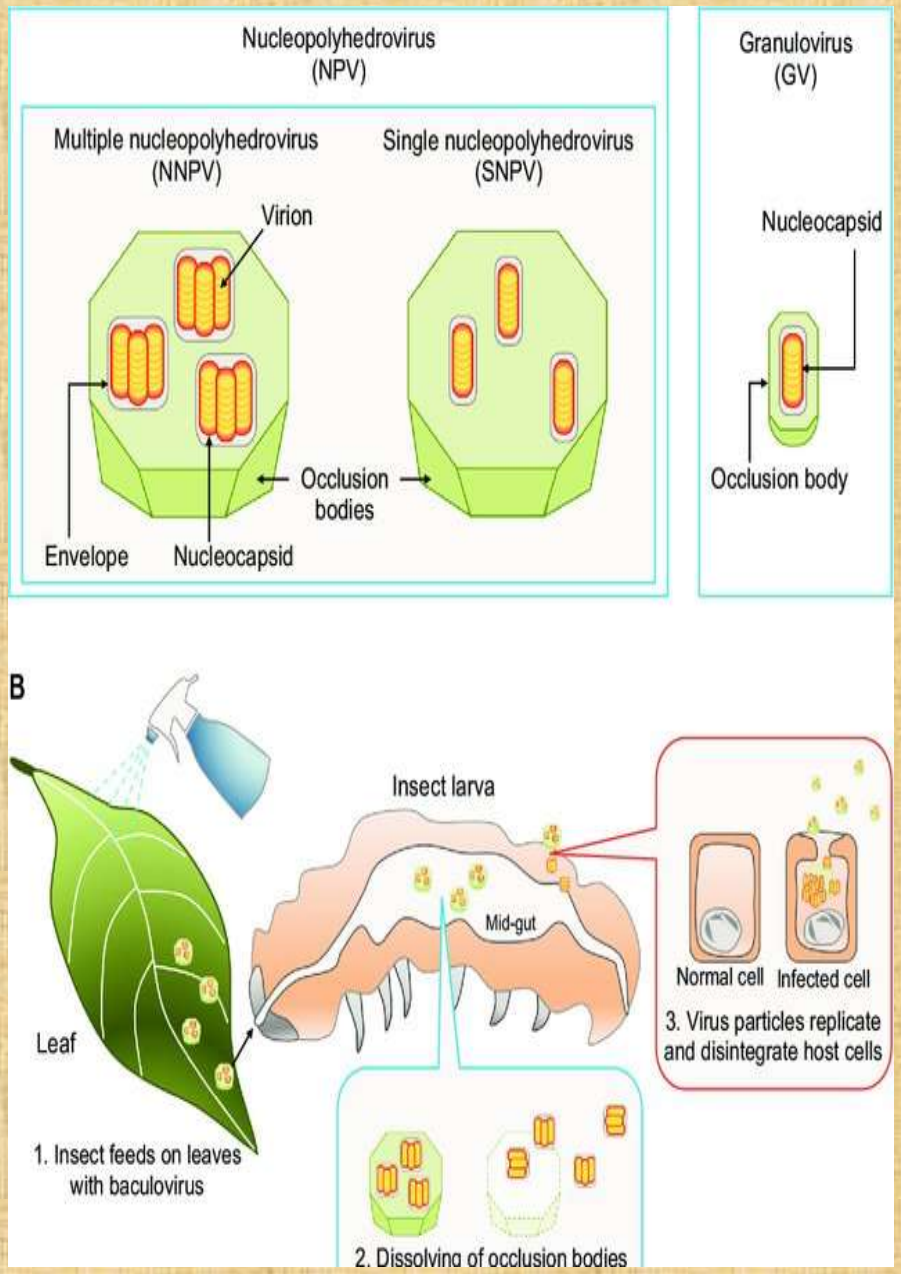
3. Viruses

Insect are attacted on many different type of entomopathogenic viruses that are obligate disease causing organisms that can only reproduce with host insect, only bucaloviruses are use as a pesticides. These are classified into two genera.

1. NPV- Nuclear Polyhydrosis Virus.
2. GV- Granulo Virus
3. Bucaloviruses

Symptoms- The infected insect stop feeding and turn into pinkish white on the ventral side because accumulation of poly hydral



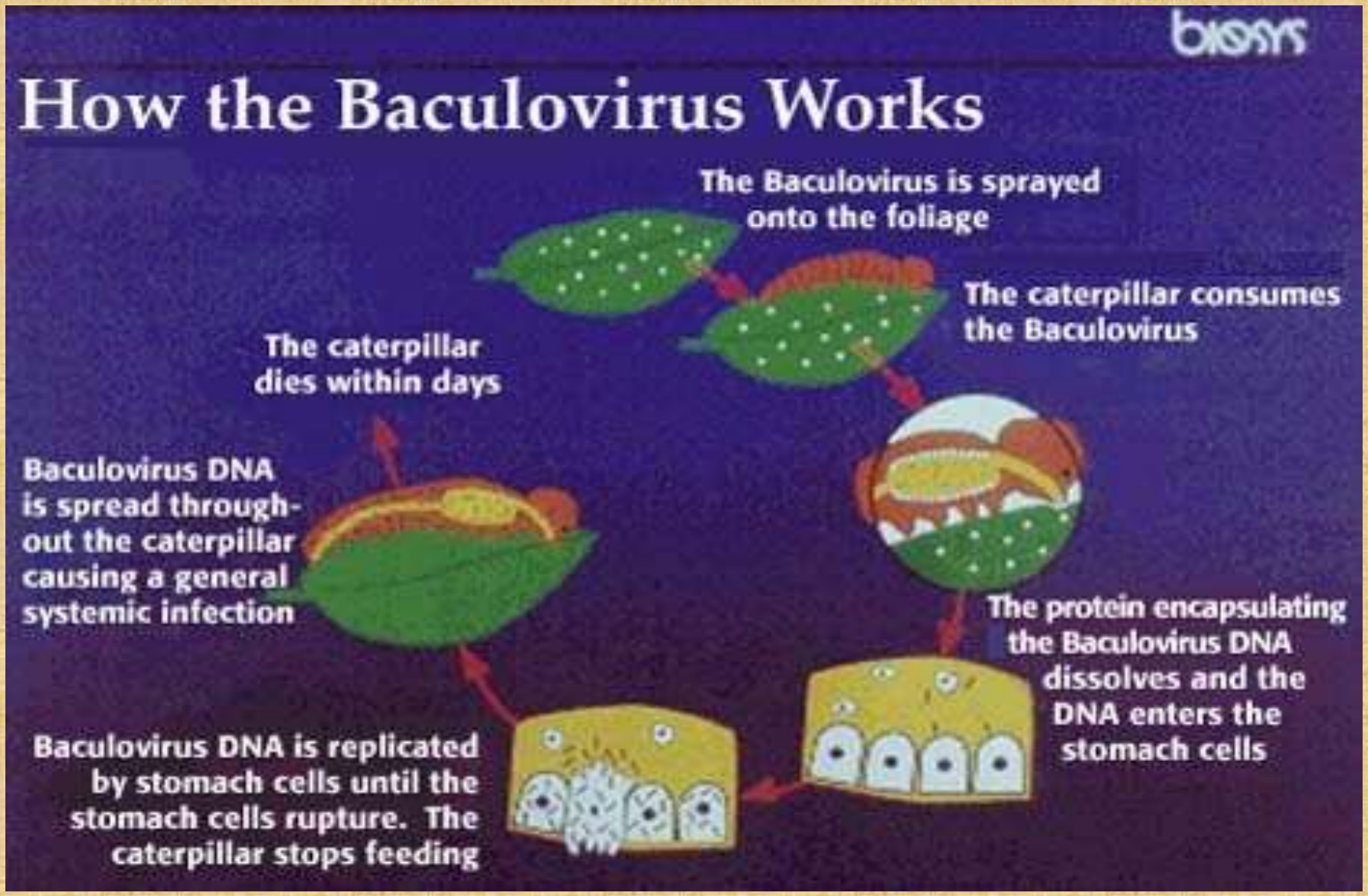
List of some important Entomopathogenic viruses

Viral species	**Target pests**
Cydia pomonella GV	Codling moth
Autographa californica MNPV	Lepidopteran larvae
Anticarsia gemmatalis MNPV	Sugercane borer
Spodotera exigua MNPV	Beet armyworm
Neodiprion lecontei MNPV	Sawfly larvae
Helicoverpa zea NPV	Heliothines
Lymantriya dispar MNPV	Gypsy moth

GV = granulovirus
NPV = nucleopolyhedrovirus
MNPV = multi-nucleocapsid nucleopolyhedrovirus

Mode of action of Baculovirus [NPV (Nuclear Polyhedrosis Viruses) granuloviruses (GV)]

- Occlusion bodies are ingested by insect larvae.
- In the highly alkaline pH of the midgut, the occlusion body protein dissolves and is further degraded by host alkaline proteases.
- The virus particles are released from polyhedra and subsequently attach to the peritrophic membrane lining the midgut.
- The lipoprotein membrane surrounding the virus fuses with plasma membrane of the gut wall cells and liberates nucleocapsids into the cytoplasm.
- The nucleotide transport virus DNA into the nucleus of the cell and virus gene expression begins.
- The virus multiplies rapidly and eventually fills the body of the host with virus particles.


How the Baculovirus Works
The Baculovirus is sprayed onto the foliage
The caterpillar consumes the Baculovirus
The protein encapsulating the Baculovirus DNA dissolves and the DNA enters the stomach cells
Baculovirus DNA is replicated by stomach cells until the stomach cells rupture. The caterpillar stops feeding
The caterpillar dies within days
Baculovirus DNA is spread throughout the caterpillar causing a general systemic infection

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4. Protozoans

Protozao kill the insects either directly or by the reducing the fecundity of the insect (adulte). Their effect on the host is chronic. They prolong the larval life in the field, thus exposing the insect longer to predators and parasitoids. These are called debililating infections. They are always associated with other insect pathogenss.

List of some important Protozoans

Name	**Target pests**
Neogregarines *Mattesia grandis*	Cotton boll worm
Microsporidians *Farinocystis tribolii*	Red flour beetle
Nosema heliothidis	American boll worm
Nosema melolonthae	June or Chaffer beetle

Mode of action Protozoan (*Nosema*)

- Protozoans produce spores, which are the infectious phase in several susceptible insects.
- *Nosema* spp. spores are assimilated by the host and develop in the midgut.
- Germinating spores are released from the sporoplasm and invade host tar- get cells, inducing massive infection and demol- ishing organs and tissues.
- Sporulation process begins again from the infected tissues and, upon expulsion and ingestion by a susceptible host, induces an epizootic infection.
- Naturally, parasitoids and insect predators commonly act as vectors distributing the disease.

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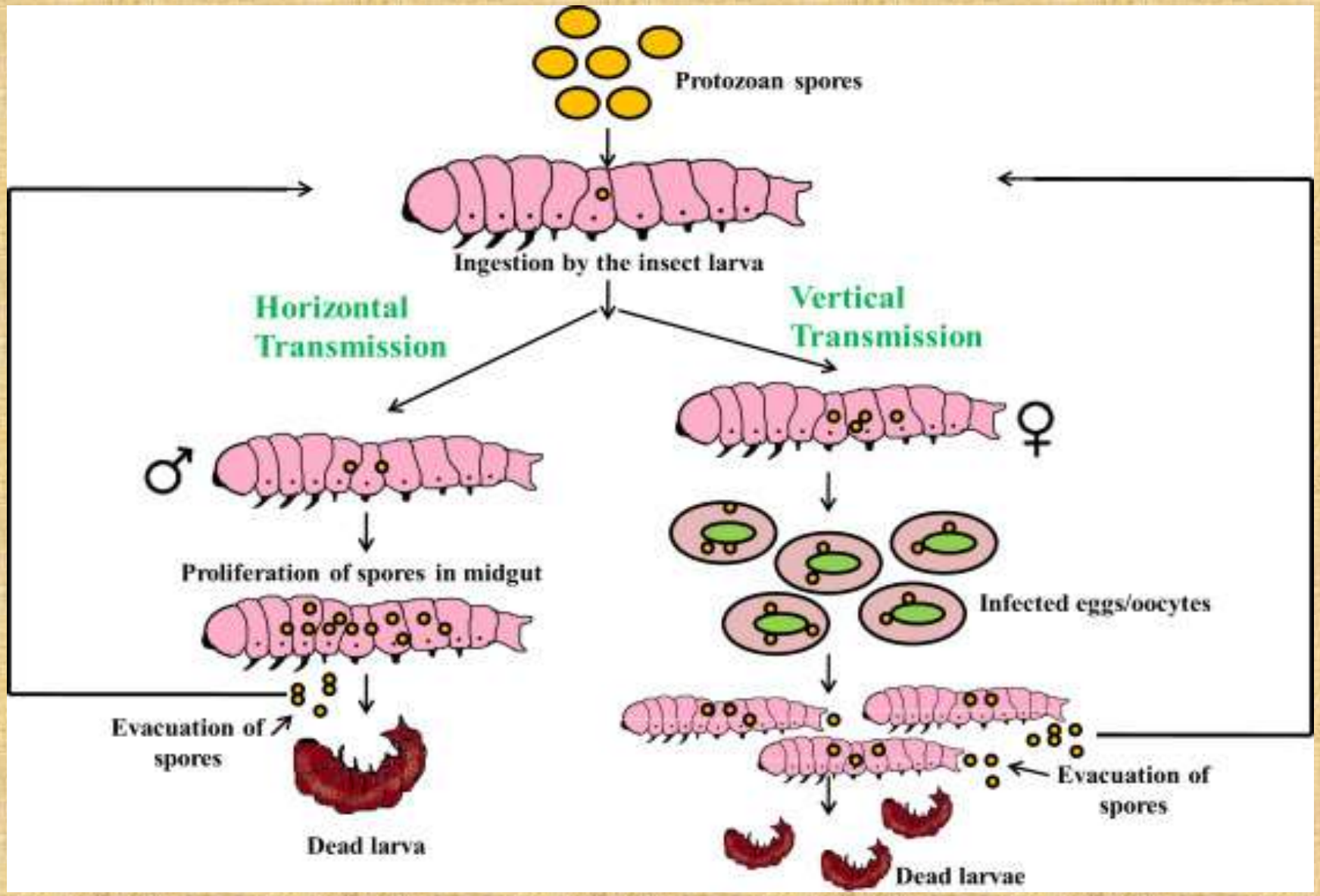
Protozoan spores
Ingestion by the insect larva
Horizontal Transmission
Vertical Transmission
♂
♀
Proliferation of spores in midgut
Infected eggs/oocytes
Evacuation of spores
Dead larva
Evacuation of spores
Dead larvae

3. Plant-Incorporated-Protectants (PIP)

- A plant-incorporated protectant (PIP) is a biopesticide produced by a gene inserted into a plant through transgenesis.
- PIP does not require killing the pest but renders the plant unsuitable for an attack.
- In some cases, the protected plant may act as a repellant or disrupt the normal physiology of the insect pests when insects ingest PIPs.
- Once the PIP is ingested it overcomes the digestive and physical barriers and then gets to the target site where it acts.
- Insecticidal proteins, particularly *Bt*, are suitable for application in PIPs and are thus being explored in pest control (Koch *et al*. 2015).
- The insecticidal proteins from *Bt* are effective, diverse and specific thus they are widely used as a model in PIP biotechnology, however, has demonstrated that Bt shows non-negligible pathogenic potentials.

List of some important Plant-Incorporated-Protectants (PIP)

Plant-Incorporated-Protectants (PIP)	**CROP**
X17-2 papaya (ringspot virus resistance gene)	Papaya
VNT1 in potato	Potato
eCry3.1Ab in event 5307	Corn
FLCry1Ab in event COT67B	Cotton
Cry2Ab2 in event MON 87751	Soybean

United States Environmental Protection Agency (USEPA)

Importance of Biopesticides

- Bacterial and fungal toxin which can destroy pests and pathogen can be directly integrated into plants with the help of biotechnology.
- Target specific
- Some species of fungi and viruses, spinoad a byproduct of fermentation is a biopesticicde.
- Biopesticides are important because they are eco-friendly and do not cause any harm to the soil, water, air and humen being.
- Important alternative, eco-friendly method of plant protection are adopted such as IPM techniques, including the use of biopesticides.

Role of biopesticides in IPM

- Reduce environmental pollution.
- Maintain ecological balances.
- Reduce pesticides residual effect.
- Conservation of natural resources.
- Preservation of biodiversity, pollinators and non-target species.
- Preservation of biodiversity.
- Reduce human and animal health hazards.
- Generation of rural employment through mass multification,

Advantages and Disadvantages of biopesticides

Factor	Advantages	Disadvantages
Eco-friendliness	Biopesticides have low toxicity against humans and the environmen	Due to their low toxicity, biopesticides exhibit slow action against target pest
Environmental persistence	Biopesticides when applied leave little or no residues thus have no pre-harvest interval. This factor is key in export crops	
Multi-mode of action	Due to their multiple mode of action, pest hardly develop resistance or cross-resistance to biopesticides	
Biodegradability	Biopesticides are characteristically low volatile compounds does pose risks to the environment and its receptors	Poor stability is often between 2-4 days which necessitate frequent and repeated application for effective eradication
Specificity	Biopesticides have little or no adverse effect on non-target organisms	Biopesticides limit actions against broad range of pests thereby would require diverse plant protection strategie

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Safety profile	Safety during application, makes it convenient for workers to complete agro-assignment on timely basis, including harvest operation	
Suitability in IPM	Biopesticides has the potential of surpassing conventional control agents when used in IPM programme and reduce the use of classical pesticide	
Usefulness of co-wastes	Wastes from biopesticides production are used as fertilizers	
Improving productivity	Use of biopesticides lead to increased yield and in complete sense defines organic farming producing and wholesome and toxin-free food and crops	
Cost	Cost to develop biopesticides is cost effective	Cost of production of a certified biopesticide product is comparatively higher
Standardization		Standardization of the quality of biopesticides remains a limitation

(Adapted from Hassan and Gokce, 2014; Marrone, 2009)

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Future Prospects

- Research should be intensified to economise the production of bioagents.
- More laboratory and field studies on stabilty of microbial agents under field conditions are required in India.
- Efforts should be made to increase shelf life and residual efficacy of plant derivatives under field condition.
- Awareness among the farmers regarding use of biopesticide.
- Need of farmers to educate through training programme, demonstration and media.
- All agriculture universities should include biopesticides and biocontrol agents in the “package of practices”.
- Review calls for a strong policy support to the development and promotion of environmentally friendly alternatives to pesticides.

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Conclusion

- Biopesticdes typically microbial biological pest control that are applied in a manner similar chemical pesticides
- Available in different formulation.
- Also used to control soil born and seed born fungal pathogens.
- high specificity.
- Eco-friendly method for controlling the pest of agriculture then the chemicals.

BIBLIOGRAPHY

Charnley AK (2003) Fungal pathogens of insects: cuticle degrading enzymes and toxins. *Adv Bot Res*, **40**:241–321.

Glare TR, Milner RJ (1991) Ecology of entomopathogenic fungi. In D.K. Arora, L.Ajello,K.G. Mukerji (eds.). *Handbook of Applied Mycology, Humans, Animals, and Insects, New York: Marcel Dekker, Inc*, **2**: 547–612.

Gautam MP, Singh SN, Kumar P, Yadav SKM, Singh DP, and Pandey MK (2019). Mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae): A review. *The Pharma Innovation JournalI*. **8(9)**:90-95.

Hassan E, Gokçe A (2014) Production and consumption of biopesticides. In: Advances in Plant Biopesticides . *Springer, New Delhi*., 361-379.

Koch MS, Ward JM, Levine SL (2015) The food and environmental safety of Bt crops. *Front Plant Sci*, 6: 283.

Marrone PG (2009) Barriers to adoption of biological control agents and biological pesticides. Integrated Pest Management. *Cambridge University Press, Cambridge, UK*,163-178.

Shashank PR, Chandrashekar KM, Naresh M, and Sreedevi K (2015) Occurrence of *Tuta absoluta* (Lepidoptera: Gelechiidae) an Invasive pest from India. *Indian Journal of Entomology*. **77(4)**:323-329.

Where's in

https://byjus.com/neet/importance-of-biopesticides/

http://npic.orst.edu/reg/pip.html

https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides

THANK YOU