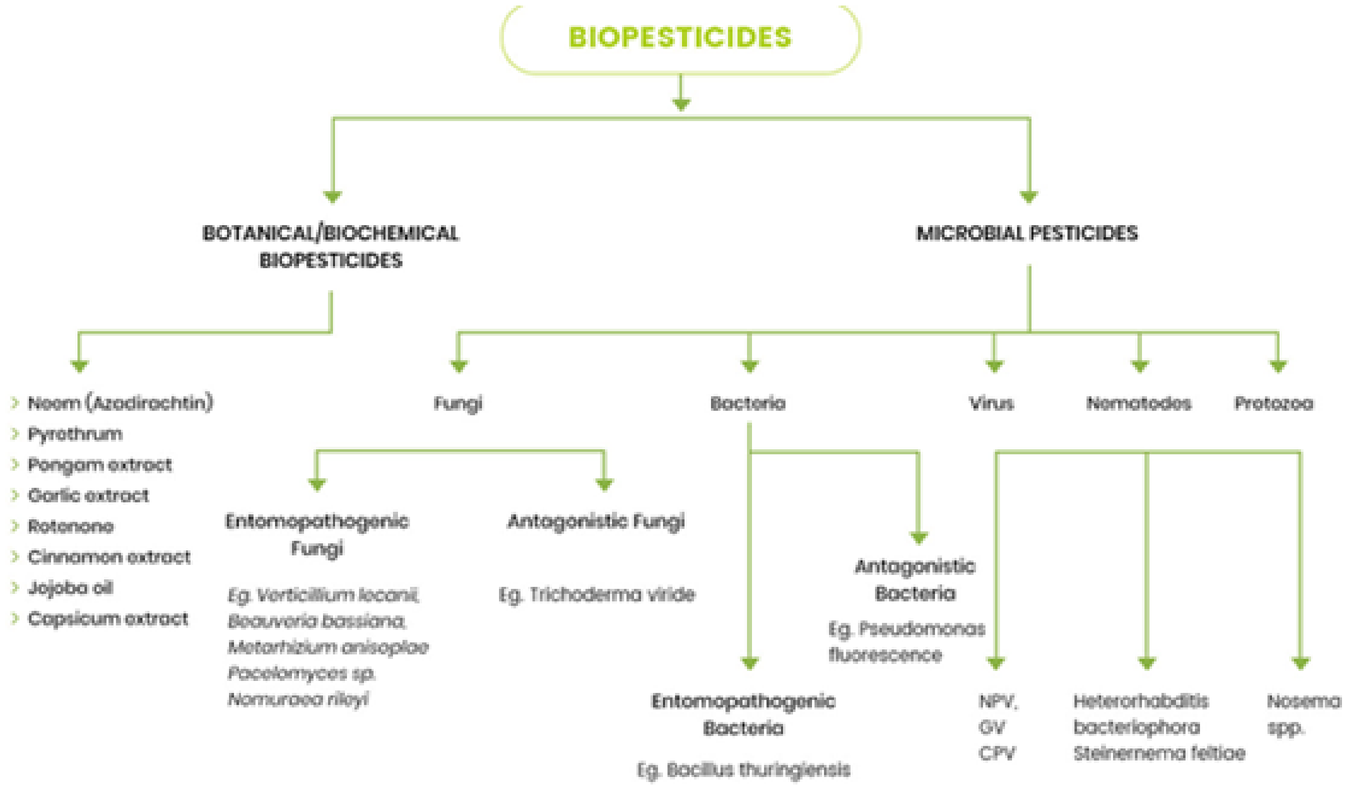
What are Biopesticides?

Biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered biopesticides. As of April 2016, there are 299 registered biopesticide active ingredients and 1401 active biopesticide product registrations.



Classes of Biopesticides- Biopesticides fall into three major classes:

1. **Biochemical pesticides** are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides, by contrast, are generally synthetic materials that directly kill or inactivate the pest. 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. Because it is sometimes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide, EPA has established a special committee to make such decisions. Four groups are in commercial use:

a. **Pyrethrum-** Pyrethrum is one of the oldest natural insecticides in use in the world today, and it has one of the best safety records of all insecticides. It is a mixture of several esters, called pyrethrins, which are extracted from flowers belonging to the genus Chrysanthemum.

b. **Rotenone**- Rotenone is a natural plant toxin used for centuries by indigenous peoples of Southeast Asia and South America for the harvesting of fish for human consumption. It has been used as a commercial insecticide for more than 150 years and for the management of fish populations since the 1930s

c. **Neem oil-** Neem oil kills a wide variety of insects, including aphids, mealybugs, whiteflies, Japanese beetles, leafhoppers, thrips, fungus gnats, and other garden pests like spider mites and nematodes. Neem oil can also kill fungal diseases like powdery mildew, black spot, scab, anthracnose, and leaf spot.

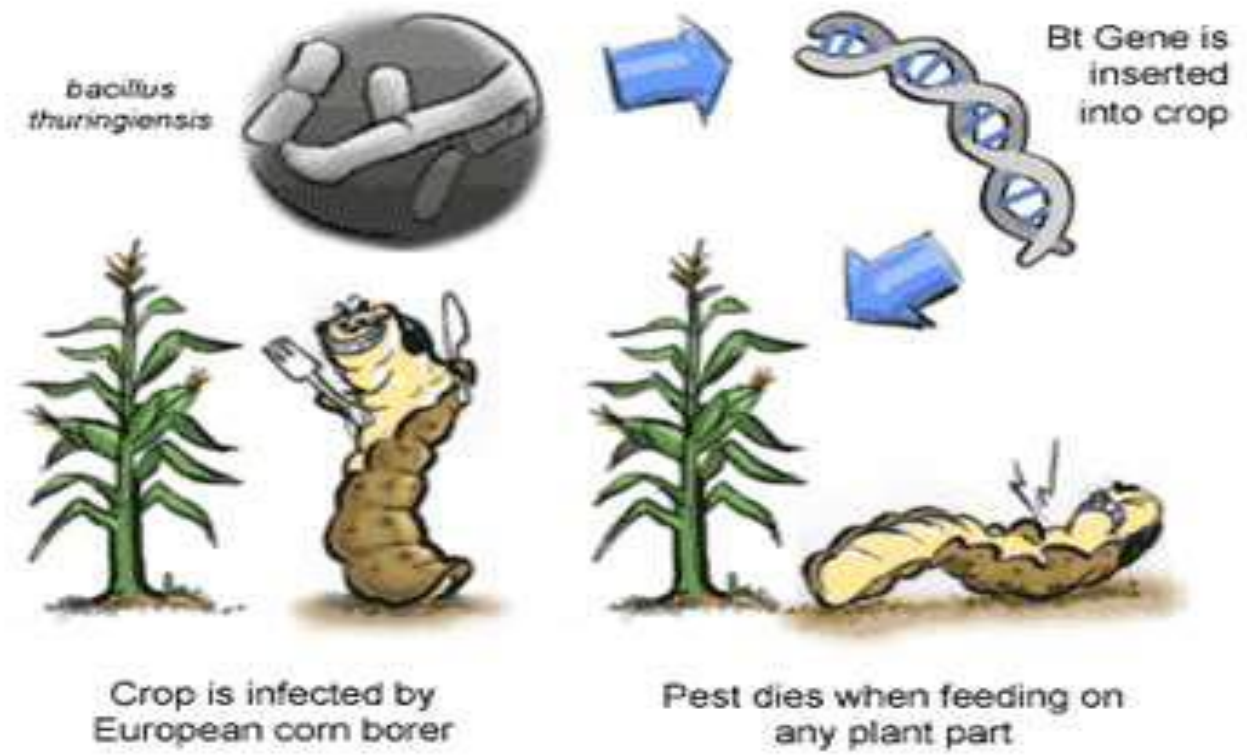
d. **Various essential oils**-Oils such as lemon, orange, and anise give fruits and seeds their characteristic odor and taste. The oils are used as pesticides to repel certain animals and insects, and to kill certain insects. When used as pesticides, these oils do not present any known risks to humans or the environment

2. .**Microbial pesticides consist of a microorganism** (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest. 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. Each strain of this bacterium produces a different mix of proteins and specifically kills one or a few related species of insect larvae. While some Bt ingredients control moth larvae found on plants, other Bt ingredients are specific for larvae of flies and mosquitoes. The target insect species are determined by whether the particular Bt produces a protein that can bind to a larval gut receptor, thereby causing the insect larvae to starve.

3. **Plant-Incorporated-Protectants (PIPs)**- Plant-incorporated protectants are pesticidal substances produced by plants and the genetic material necessary for the plant to produce the substance. PIPs are produced when scientists take the genetic information

required to produce a pesticidal substance and introduce it into the target crop's own genetic material. This allows the crop to produce its own additional 'biological pesticide' and enhance its protection. *For example, scientists can take the gene for a specific Bt pesticidal protein and introduce the gene into the plant's genetic material. Some of the crops that can be made to produce PIPs are corn, soybeans, cotton, potatoes and plums.For example, scientists can take the gene for the Bt pesticidal protein and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest. The protein and its genetic material, but not the plant itself, are regulated by EPA.*

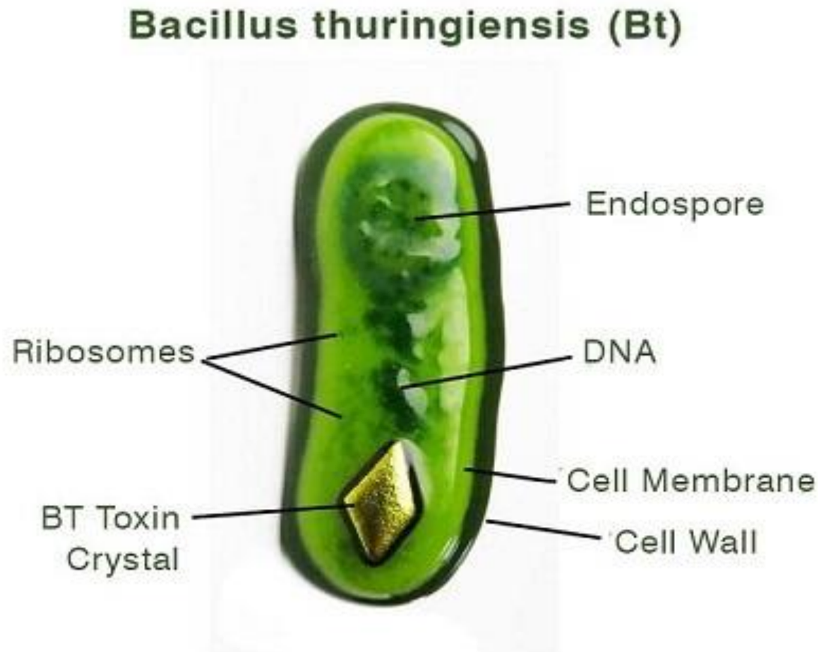


Constitute the largest group of broad- spectrumcbiopesticides which are pest specific. There are atleast 3000 naturally occurring insectspecific microorganisms, 100 of which are insecticidal.

1. Bacterial biopesticides
2. Viral biopesticides
3. Fungal biopesticides
4. Protozoan biopesticides

1. BACTERIAL BIOPESTICIDES- Mainly 4 categories:

A. Crystalliferous spore formers (*Bacillus thuringiensis*)- ***Bacillus thuringiensis.*** GP, spore forming, facultative bacterium with nearly 100 subspecies and varieties divided into 70 serotypes. Specific, safe and effective tool for insect control. Insecticidal property resides in Cry family of crystalline proteins that are produced in the parasporal crystals and are encoded by the cry genes.



A. *Bacillus thuringiensis* –CRY proteins- Cry proteins are globular molecules with 3 structural domain connected by single linkers. This 3 domain family is characterised by protoxins of two different lengths, one being longer with C terminal extension necessary for toxicity. This extension also has a characteristic role in crystal formation within the bacterium. Cry proteins are responsible for feeding cessation and death of the insect.

Bt subspecies and targets		
1	*B. thuringiensis tenebrionis*	Colorado potato beetle and elm leaf beetle larvae
2	*B. thuringiensis kurstaki*	Variety of caterpillars
3	*B. thuringiensis isralensis*	Mosquito, blackfly and fungus, gnat larvae
4	*B. thuringiensis aizawai*	Wax moth larvae and various

C. Bacillus sphaericus- GP, strict aerobic bacterium, which produces round spores in a swollen club like terminal or subterminal sporangium. Produces an intracellular protein toxin and a parasporal crystalline toxin at the time of sporulation. • The mosquito – larvicidal binary toxin produced by *B. sphaericus* is composed of Bin A (51.4 kDa) and Bin B (41.9 kDa).

2. VIRAL BIOPESTICIDES- Naturally occurring baculoviruses can be used to control a wide range of insect pests. Most baculoviruses are used as biopesticides, that is, they are sprayed onto high-density pest populations in a manner akin to the use of synthetic chemical pesticides. Viral pesticides are used to control Lepidopteran larvae like Helicoverpa, Spodoptera sp on Cotton, Corn, Sorghum, tomatoes. Baculoviruses are the commonly used viral biopesticide.

3. FUNGAL BIOPESTICIDES- Fungal biopesticides can be used to control plant diseases as well as some pests and weeds. Fungi are a diverse group of organisms and can be found in almost every environment on earth. Two of the most common commercial biopesticides are Trichoderma species and Beauveria bassiana. Fungi specifically associated with insects (aphids, thrips, mealy bugs, whiteflies, scale insects, mosquitoes and mites) are known as entomopathogenic fungi. Obligate or facultative, commensals or symbionts of insects. The fungi attack the host via integument or gut epithelium and establish their conidia in the joints and the integument.Belong to 4 major groups:

I. Laboulbeniales
II. Pyrenomycetes
III. Hyphomycetes
IV. Zygomycetes

4. **PROTOZOAN BIOPESTICIDES-** Although they infect pests, induce chronic and debilitating effects on targets, the use of protozoa as biopesticide has not been very successful. Microsporan protozoans are used as possible component of IPM. Microsporidia are ubiquitous, obligate intracellular parasites. Eg: *Nosema* and *Vairimorpha* have some potential to attack lepidopteran and orthopteran insects.

a. Nosema pyrausta- A microsporidian which infect European corn borer, *Ostrinia nubilalis.* Spores eaten by corn borer larvae germinates in the midgut and injects sporoplasm into midgut cell. The sporoplasm reproduces and then forms more spores, which can infect other tissues. Spores in infected midgut cells are sloughed into the gut lumen and are eliminated along with the faeces to the plant. These spores remain viable and are consumed during larval feeding so that infection is repeated in midgut cells of new host. This is horizontal transmission. *Nosema* can be passed by vertical transmission. As the infected female larva develops to an adult, the ovarian tissue and developing oocytes become infected. The embryo and hatched larvae is infected. It suppresses by reducing oviposition, % hatch and survival of infected larvae.

b. ***Nosema locustae-*** Infects grasshoppers***.*** Most effective when ingested by nymphal stages of grasshoppers and kills them within 3 – 6 weeks post infection. Not all infected grasshoppers are killed by this protozoan infection.

c. **Chilodonella uncinata** – As potential protozoan biopesticide for mosquito vectors of human diseases.

MICROBIAL PRODUCTS IN BIOPESTICIDEs IN PLANTS- Some transgenic crops can be considered among microbial based products Eg: *Bacillus thuringiensis* based genetically engineered crops like Bt cotton and maize. Genetically modified (GM) sugar beet, papaya, sweet pepper, tomato etc are successfully grown.

Advantages of Biopesticides

1. **Environmental safety** – Biopesticides are made from natural materials and are less toxic than synthetic pesticides, making them safer for the environment.
2. **Target specificity** – Biopesticides are often more specific in their actions and are less likely to harm non-target species compared to synthetic pesticides.
3. **Improved resistance management** – Biopesticides can help to reduce the development of pesticide resistance in pests, improving the long-term effectiveness of pest control efforts.
4. **Reduced residue** – Biopesticides often have lower levels of residue compared to synthetic pesticides, reducing the risk of contamination in food and water.
5. **Compatibility with organic farming** – Biopesticides are allowed in organic farming, so they can be used to protect crops without compromising the organic certification.

Disadvantages of Biopesticides

1. **Limited effectiveness** – Biopesticides may not be as effective as synthetic pesticides at controlling certain pests, particularly in cases of severe infestations.
2. **Short shelf life** – Biopesticides may have a shorter shelf life than synthetic pesticides, making them less convenient to store and use.
3. **Limited availability** – Biopesticides may not be available for all pests or crops, limiting their use in certain situations.
4. **Cost** – Biopesticides may be more expensive than synthetic pesticides, particularly if they are imported or in high demand.
5. **Complexity** – Biopesticides may require special equipment or application techniques, making them more difficult to use than synthetic pesticides.

1. **NEEDS FOR BIOPESTICIDES-** Proper pest management is important factor for healthy and high yielding crop to fulfill the food demand for increasing population. Chemical pesticides have accelerated land, air and water contamination. They have been the main cause of insect resistance as well as adverse impacts on natural enemies and humans In 1994, we established the Biopesticides and Pollution Prevention Division in the Office of Pesticide Programs to facilitate the registration of biopesticides. This division promotes the use of safer pesticides, including biopesticides, as components of IPM programs. The division also coordinates the Pesticide Environmental Stewardship Program (PESP). Since biopesticides tend to pose fewer risks than conventional pesticides, EPA generally requires much less data to register a biopesticide than to register a conventional pesticide. In fact, new biopesticides are often registered in less than a year, compared with an average of more than three years for conventional pesticides.
2. While biopesticides require less data and are registered in less time than conventional pesticides, EPA always conducts rigorous reviews to ensure that registered pesticides will not harm people or the environment. For EPA to be sure that a pesticide is safe, the Agency requires that registrants submit the results of a variety of studies and other information about the composition, toxicity, degradation, and other characteristics of the pesticide.