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Introduction to Biopesticide Active Ingredients

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2025 ADJUVANTS, INERTS & CROP PROTECTION CONFERENCE

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What is a biological crop protection product?

- Examples:
  - *Microbial extracts & isolates , naturally occurring or from genetic modification or synthetic biology
  - *Plant extracts, natural oils, allelochemicals, etc.
  - *Living micro-organisms; i.e. *fungi*, *bacteria*, *and viruses*
  - *Naturally occurring arthropod predators
  - Proteins, peptides, and nucleic acids (effectively biopolymers)

*Source: Agbioinvestor, The Biologicals and Biostimulants Industries Report 2022

Benefits:

- Improved sustainability profile
- Higher selectivity, reduced off-target toxicity
- Novel modes of action (manage resistance, IPM)

Challenges:

- Variable efficacy and/or higher cost in use
- Inconsistent performance
- Active agent instability; in some cases delivery

Types of Biological Pesticides

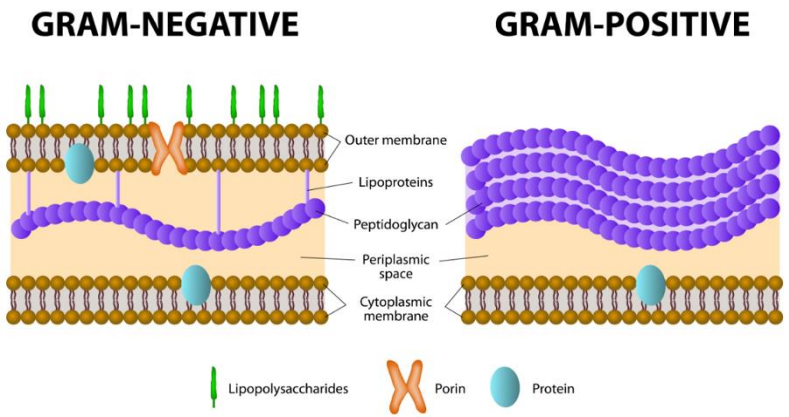
- Microbial formulations can present a range of challenges from end product stability to maintaining viability of a microorganism
- Biological controls hold an important position in integrated crop management alongside traditional plant protection products

Biopesticides – Biologicals: *Active Ingredient Types*					
Macrobials	*Microbials*	*Natural Products*	*Fermentation Products*	*Semiochemicals*	*Proteins, Peptides, Nucleic Acids**
Insects, bugs, wasps and mites that prey on pest species	Bacterial, viral and fungal pathogens of insect, fungal and plant pests	Products derived from plant or animal sources that have crop protection activity	Products derived from microbial fermentation that have crop protection activity	Pheromones, pest attractants, mating disruptors and sexual confusion elicitors	Broad range of MW biopolymers, primarily of microbial origin, with activity for controlling pests

Source: Agbioinvestor, market share as defined by % of market by value
*Separate category not part of Agbioinvestor groups; suggested by Croda

Properties of biopesticide actives

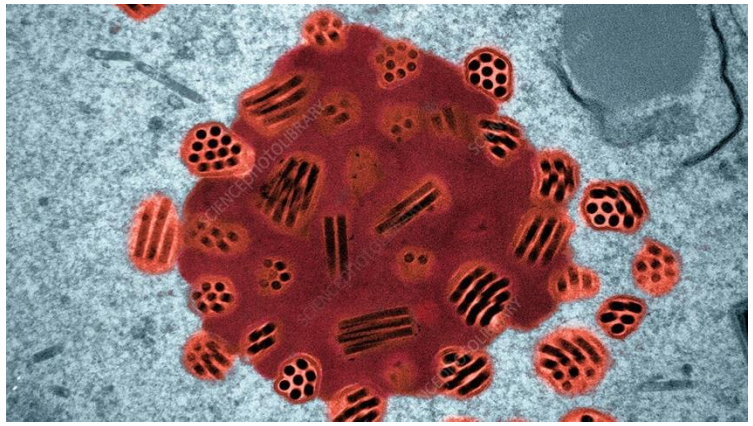
- **Bacteria** are single-celled microorganisms used to promote growth and to control pests
- Broadly categorised as Gram-positive or Gram-negative depending on cell wall thickness
  - Gram-negative bacteria have much thinner cell wall
  - Spore forming or non-spore forming; former (generally gram-positive) more resistant to environmental stress and germinate in favourable conditions



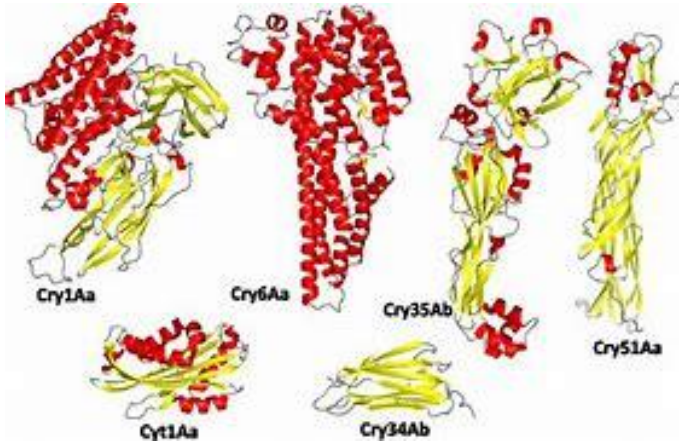
- **Fungi** are single or multi-celled microorganisms, offering similar benefits to bacteria
  - Cell walls made up mostly of chitin
- Majority form spores (*Trichoderma spp.*), but can be non-spore forming (*Rhizoctonia spp.*)
  - Not Gram-positive nor Gram-negative; exhibit cell wall characteristics most like Gram-positive bacteria
  - Generally, fungi are less sensitive than bacteria due to their more resistant structures

Properties of biopesticide actives

- **Viruses** manage primarily insect pests; offer a sustainable alternative to chemical pesticides
  - Typically infect the insect through ingestion and pathogenic to specific insect pests
  - Infect and kill their hosts, often causing disease outbreaks
  - Types are baculoviruses, cypoviruses, and densoviruses
  - Slower acting vs. chemical pesticides, narrow host range, and difficulties in large-scale production

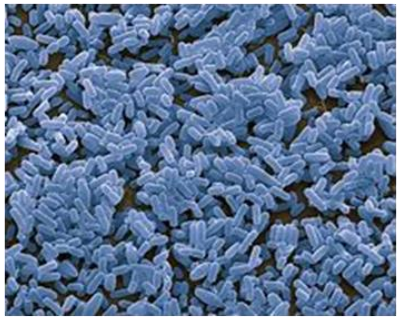
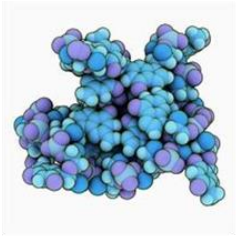
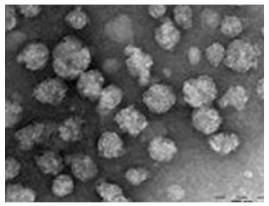
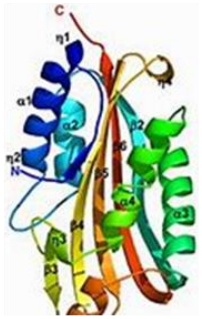


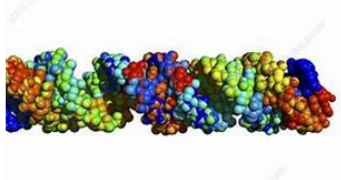
- **Proteins, Peptides, and Nucleic acids** are nonliving but commonly biomanufactured
  - Broad range of polymers in terms of molecular weight, structure, stability, and mode of action
  - May or may not be separated from production biomass (downstream processing or DSP)
  - Some like peptides may occur in smaller sizes and be more easily taken up by pests, others need delivery
  - Some (e.g., nucleic acids) may need complexation concentration, and encapsulation to reach target



Conclusions

- Biopesticides encompass a broad range of active ingredients that may be either living or nonliving
- As biomanufactured products, they contain more or less purified biomass or living cells (not “chemical active”)
- Microbial pesticides are living so viability and vigor needs to be maximized to enhance performance (tank mixture)
- Living and some nonliving biopesticide active types are sensitive and will need protection during delivery
- Without protection (e.g. encapsulation), many biopesticide actives are susceptible to degradation
- Complex delivery systems for some actives like nucleic acids may be impacted in complex tank mixtures



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