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Study material for Sem-II class  
Dated: 31.07.2023 Teacher: SA sir*

# **Fungal antibiotics**

# Secondary metabolites

Microbial secondary metabolites are low molecular mass products of secondary metabolism, usually produced during the late growth phase (**idiophase**) of a relatively small sort of microorganisms.

Secondary metabolites, such as **antibiotics**, are organic compounds that **are not directly involved in the normal growth**, development or reproduction of an organism.

Absence of secondary metabolism **does not result in immediate death**, but rather in long-term impairment of the organism's survivability.

Secondary metabolites often play an important role in **plant defense**.

Based on their biosynthetic origin secondary metabolites are—

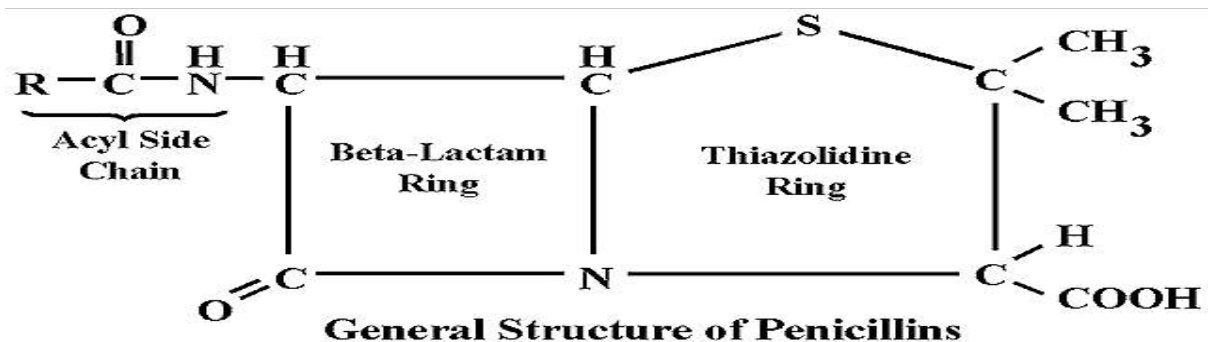
- i) Alkaloids
- ii) Terpenoids
- iii) Steroids
- iv) Flavonoids
- v) Glycosides

## Antibacterial antibiotics of Fungal origin:

### Penicillin:

**Beta-lactam antibiotics** are antibiotics that contain a beta-lactam ring in their molecular structure. The first  $\beta$ -lactam antibiotic discovered, **penicillin**, was isolated in 1928 by Alexander Fleming from a rare variant of *Penicillium notatum* (Now, *P. chrysogenum*).

**Mode of action:** Most  $\beta$ -lactam antibiotics work by **inhibiting cell wall biosynthesis** in the bacterial organism and are the most widely used group of antibiotics.

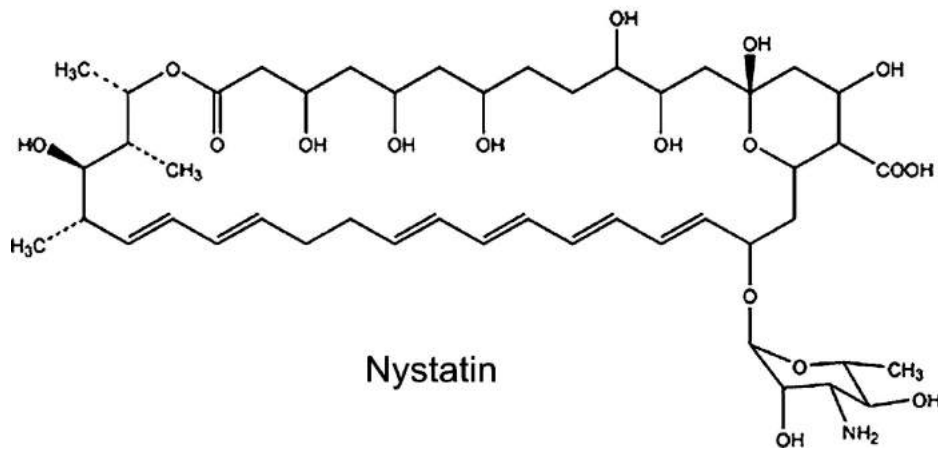
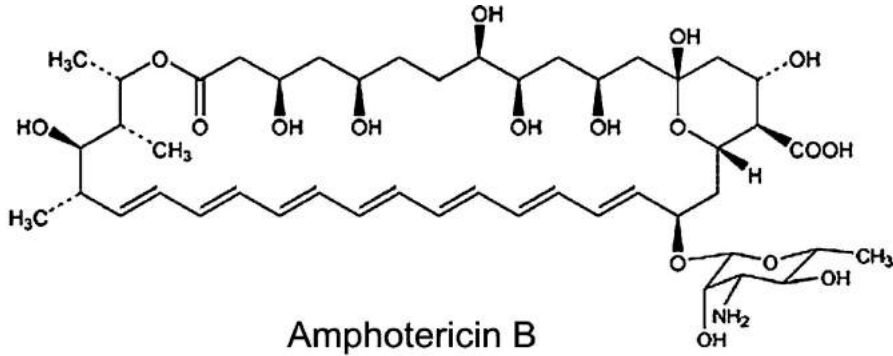


## Antifungal antibiotics of Bacterial origin:

**1. Amphotericin B:** It is a polyene antifungal antibiotic produced by *Streptomyces nodosus*.

**Mode of action:** Amphotericin B binds with **ergosterol**, a component of fungal cell membranes, forming pores that cause rapid leakage of monovalent ions ( $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{H}^+$  and  $\text{Cl}^-$ ) and subsequent fungal cell death.

**2.Nystatin:** It is a polyene antifungal antibiotic to which many molds and yeasts are sensitive produced by *Streptomyces noursei*.



## Antifungal antibiotic of fungal origin:

### Griseofulvin :

It is a Beta-lactam antibiotic produced by *Penicillium griseofulvum*.

Mode of Action: It breaks down fungal microtubules.

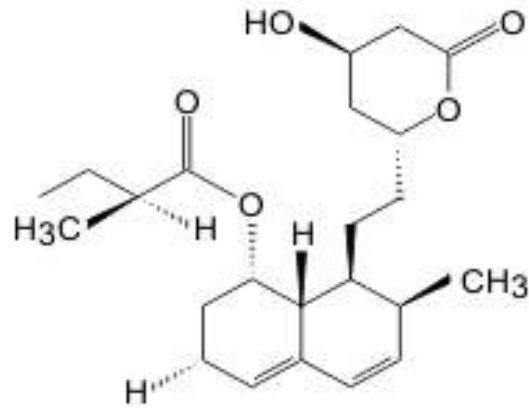


## Cholesterol lowering drugs:

**Lovastatin** : produced by the fungus *Aspergillus terreus*

**Lovastatin** is used along with a proper diet to help lower "bad" cholesterol and fats (such as LDL, triglycerides) and raise "good" cholesterol (HDL) in the blood. It belongs to a group of drugs known as "statins." It works by reducing the amount of cholesterol made by the liver.

**Mevastatin**: Produced by the fungus *Penicillium citrinum*.



Mevastatin

## Anti-cancerous drugs of fungal origin:

**1. Taxol :** produced by *Taxomyces andreanae*, an endophytic fungus of Pacific yew plant, *Taxus brevifolia*.

**TAXOL**

Source: *Taxomyces andreanae*



- Fungal Endophyte on *Taxus buccata* & *Taxus brevifolia* – Gymnosperms
- Isolated from the phloem (inner bark)
- Highly effective against Breast & Ovarian cancer.



**2. *Cariolus versicolor* (*Trametes versicolor*)**, a mushroom contains Polysaccharide-K which increases natural killer (NK) cells in body which ultimately causes cancer lowering.



## Biofertilizers

Biofertilizers comprise microbial inocula of living microorganisms which exert direct or indirect benefits on plant growth and crop yield.

### 1. Mycorrhizae as biofertilizer:

**Arbuscular mycorrhizal fungi:** These are the most abundant fungi in agricultural soil forming symbiotic relationships with plant roots of more than 80% of land plants.. The mycorrhizal inocula improve crop yield because of increased availability or uptake or absorption of nutrients, stimulation of plant growth by hormone action and by decomposition of organic residues.

## Endomycorrhizae (plant root cross section)

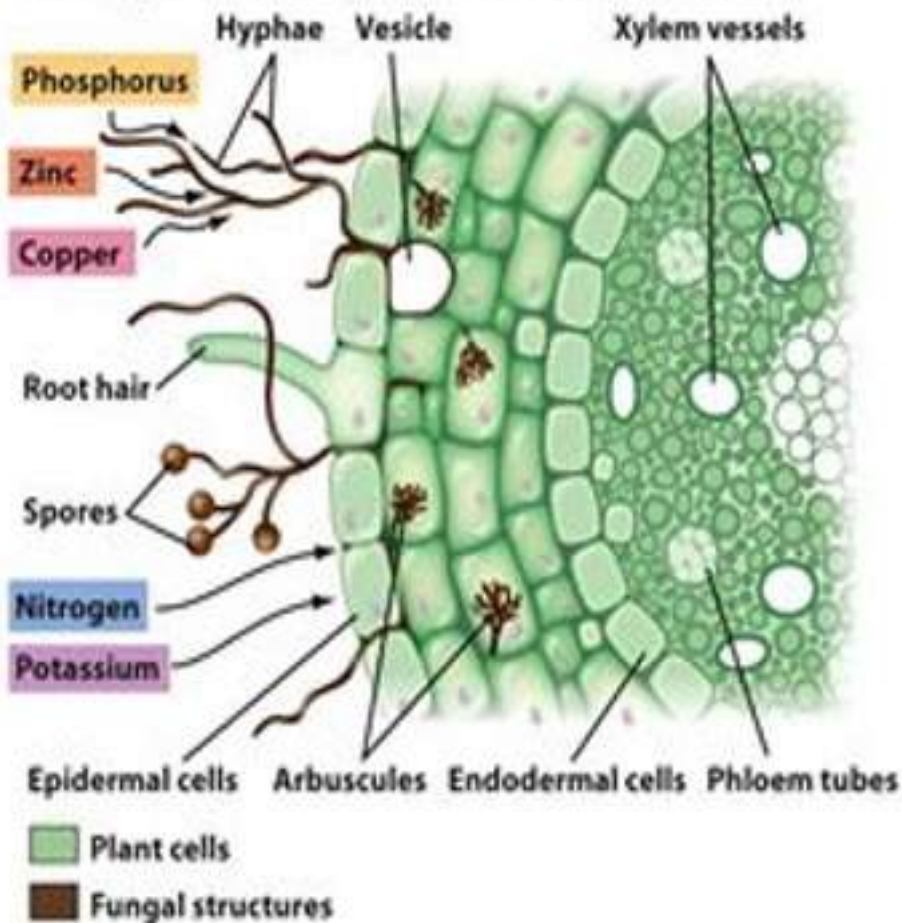


Figure 21.26a Microbiology: An Evolving Science  
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## Mycorrhizae as biofertilizer

### 2. *Penicillium* as biofertilizer:

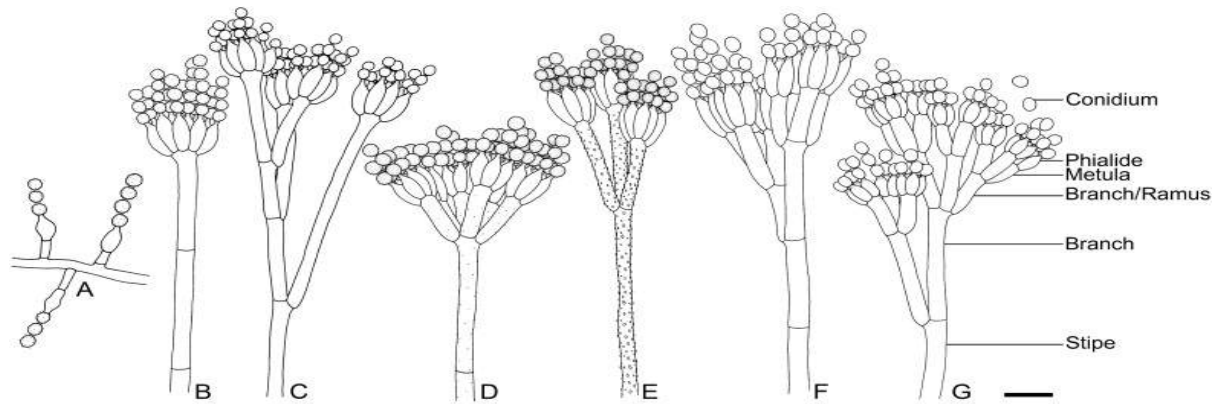
Different species of *Penicillium* have been used as biofertilizers to improve plant growth. They are phosphate solubilizing microorganisms that improve phosphorus absorption in plants.

i) *Penicillium bilaiae*: is applied to increase dry matter, phosphorus uptake and seed yield in canola (*Brassica napus*).



ii) *Penicillium radicum*: Wheat roots

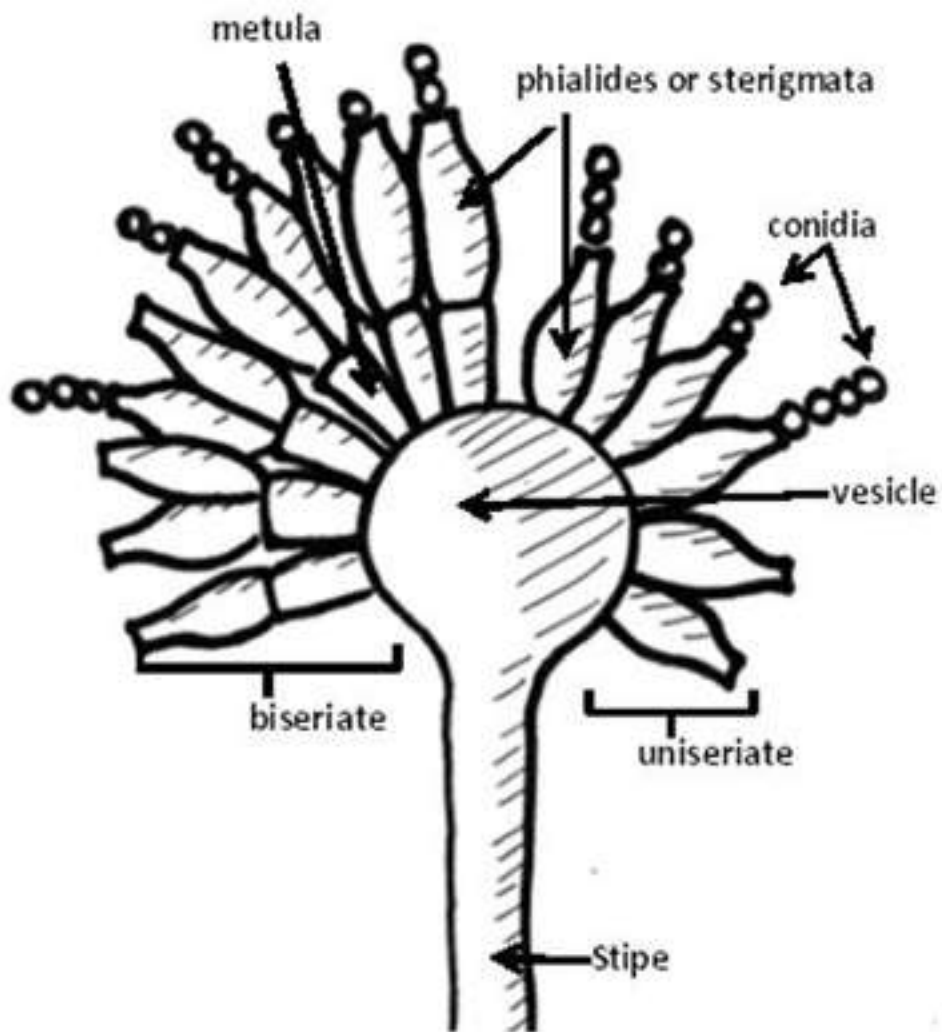
iii) *Penicillium italicum*: Soybean



### 3. *Aspergillus* as biofertilizer:

***Aspergillus*:** Several species of *Aspergillus* have been reported to be involved in the solubilization of inorganic phosphates through the production of organic acids such as **citric acid, gluconic acid, glycolic acid, oxalic acid, and succinic acid**. These species are *Aspergillus flavus*, *A. niger*, and *A. terreus*.

*Aspergillus fumigatus* which isolated from compost has been reported to be potassium releasing fungus.



***Aspergillus species***

## Mycotoxins

Any toxic substance produced by a fungus.

Mycotoxin is a secondary metabolite produced by fungi and is capable of causing disease and death in both humans and other animals.

# 1.Aflatoxin:

Aflatoxins are fungal toxins produced by *Aspergillus flavus*, *Aspergillus parasiticus* etc.

Peanuts, cotton seeds and copra are the most favourable substrates and are called **high aflatoxin risk** materials.

Aflatoxins are most potent **carcinogenic** agents which are reported to bind with DNA and prevent its transcription arresting protien synthesis.

These are responsible for **liver cancer** in animals and human beings.



# 2.Ergot toxins:

These toxins are produced by *Claviceps purpurea* and contains poisonous alkaloids like **ergotamine**, **ergocristinine**, **ergocristinin**, **ergometrimine** and **ergonovin**. These alkaloids cause diarrhoea, abdominal pain, vomiting and psychiatric disturbances.

**LSD (Lysergic acid dimethyl amide)** is a **hallucinogenic compound** which is also obtained from ergot, the sclerotia formed by *Claviceps purpurea* which infect rye (*Secale cereale*).

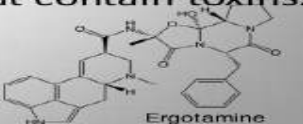
## Ergot Poisoning (St. Anthony's Fire)

**Species:**  
*Claviceps purpurea*, and *Aspergillus* and *Penicillium*

**Affected foods :-** rye, barley, wheat, and oats

**Interesting facts:**

- First documented case of ergot poisoning was in 857. [5]
- Ergot contains a chemical precursor to lysergic acid (LSD).
- Disease of barley, oats and wheat.
- Grains are replaced by ergot sclerotia that contain toxins.
- Main toxin is called ergotamine.
- Named for the belief that a pilgrimage to the shrine of St. Anthony would alleviate the symptoms.



Ergotamine

# Biological Control of Plant diseases

## Mycofungicides

Fungicides are those that are used to control plant diseases by killing the parasitic fungi.

Mycofungicides are fungal origin biocidal chemical compounds or biological organisms used to kill parasitic fungi.

### 1. Griseofulvin:

It is one of the best known antibiotics against fungal disease of skin, dermatophytosis (ringworm), is extracted from *Penicillium griseofulvum*.



#### GRISOFULVIN- INTRODUCTION

- Griseofulvin is an antifungal antibiotic first isolated from a *Penicillium* species in 1939. It is a secondary metabolite produced by the fungus *Penicillium griseofulvum*. The compound is insoluble in water, and slightly soluble in ethanol, methanol, acetone, benzene,  $\text{CHCl}_3$ , ethyl acetate, and acetic acid.

## 2. *Trichoderma*:

This fungus has been developed as biocontrol agents against fungal diseases of plants. The most biocontrol agents are from the species *T. harzianum*, *T. viride* & *T. hamatum*. And the antibiotics produced by these species are gliotoxin, harzianic acid, viridin, trichoviridin & viridiol.



**Figure 3:** Antagonistic effect of *Trichoderma viride* (01PP), *Trichoderma harzianum* (Thazad) against *Fusarium oxysporum* in PDA Medium.

## Mycoherbicides

Mycoherbicide is a fungus or a substance derived from a fungus, used to destroy weeds.

Many fungi are pathogenic to specific species of weeds. Such fungi are used to kill the weeds selectively and eliminate them from the area. These weeds-killing fungi are called mycoherbicides.

**1. *Puccinia chondrillina*:** This fungus causes rust in *Chondrilla juncea* and kills the weed.

**2. *Phytophthora palmivora*:** This fungus is used to control the weed *Morrenia adorata*.

**3. *Cercospora rodmanii* :** It is a pathogenic fungus which kills the water hyacinth, *Eichhornia crassipes*. Therefore, it is inoculated in ponds and lakes to control overgrowth of water hyacinth.

# Mycoinsecticides

Mycoinsecticides are fungi that kills insects.

Mycoinsecticides are those that are used to control plant diseases by killing pests.

## *1. Beauveria bassiana:*

It is a entomopathogenic fungus that causes white muscardine disease on various arthropod species. It is used as a biological insecticide to control a number of pests such as termites, thrips, whiteflies, aphids and different beetles.



## *2. Entomophthora muscae:*

It is a pathogenic fungus which causes a fatal disease in flies. It can cause epizootic outbreaks of disease in houseflies and is a potential biological control agent.



### ***3. Metarhizium anisopliae:***

It is a mitosporic fungus that grows naturally in soil and causes disease in various insects by acting as a parasitoid.



## **Myconematicides**

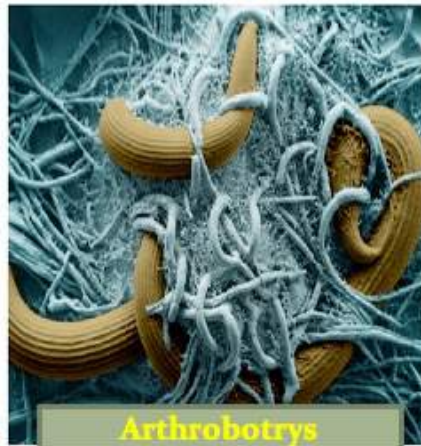
Myconematicides is a method for controlling nematode infection in a plant.

### ***1. Arthrobotrys:***

These mitosporic fungi are predatory fungi that capture and feed on nematode worms. Rings that form on the hyphae constrict and entrap the worms, then hyphae grow into the worm and digest it.

## ***2.Dactylella:***

These mitosporic fungi are notable for trapping and eating nematodes.



**Arthrobotrys**



**Dactylella**

.....Thank You.....