

# **Economic Importance of Fungi**

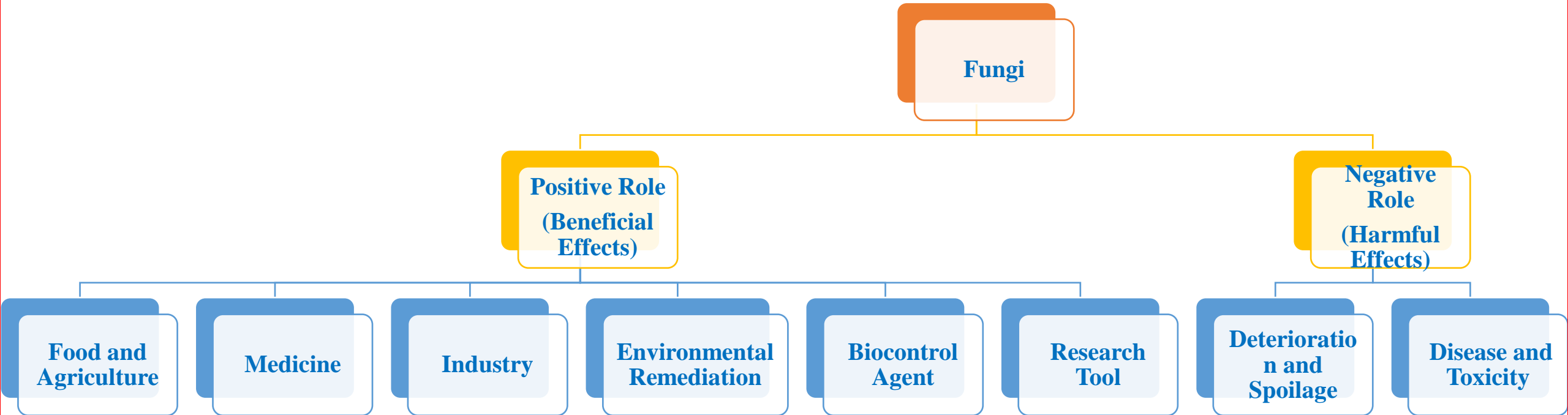
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# Fungi....

- **Fungi are heterotrophic eukaryotes, that lacks chlorophyll**
- **They get nutrition from other organic matters either dead or living**
- **Fungi influences our daily life directly or indirectly and plays a vital role in the biosphere and has great economic importance on account of their both benefits and harmful effects**
- **Fungi are one of the most important groups of organisms on the planet as it include hundreds of species, some are prized for its usefulness and others are rejected for causing great harm to plant, animals and Humans**

# Economic Importance of Fungi



# **Beneficial Effects of Fungi**

- 1. Fungi in Food and Agriculture**
- 2. Fungi in Medicine**
- 3. Fungi in Industry**
- 4. Fungi in Environmental Remediation**
- 5. Fungi as Biocontrol agents**
- 6. Fungi as Research Tool**

# Fungi in Food and Agriculture

- Food value of fungi is well known since past
- Fungi used as food include, Morels, Mushrooms, Truffles, Puffballs and nonwoody Polypores
- ✓ Morels are members of Ascomycetes commonly called Guchchhi in north India
- ✓ Truffles are Ectomycorrhizal fungi found associated with roots of higher plants commonly called Tubers and Salboda in Chhattisgarh
- ✓ Puffballs are large white fruiting of fungi edible at young stage
- ✓ Mushrooms are fruit bodies of Basidiomycetes fungi, found both natural and cultivated as button mushroom (*Agaricus spp.*), oyster mushroom (*Pleurotus spp.*) and paddy straw mushroom (*Volvariella spp.*)

- Some yeasts and mycelial fungi are cultured on a large scale and then undergo further processing to provide various protein-rich food products for human or livestock consumption
- ✓ Quorn™ mycoprotein is produced commercially from the mycelial fungus *Fusarium venanatum*
- Some fungi show symbiotic relationship with the roots of higher plant known as Mycorrhizas
- ✓ Mycorrhizas appears as ecto or endo mycorrhiza, significantly improve plant growth and vigour through help in nutrient uptake and provides disease protection, resulting in increased yields in crop plants
- Other fungal species are used in the biological control of insect and nematode pests, weeds and pathogenic microorganisms
- ✓ The fungus *Beauveria bassiana* is used to control a number of insect pests

- **Fungi are primary decomposers of any ecosystem and released enzymes convert essential elements into new materials resulting increase in the fertility of soil**
- **Some fungi also help to prevent leeching of inorganic substances in soil**
- **Some yeasts like *Saccharomyces* and *Rhodotorula* are known to be non symbiotic nitrogen fixers**

# Fungi in Medicine

- Some fungi produce substances which help to cure diseases caused by the pathogenic microorganisms, called the **Antibiotics**
- Penicillin was the first antibiotic extracted from *Penicillium notatum* which is far more effective than ordinary drugs and germicides

Antibiotic	Source	Activity
Fumigatin	<i>Aspergillus fumigatus</i>	Antibacterial
Statolen	<i>Penicillium stoloniform</i>	Antiviral
Ustilagic acid	<i>Ustilago mydis</i>	Antifungal, Antibacterial
Fumigallin	<i>Aspergillus fumigatus</i>	Amoebocitic
Griseofulvin	<i>Penicillium griseofulvum</i>	Antifungal



- *Claviceps purpurea* produces sclerotia called the ergot which contains a mixture of alkaloids and used in veterinary and human medicine
- A derivative of ergot known by the name of lysergic acid (LSD) is used in experimental psychiatry
- Some species of *Rhizopus* and *Aspergillus* are sources of valuable steroids
- Ephedrine is extracted from species of Yeast widely used in asthmatic diseases
- The giant puff ball *Clavatia* contains an anti-cancer substance clavacin used for prevention of stomach tumors
- Fungi (*Leptolegnia caudate* and *Aphanomyces laevis*) are used to trap mosquito larvae and thus help in malaria control

# Fungi in Industry

## (i) Alcoholic fermentation:

- This is dependent on the fact that the fermentation of sugar solutions by fungal species produces ethyl alcohol and carbon dioxide
- The yeasts secrete the enzyme complex called zymase which brings about conversion of sugar into alcohol
- The carbon dioxide released is also considered a valuable by-product, collected, solidified and sold as “dry ice” in the baking or bread-making industry to cause the dough to rise and to make the bread light
- Moulds as *Mucor racemosus* are employed as starters to bring about scarification of the starch and at the second stage yeast is employed to act on the sugar in industrial production of alcohol
- *M. rouxii* , some species of *Rhizopus* and *Aspergillus flavus* is used in the production of African native beer

## (ii) Enzyme preparations:

- Fungal enzymes are used for dextrinization of starch and desizing of textiles through Digestin, Polyzime etc..

Enzymes	Fungal Sources
Amylase, Pectinase, Protease and Glycoamylase	Aspergillus oryzae, A. niger
Rennet	Mucor sp.
Glucose oxidase	Penicillium chrysogenum
Cellulase	Trichoderma viridae
Invertase	Saccharoymces cerevisiae

### (iii) Preparation of organic acids:

- The important organic acids produced commercially as the result of the biochemical activities of moulds

Organic Acid	Fungal Sources
Oxalic acid	<i>Aspergillus niger</i>
Citric acid	<i>Penicillium</i>
Gluconic acid	<i>Penicillium and Aspergillus</i>
Gallic acid	<i>Aspergillus gallomyces</i>
Itaconic acid	<i>Aspergillus terreus</i>
Kozic acid	<i>Aspergillus flavus</i>
L-Malic acid	<i>Schizophyllum</i>
Succinic acid	<i>Saccharomyces sp.</i>

#### (iv) Gibberellins:

- These are plant hormones produced by the fungus *Gibberella fujikuroi* which cause a disease of rice
- Gibberellin is used to accelerate growth of several horticultural crops

#### (v) Cheese Industry:

- Certain fungi popularly known as the cheese moulds play an important role in the refining of cheese and give cheese a characteristic texture and flavour
- The two chief kinds of mould refined cheese are:

(a) Camembert and Brie types, soft cheese

(b) Roquefort Gorgonzola and Stilton types. They are green or blue veined cheese

*Ex. Penicillium camemberti* and *P. caseicolum* in the first type and *P. roqueforti*

## (vi) Manufacture of Proteins:

- The yeast (*Saccharomyces cerevisiae* and *Candida utilis*) contain high percentage of protein of great nutritive value
- They are grown with ammonia and molasses as the source of carbon and the product is called Food Yeast contains 15% protein

## (vii) Vitamins:

- The yeasts, are the best source of vitamin B complex
- A number of moulds and yeasts are utilized in the synthesis of Ergosterol which contains Vitamin D
- Riboflavin is obtained from a filamentous yeast, *Ashby gossypii*

## (viii) Fat Production:

*Aspergillus nidulans*, *A. nidulans*, *A. fisheri*, *Penicillium piscarium*, *P. javanicus*

### (ix) Pigments:

Some fungi are grown commercially for extraction of pigments and used for preparation of various dyes

Pigment	Fungus
Atromentin	Paxillus atromentosus
Catenerin	Helminthosporium sp.
Phoenicin	Penicillium phoenicum
Neocercosporin	Cercospora kikuchi

### (x) Latex production:

Ex. Bleeding fruit bodies of *Stereum gausapatum* and Lactiferous hyphae of *Lactarium sp.*

# Fungi in Environmental Remediation

- Fungi play a vital role in recycling essential elements, particularly carbon as they are decomposers of ecosystem
- Saprotrophic fungi utilize dead organic materials as sources of nutrients and are very effective and efficient biodegraders with wide range of extracellular enzymes and capable of degrading complex polymers, such as cellulose, proteins and lignins
- Some species of yeasts and mycelial fungi are used in processes aimed at reducing the concentrations and toxicities of waste materials, particularly from industrial processes, before those wastes are released into the environment - a process known as **bioremediation**

*Aspergillus niger* is used to breakdown tannins in tannery effluents to less toxic compounds.

Some (*Pleurotus ostreatus*)fungi are hyper accumulators and capable of absorbing and concentrating heavy metals



# Fungi as Biocontrol Agents

- Fungi are involved in exploiting insects, other small worms and help in controlling pests
- Fungi such as *Empusa sepulchris*, *Metarrhizium anisopliae*, *Cordyceps melothac* etc. are used to control insect pests
- Some common fungal inhabitants of the soil help to combat diseases caused by soil borne fungi (*Trichoderma lignorum* and *Gliocladium fimbriatum* are found in damp soils. They have an inhibitory effect on the growth of the mycelium of *Pythium*)
- Some predacious fungi in the soil can trap and destroy the nematodes by forming loops on the mycelium
- Some predatory soil fungi produce conidia which are sticky to stick the nematodes and germinate to produce hyphae which penetrate into the tissues of the host and absorb nourishment
- *Beauveria bassiana* is used as nematicide is against borers, thrips, and aphids
- *Trichoderma viride* and *T. harzianum* are other examples which are used against a large number of soil-borne pathogens

# Fungi as Research Tools

- Many fungi are used as basic material for study of fundamental biological processes due to their fast rate of reproduction, short life cycle and production of meiotic spores
- *Neurospora* has ideal research material for geneticist
- *Physarum polycephalum* is good material of study of DNA synthesis, morphogenesis, mitotic cycle and many other cellular processes
- To detect the presence and quantity of vitamin B in given sample, *Neurospora crassa* is commonly used
- Similarly *Aspergillus niger* is used for detection of trace elements like zinc, nickel and copper even when they are present in very minute quantities

# **Harmful Effects of Fungi**

- 1. Deterioration and Spoilage**
- 2. Disease in Humans, Animals and Plants and Toxicity**

# Deterioration and Spoilage by Fungi

- The excellent biodegradative abilities of fungi contribute many saprotrophic fungi to contaminating food sources or destroying many consumer goods
- Some saprotrophic fungi are dangerous contaminants of seeds and grains through carcinogenic mycotoxins (fungal toxins) production
- Some *Aspergillus* species produce a group of chemically related mycotoxins called aflatoxins

- Many species of Mucorales, Zygomycetes and Deuteromycetes cause rotting of fruits and vegetables
- *Rhizopus spp.* are responsible for rotting of sweet potatoes
- Some fungi such as *Penicillium digitatum*, *P. expansum*, *Aspergillus glaucans*, *A. niger*, *A. clavatus* and *Fusarium sp.* Spoil the meat during storage and transportation
- Common bakery items are spoiled by *Mucor mucedo*, *Aspergillus repens* and *A. flavus*
- Wool, Rayon, Cotton and silk like textiles are also get spoiled by some fungal species (*Alternaria*, *Penicillium*, *Steinphyllum*, *Trichoderma*, *Stachybotrys* and *Chaetomium spp.*)
- Many fungi decompose cellulose and lignin and ruin paper (*Aspergillus*, *Chaetomium*, *Cladosporium*)
- *Aspergillus niger*, *Penicillium* and *Paecilomyces* are capable to destroy leather goods

- Rubber products are spoiled by *Aspergillus candidus*, *A. niger*, *A. terreus* and *Penicillium sp.*
- Many fungi are responsible to cause mold spotting and discoloration of the painted surfaces (*Aspergillus*, *Penicillium*, *Cladosporium* and *Pullularia sp.*)
- The dry rot fungus, *Serpula lacrymans* attacks wood and potentially dangerous for the construction of buildings
- The members of polyporales are predominantly occur on living trees and responsible for wood rot (***Polyporus tomentosus* and *Ganoderma sp.***)
- Fungal mycelium have been reported growing in Kerosene based fuel tanks of Aircrafts and plug the pipes, grow on aluminium alloy and may corrode the metal

# Fungal Diseases and Toxicity

## (i) Diseases of Man:

- Some fungi are actively parasitic in humans, while others induce severe allergic reactions if their spores are inhaled
- ✓ **Mycoses: True infection of fungi**
- ✓ **Mycotoxicoses: Ingestion of toxic fungal metabolites**
- **Dermatophytes cause infection of keratinized tissue, hair and nails**
- **Tinea is a common skin disease in humans caused by *Epidermophyton*, *Microsporum* and *Trichophyton***
- ***Sporotrichum* is responsible for subcutaneous infections**
- ***Cladosporium* is responsible for Chromomycosis**
- ***Histoplasma*, *Candida* and *Blastomyces* cause fetal diseases in humans**
- ***Neurospora* and *Fusarium sp.* infect corneal tissues of eye**

- Some species such as *A. fumigatus*, *A. flavus*, and *A. niger* are common human pathogens and responsible for disease collectively known as aspergilloses such as aspergilloses of lungs, external ear, etc.
- Many parasitic Fungi Imperfecti live in the mucous membranes of throat, bronchi and lungs and cause infection of mouth and lungs
- A few fungi cause skin discoloration and members of Trichophytoneae are the causative agents of a disease known as athlete's foot
- The well-known skin disease 'ring worm' and barber's itch are also fungal diseases
- Members of Fungi Imperfecti causes a throat or mouth disease known as thrush
- Several species of mushrooms are known to highly toxic causing liver and neuro damage (*Amanita*, *Scleroderma*)



Name of Disease	Pathogen
Aspergillosis	Aspergillus flavus, A. niger
Blastomycosis	Blastomyces dermatidis
Otomycosis	Aspergillus fumigatus
Neuritis	Mucor pusillus
Onychomycosis	Trichophyton purpureum
Candidiasis	Candida albicans
Histoplasmosis	Histoplasma capsulatum
Geotrichosis	Geotrichum candidum
Chromomycosis	Cladosporium immitis
Allergy	Spores of Aspergillus, Chaetomium
Dermatomycosis	Trichoderma viride

## (ii) Diseases in Animals:

- Certain species of fungi cause **Phycomycosis, Rhinosporidiosis and Mycotic abortions in animals** (*Trichophyton, Microsporum*)
- **Ringworm disease of Dogs** (*Microsporum cains*)
- *Aspergillus flavus* cause **bivine abortion in ducks, birds and chicken**
- *Saprolegnia* and *Achlya* act as **common parasites of fishes**

Name of Disease	Pathogen
Penicillosis	Penicillium spp.
Aspergillosis	Aspergillus spp.
Ahtelete foot	Tinea rubrum
Ringwoam	Trichophyton, Microsporum
Mucomycosis	Mucor, Rhizopus

### **(iii) Diseases of Plants:**

- **Diseases caused by fungi are responsible for a huge loss to our crop and other economic plants**

#### **(a) Damping off disease:**

- **The seedlings of tomatoes, cotton, mustard, peas, beans, tobacco, spinach, get soft and turn down due to this disease. It is caused by a species of *Pythium***

#### **(b) The potato blight:**

- **The Early and Late blight of potatoes is another destructive crop disease. It does a great damage to the potato tubers**

#### **(c) Downy mildews of grapes:**

- **It ruins the vine yards and thus causes heavy losses to the crop**

#### **(d) Ergot disease of rye:**

- **It is an important disease of a cereal crop results in the formation of poisonous sclerotia in the kernel, called ergot of rye**

**(e) Scab:**

- **It is a serious disease of the apple crop. It lowers the quality as well as quantity of the fruit**

**(f) Brown rot of stone fruits:**

- **It causes enormous losses in the fruit crop of apricots, cherries, plums and peaches.**
- **Brown Rot of Stone Fruits**

**(g) Smut diseases of corn, wheat, oat and other cereal crops cause serious reduction in the yield and quality of grain**

**(h) Red rot disease of sugarcane:**

- **It is a serious disease of sugarcane, particularly in the northern parts of the country**

**(i) Rust diseases:**

- **They attack our cereal crops and forest timber, as black stem rust, yellow rust and orange rust are a serious threat to our crops**

<b>Name of Disease</b>	<b>Pathogen</b>
<b>Potato wart</b>	<i>Synchytrium endobioticum</i>
<b>Papaya stem rot</b>	<i>Pythium sp.</i>
<b>Late Blight of Potato</b>	<i>Phytophthora infestance</i>
<b>White rust</b>	<i>Albugo candida</i>
<b>Downy mildew</b>	<i>Pernospora sp.</i>
<b>Powdery mildew</b>	<i>Erysiphe sp.</i>
<b>Leaf curl of Peaches</b>	<i>Tephrina deformans</i>
<b>Stem gall of coriender</b>	<i>Protomyces macrosporous</i>
<b>Rust</b>	<i>Puccinia spp., Uromyces spp. Melamspora sp.</i>
<b>Ergot of rye</b>	<i>Claviceps purpurea</i>
<b>Smut disease</b>	<i>Ustilago nuda, U. hordei</i>
<b>Early Blight of Potatos</b>	<i>Alternaria solani</i>
<b>Wilt</b>	<i>Fusarium sp.</i>
<b>Tikka disease of ground nut</b>	<i>Cercospora personata</i>
<b>Stripe disease of barley</b>	<i>Helminthosporium graminieum</i>

**Thank you..**