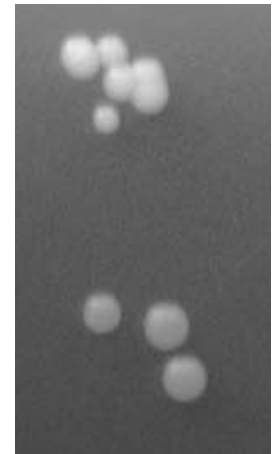


Morfologia e Taxonomia dos Fungos

Fungos: ~100.000 espécies descritas

~5.100.000 espécies existentes

Morfologia





Pezizaceae
Ascomiceto com
apotécio em forma de
copo



Hericium –
Basidiomiceto,
comestível



Gênero *Amanita* –
algumas espécies
altamente
venenosas para o
homem.



Pilobolus

Mucorales
(Zigomiceto)

Cresce sobre fezes de gado.
Possui esporângios explosivos
que podem carregar inclusive
pequenos nematodos que
causam infecções pulmonares
no próprio gado.



Geastrum triplex –
basidiomiceto, liberando
seus esporos.



Auricularia judae -
Basidiomiceto



Basidiomicetos com
formato “Bracket”

Estima-se que o total de biomassa produzido na terra por ano é de 10×10^{10} toneladas. Desse total 20×10^9 é de lignina!

Os Basidiomicetos são os mais efetivos nesse processo.



Qual o maior ser vivo existente no planeta?

Armillaria ostoyae – humongous fungo

"All the News That's Fit to Print"

The New York Times

National Edition
THURSDAY, APRIL 2, 1992
75-23

World's Biggest, Oldest Organism Twin Crowns for 30-Acre Fungus

By NATALIE ANGIER

Scientists have discovered what could be the largest and oldest living organism on earth, an individual mushroom that is the blue whale of the forest world, an individual sequoia tree or such past preorders to size supremacy as the dinosaur.

The organism is a giant fungus, an interwoven filigree of mushrooms and sporelike tentacles spawned by a single fertilized spore 1,500 to 10,000 years ago and now extending for more than 30 acres in the soil of a forest near Crystal Falls, Mich., along the Wisconsin border.

The fungus, called *Armillaria bulbosa*, has many tiny breaks in it but is genetically uniform from one end of its expanse to the other, which is why scientists say it rightfully deserves to be called a single individual. They suggest it has been growing possibly since the end of the last Ice Age, making it older than any other known organism on earth. If all its mushrooms and tendrils are considered together, the fungus weighs about 100 tons, about as much as a blue whale.

Dr. Myron L. Smith and Dr. James B. Anderson of the University of Toronto in Mississauga, Ontario, and Dr. Johann N. Braun of Michigan Technological University in Houghton report their discovery of the mammoth *Armillaria* in today's issue of the journal *Nature*.

"This is a fascinating report," said Dr. Thomas D. Bruns, an assistant professor of plant pathology and a fungal researcher at the University of California at Berkeley. "The catchy part of it is, when you really begin to appreciate how large this thing is, it's mind-boggling. People usually think of a mushroom as a little creature, but most of the action of a fungus is underground."

The organism survives by feeding on dead wood and other detritus, spreading outward right beneath the surface as it senses the presence of nutrients nearby. But scientists believe that the fungus has probably reached its maximum dimensions; at one, and possibly several, of its borders, the *Armillaria* is bumping up against competing fungi, which are blocking the older giant's further colonization of the forest.

Researchers said the finding will have biologists to rethink their assumptions about what constitutes an individual in fundamental problems in the study of the natural world and its ecosystems. Scientists normally view a single organism as something bound by a type of skin, whether of animal flesh or plant cellulose. But fungi, along with other organisms like coral and some types of grasses, grow as a network of cells and threadlike members whose boundaries are not always clear.

What is more, some elements of the newly discovered *Armillaria* grow independently, thus straining the idea that the entire fungal patch can truly be considered an individual. Nevertheless, biologists said that given its uniform genetic makeup the mold merited its ranking as a one giant creature.

"The individual is the basic unit of biology," said Dr. Risto Viding, an assistant professor of botany at Duke University. "Fungi like *Armillaria* offer us an opportunity to re-examine what the basic unit might be."

Scientists said the new work was particularly significant because it used molecular genetic analysis, similar to the techniques of DNA fingerprinting, to prove that the 30-acre fungus was a discrete being, which had grown over the years by sending out clonal shoots of itself. Other extremely large fungal growths have been identified in the past, but researchers could never be sure that the growths represented individual fungi, rather than populations of smaller molds whose edges had become smeared together.

"We used genetic markers to distinguish between these two possibilities," Dr. Anderson said. "It shocked us to have found such a large fungal entity that is so ancient."

"A lot of people have asked us if this is an April Fool's joke," he continued. "I've assured them it is not."

Target Growth Is Possible

As startled as they were to discover the colossal patch of fuzz, the researchers said *Armillaria* may not even be the largest fungal clon around.

"It's the most successful one we're aware of, but that is in a mixed forest with many kinds of trees," Dr. Bruns said. "We would think where there was a stand of pure trees like birch or aspen, a single fungus might be more successful still." In that case a fungus with a taste for a particular type of tree might be able to proliferate especially quickly and over the entire area before encountering any competitor.

The new discovery also underscores the ubiquity and power of the planet's fungi, a kingdom of organisms quite distinct from the plant and animal kingdoms.

"Fungi are the base of all terrestrial ecosystems," Dr. Bruns said. "The ecosystem on the planet would continue to operate without fungi to decompose and recycle wood and plants."

But fungi are not always innocuous; they sometimes attack healthy tissue. A few virulent fungal species, like the Dutch elm pathogen, have managed to devastate entire populations of trees.

Mapping a Discovery

The scientists came upon the described mega-fungus in 1988 while studying tree pathogens for the Michigan Department of Natural Resources. They collected samples of *Armillaria* mushrooms, familiarly known as honey mushrooms, to learn the underlying mechanisms that nourish them for the fungus. They analyzed 12 genes from the fungus and realized that all their genes were the clonal offspring of a being.

Going back over the next a year and collecting even more samples, they continued to track the borders of that fungus as it was realizing that they had things enormous on their hands.



Giant fungus was found in forest near Crystal Falls, Mich.



Mushrooms growing through a tree stump are only type of an organism iceberg. A 100-ton giant fungus, extending through 30 acres-Michigan forest, is believed to be the largest organism in the world.

Through experiments measuring the growth rate of the fungus on wooden stakes they were able to estimate how long it would have taken the clone to reach its current dimensions.

Feeding Off Rivals

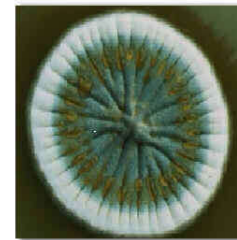
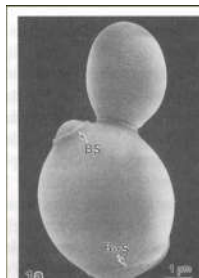
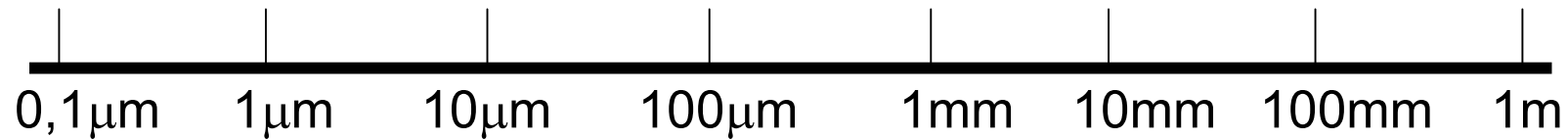
The scientists now believe that at some points in the distant past a fertilized spore, blown from a parent *Armillaria* mushroom, landed onto the ground and germinated. It grew into a brown, tentacle-like *Armillaria* "ward," sprouting small stems on the forest floor. Eventually, the fungus, wanting to begin sprouting mushrooms to its above ground and disperse new spores to the wind.

1500 anos
9700 kg
8,4 km²



Aspectos básicos relacionados aos fungos

Os Fungos formam um grupo extremamente heterogêneo, sendo largamente distribuído na Natureza.



Tipos Essenciais:

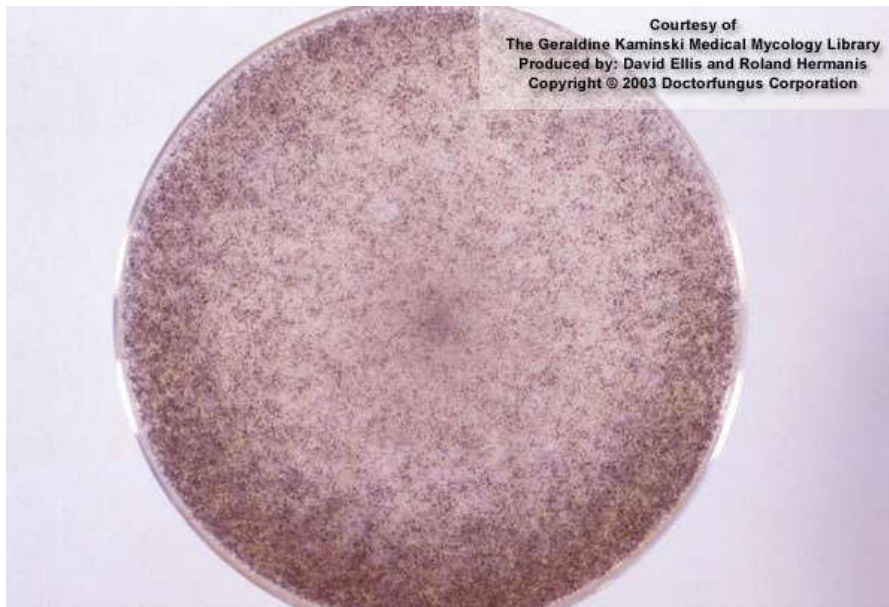
Macroscópicos → Cogumelos



Microscópios { **Bolores** – formam colônias filamentosas
Leveduras – colônias cremosas



Velocidade de crescimento afeta a morfologia da colônia:

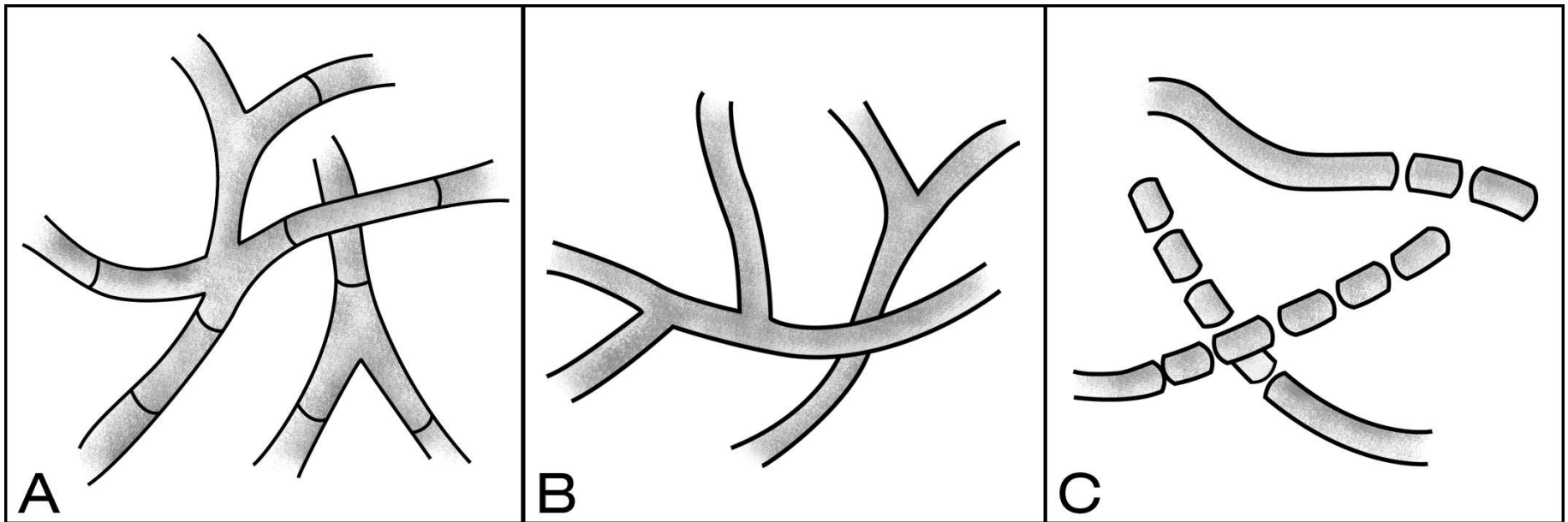


Rhizopus sp apresenta crescimento rápido, enquanto *Histoplasma capsulatum* é lento

Morfología Microscópica

Os **Bolores** são formados por seu conjunto de **hifas**, também conhecido por **Micélio**.

O micélio cumpre tanto papel vegetativo (a e b) como reprodutivo (c)

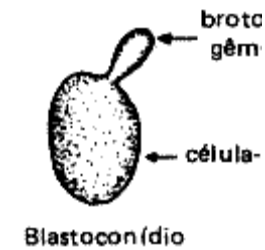


Morfologia Microscópica

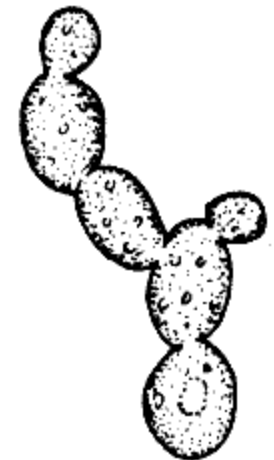
Bolores – micélio pluricelular



Leveduras – unicelulares



Pseudofilamentoso

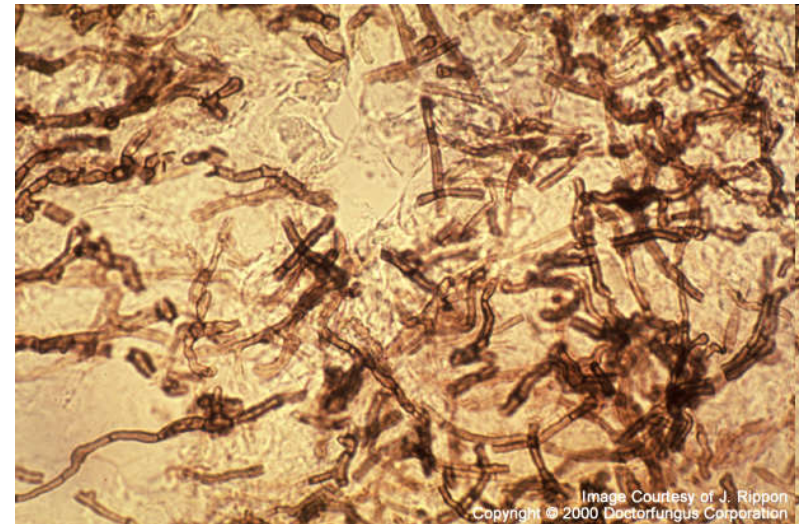


Pseudo-hifa

Quanto ao aspecto de cor as hifas podem apresentar-se:
Claras ou hialinas
Escuras ou demácias (acúmulo de melanina)



Aspergillus nidulans



Scytalidium dimidiatum

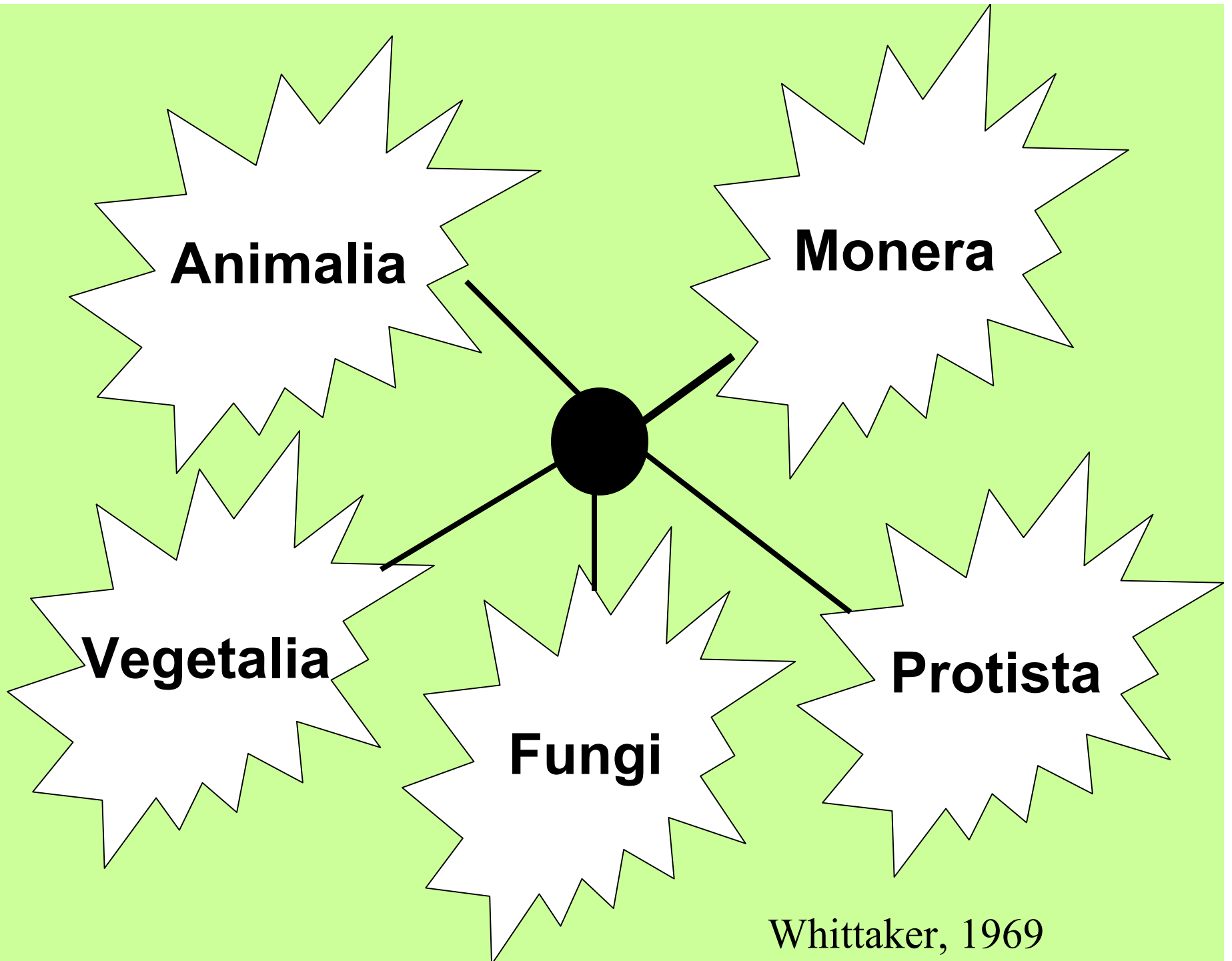
Taxonomia

Reino Fungi – Monofilético

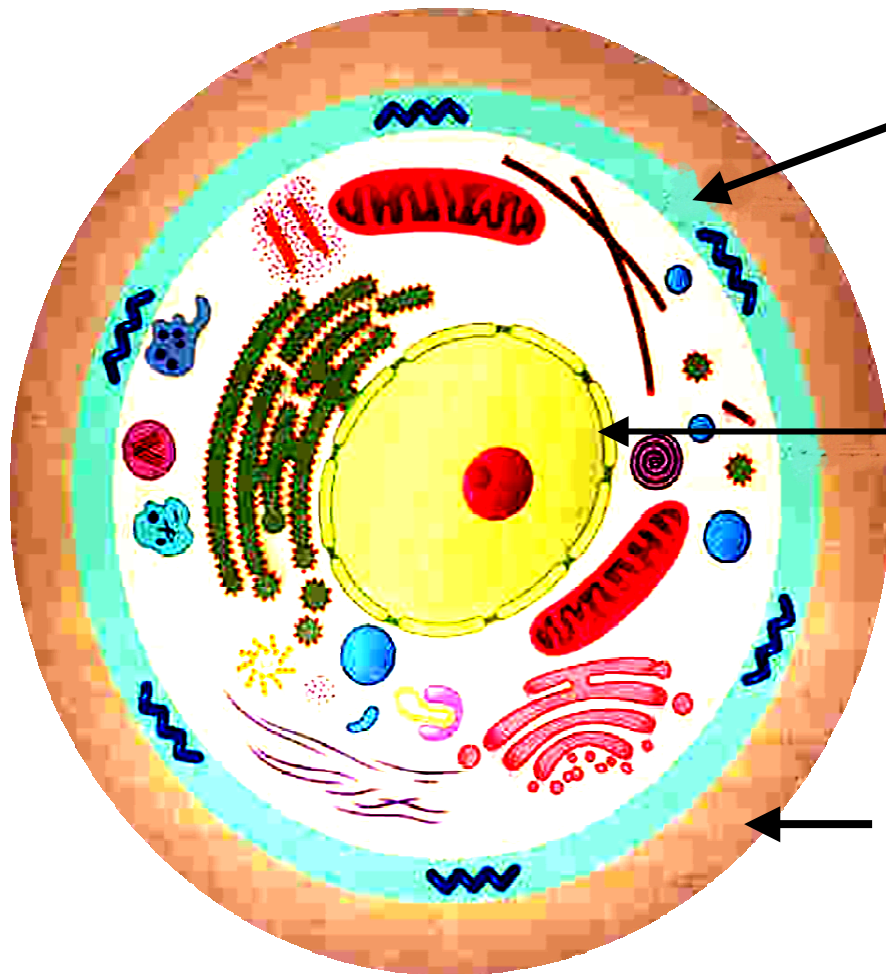
Eumicetos – Fungos verdadeiros



O termo “fungo” se refere historicamente a muitos organismos com características semelhante aos fungos verdadeiros (ex. Crescimento filamentoso), como bactérias (actinomicetos) , Oomicetos, protistas, algas ...



Whittaker, 1969

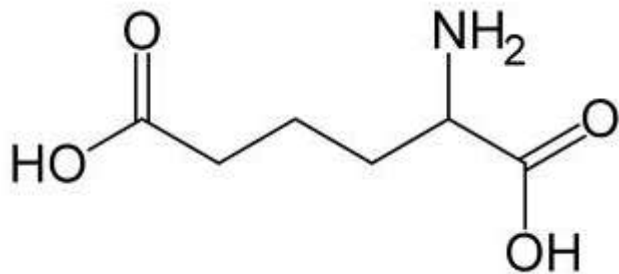


Membrana celular:
contém ergosterol ao
invés de colesterol

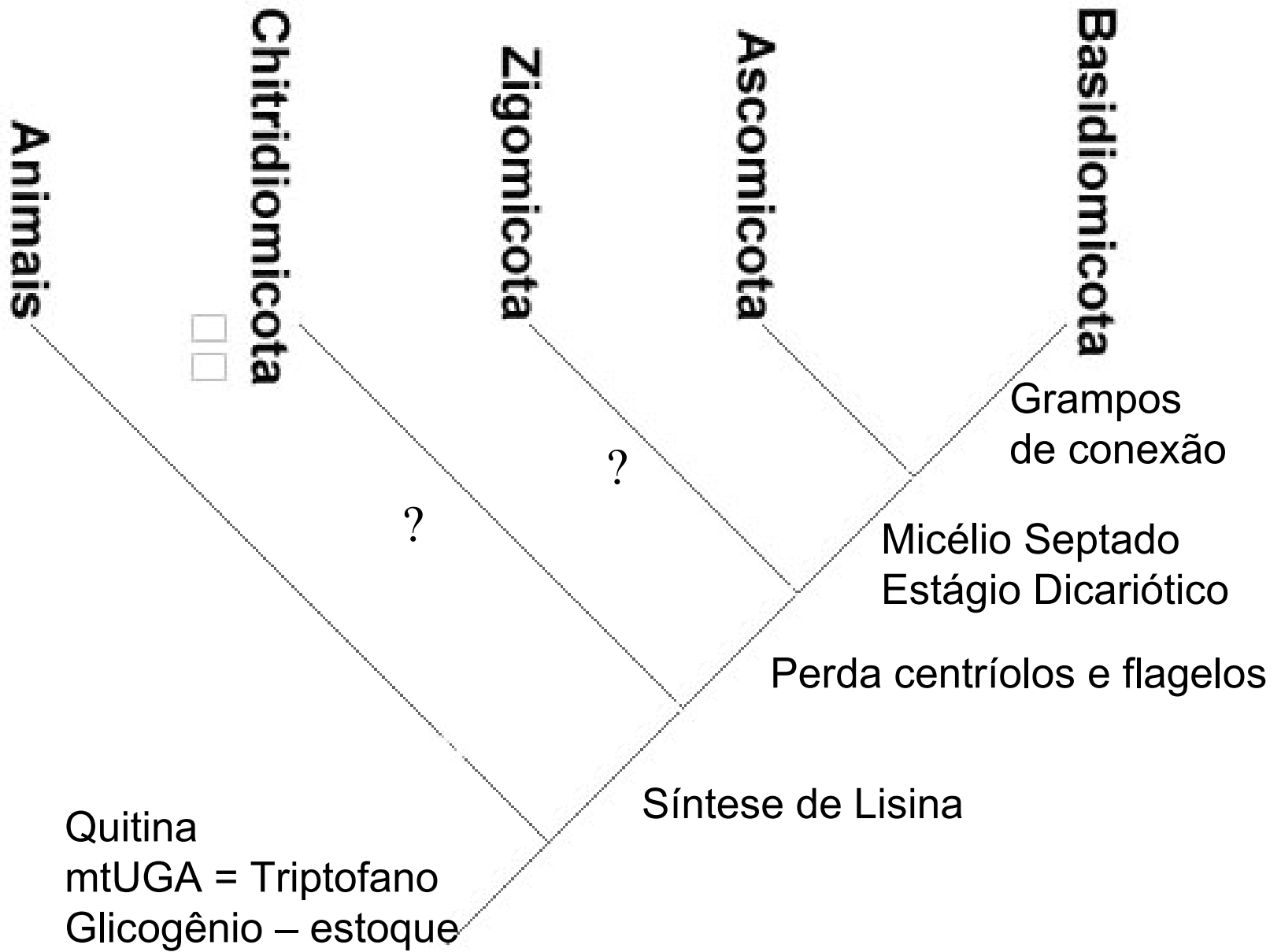
Algumas drogas podem
ser específicas em
interromper o
metabolismo DNA
fúngico

Ao contrário das células
de mamíferos, os fungos
possuem parede celular

A via biossintética de aminoácidos a partir do ácido aminoadípico e presença de parede celular com quitina e β -glucanos definem monofileticamente os eumicetos.



ácido aminoadípico



Árvore filogenética baseada nas características morfológicas, bioquímicas apontadas acima – Alexopoulos et al.1996 – Introductory Mycology

Tipos de Reprodução

Os fungos são capazes de se propagar de diversas maneiras, através de núcleos haplóides, diplóides, poliplóides, aneuplóides, dicarions

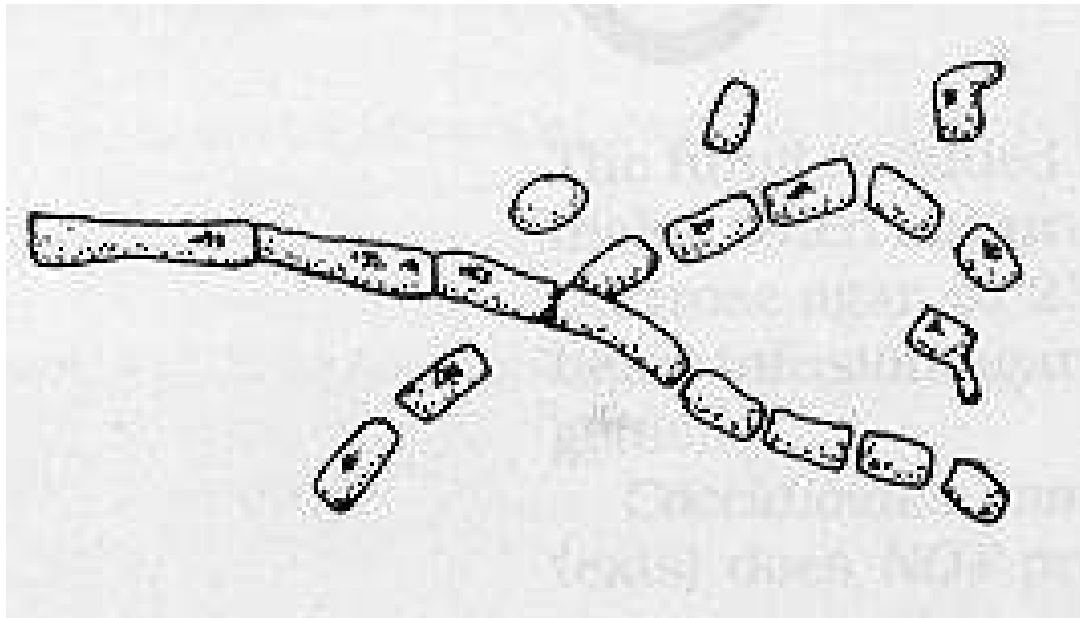
•**VEGETATIVA - ASSEXUADA :**
não ocorre fusão de núcleos

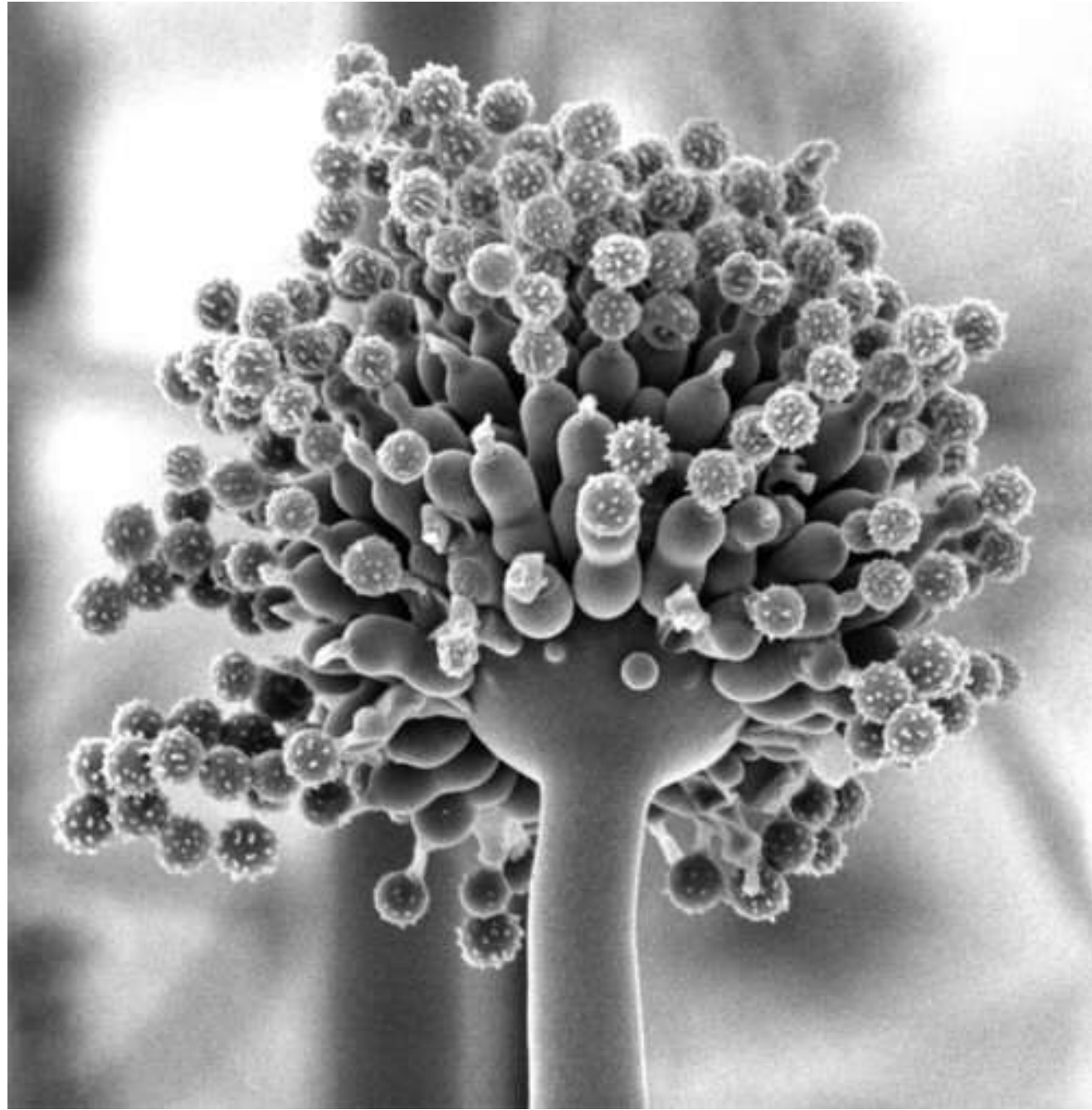
•**SEXUAL:**
união núcleos – seguido de divisão meiótica

•**PARASEXUAL:**
ocorre união núcleos – divisão mitótica – haploidização por aneuploidia

ASSEXUADA:

sem diferenciação celular, normalmente por fragmentação.





Conídios – ectósporos produzidos a partir de hifas especializadas, conidióforos.



Esporangiósporos – endósporos produzidos no interior de um esporângio

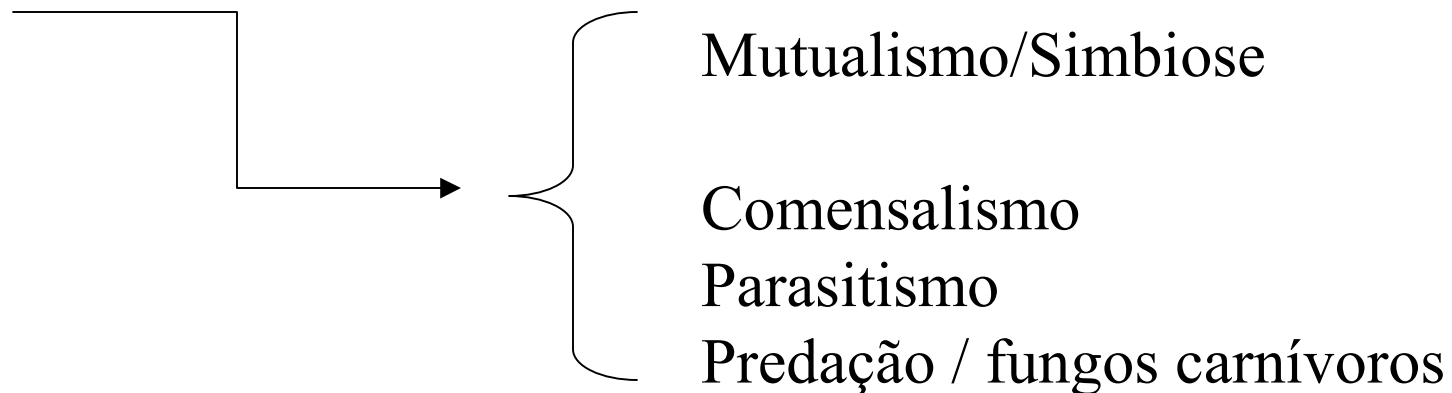


Fisiologia

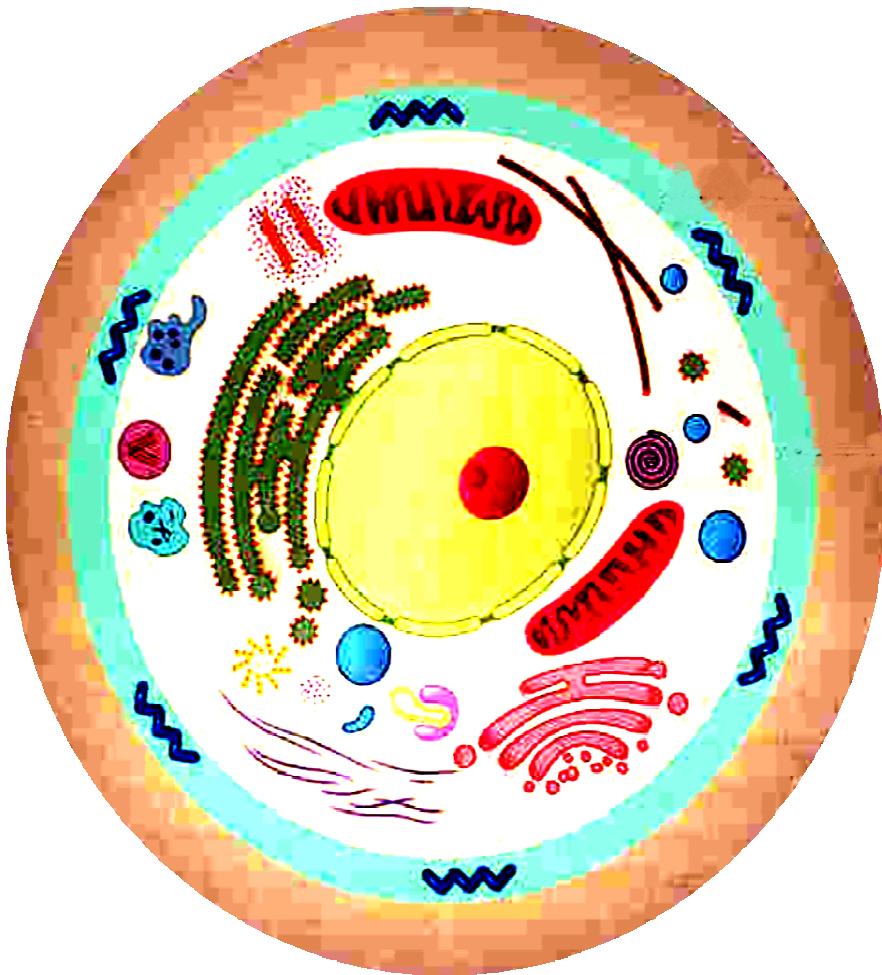
Características gerais de sua nutrição:

Organismos heterotróficos, absorção dos nutrientes do meio:

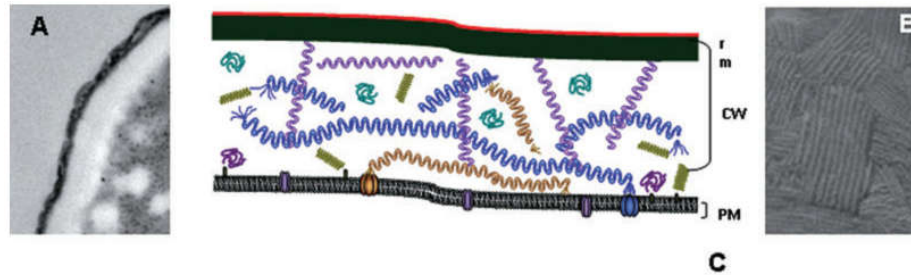
- Saprotismo → matéria orgânica morta
- Interações com outros organismos → matéria orgânica viva



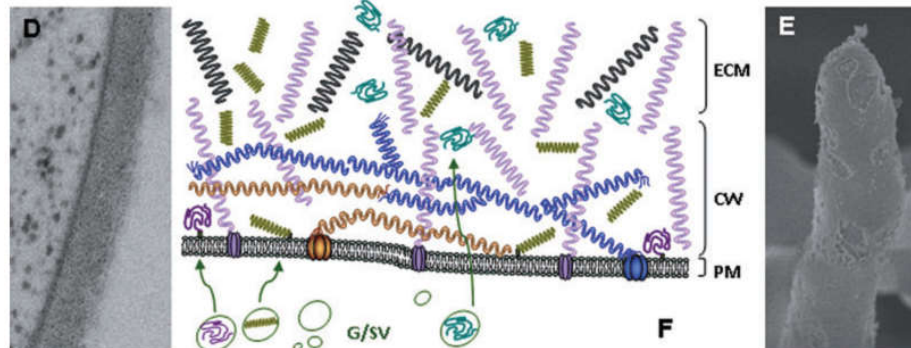
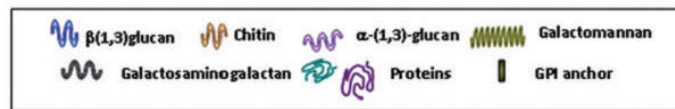
Em sua estrutura celular, os fungos são muito semelhantes às células dos animais



Estrutura da parede celular

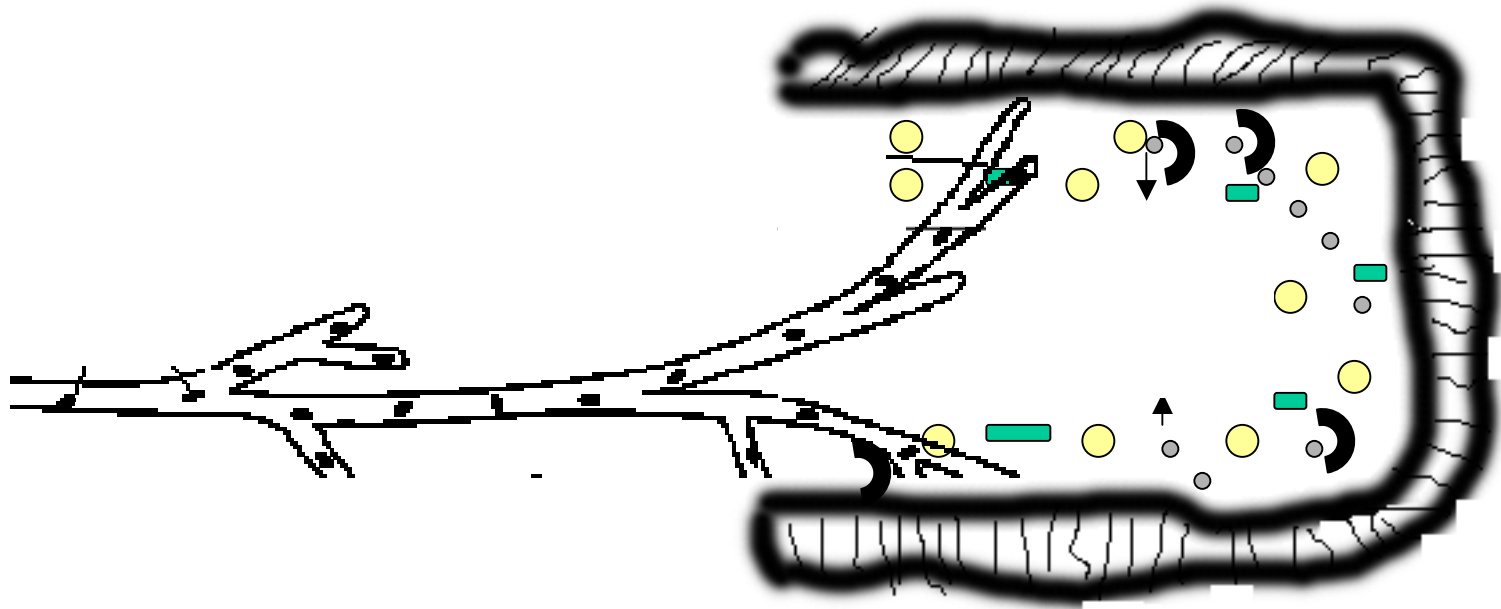


Conidio
dormente



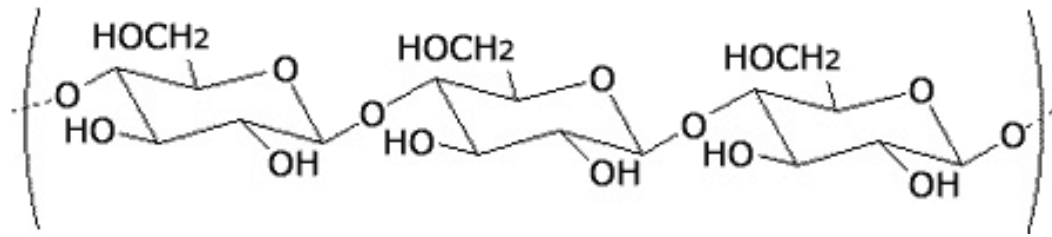
Hifa

Os Fungos saprófitas obtém seus nutrientes através da secreção de várias enzimas ao ambiente externo, digerindo o substrato tornando-o solúvel e passível de passar pela parede celular fúngica.

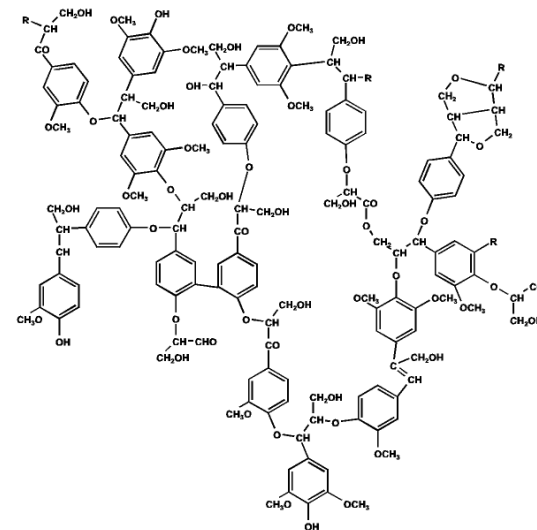


Em última análise o que determina em que substratos um fungo saprófita é capaz de crescer, depende do tipo de enzimas digestivas que ele é capaz de liberar.

Celulose - celulase



Lignina - ligninase





Hypocrea(H)/*Trichoderma*(T) tem sido largamente utilizados pela indústria como fonte de celulases e hemicelulases .

→ O substrato digerido deve ser protegido da ação de organismos oportunistas

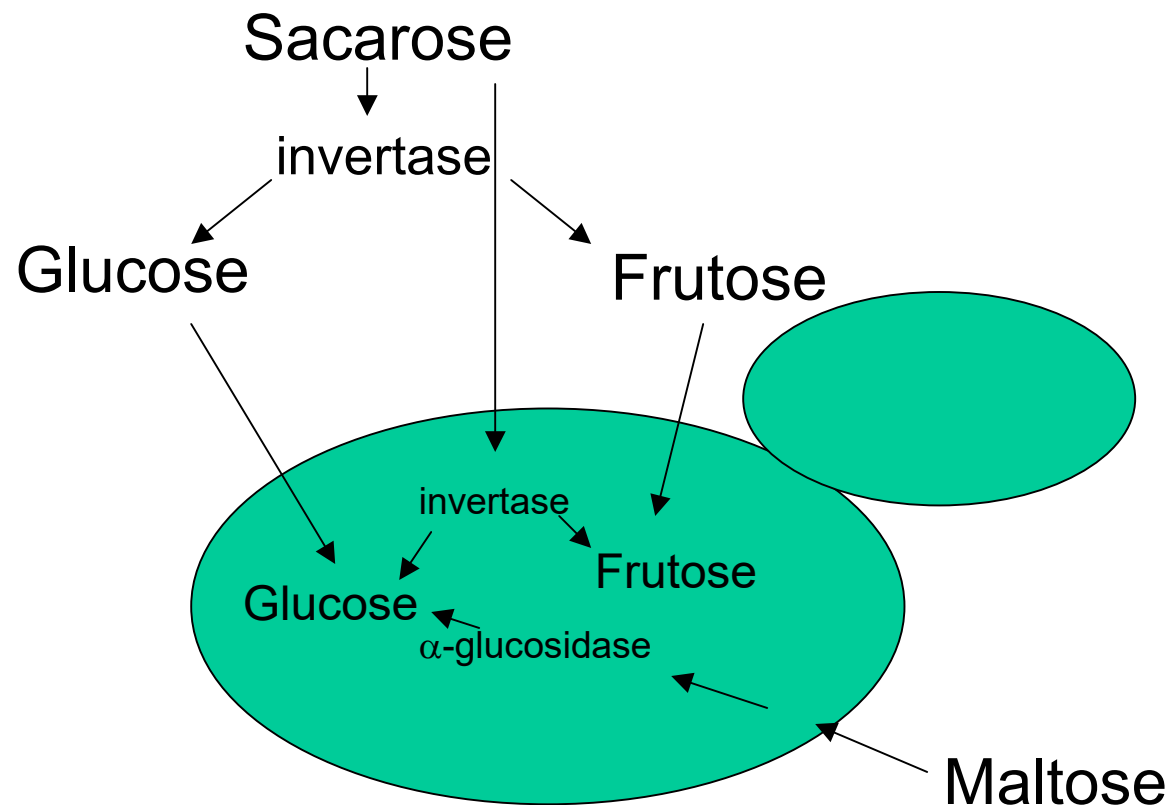
→ Ativação metabolismo secundário e secreção de antibióticos e micotoxinas

Alguns antibióticos secretados pelos fungos:

<i>Penicillium sp</i>	Penicilina
<i>Cephalosporium</i>	Cefalosporina
<i>Aspergillus fumigatus</i>	Dictopiprazinas
<i>Penicillium griseofulvum</i>	Griseofulvina
<i>Aspergillus nidulans</i>	Anidulafungina

A partir da digestão do substrato o fungo deve obter:

➔ Fonte de carbono – açúcares: monossacarídeos por difusão facilitada, dissacarídeos e trissacarídeos por transporte acoplado a H⁺

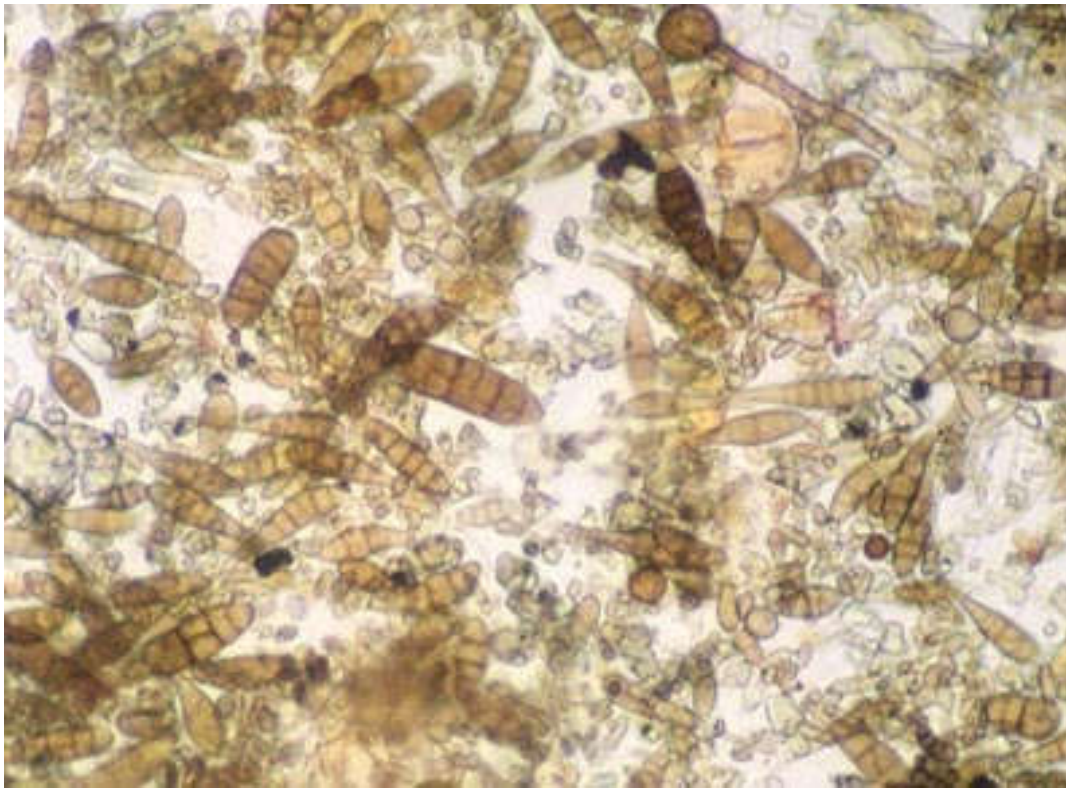


➔ Fonte de nitrogênio – uréia, sais de amônio, nitritos, nitratos, aminoácidos.

➔ -Vitaminas – biotina, tiamina, riboflavina ...
-Micronutrientes – fosfato, magnésio, ferro, cobre ...

Ar

O Ar é rico em esporos de fungos que se dispersam continuamente pela ação dos ventos.



Método Fita adesiva
Ambiente externo

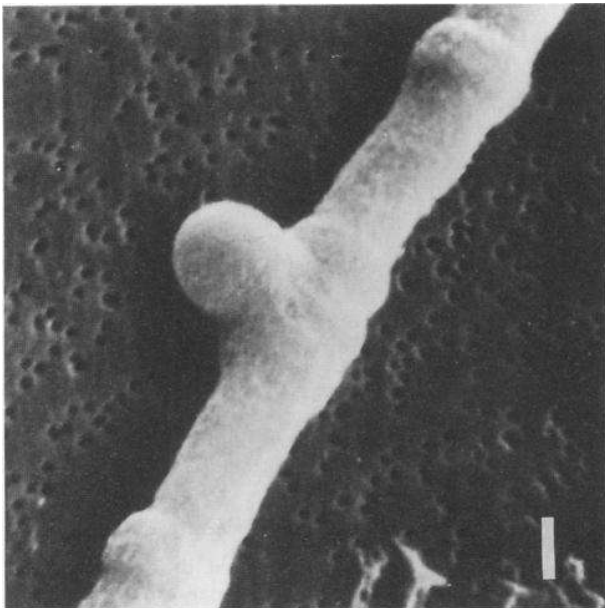
Fita adesiva: Ambiente Interno



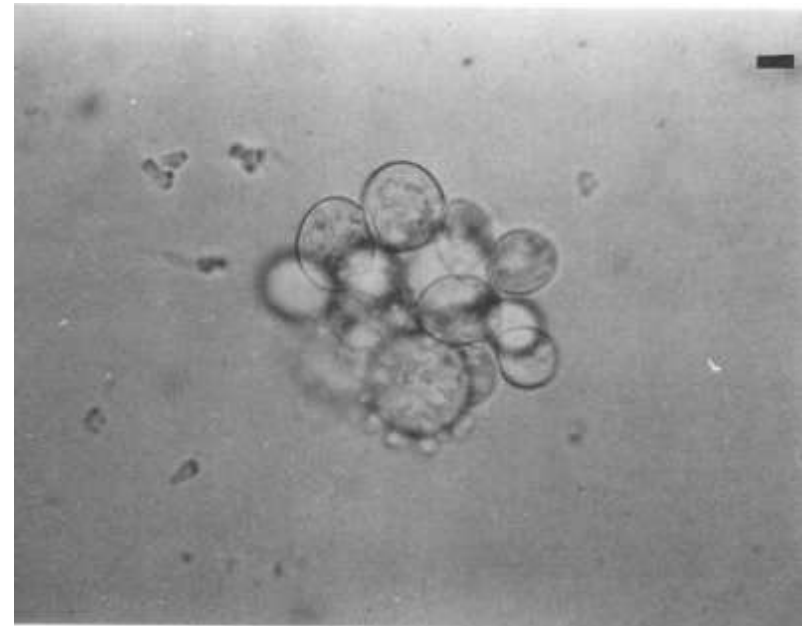
Relações Ecológicas

Parasitismo: Fatores de virulência levam microrganismos saprofíticos para vida parasitária (ação imunossupressiva, capacidade de aderência, formação de cápsulas, dimorfismo, etc...) Ex. dimorfismo em *Paracoccidioides*

25°C

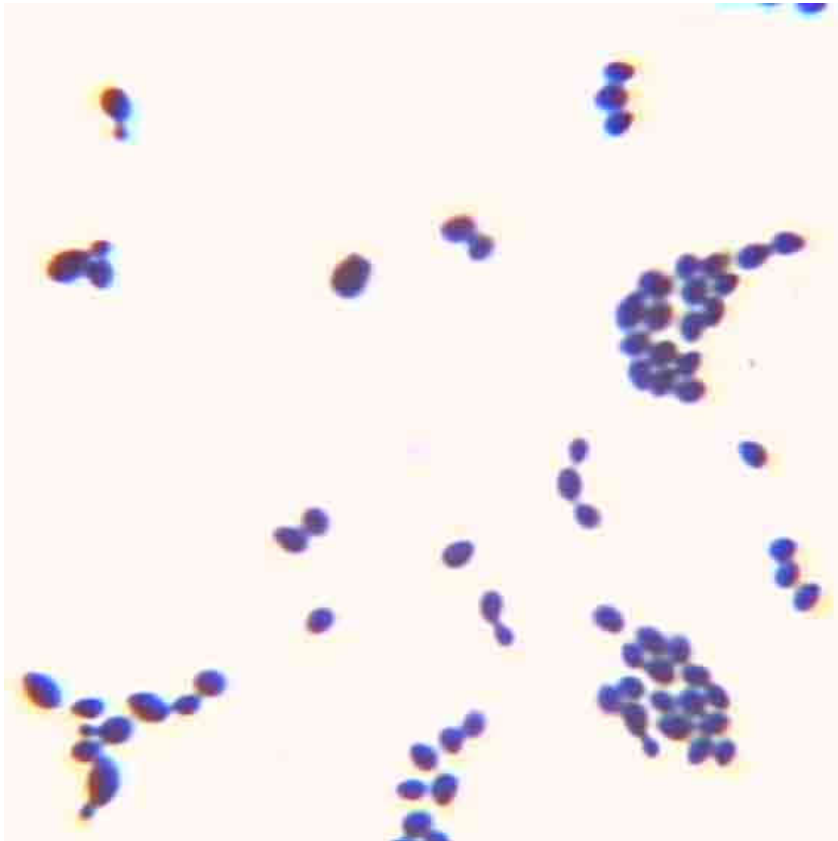


37°C



Comensalismo: Relação com efeito benéfico para um dos participantes e neutro para o outro.

Candida albicans: comensais do trato gastro-intestinal humano, mas se tornam parasitas dependendo do estado fisiológico do hospedeiro.

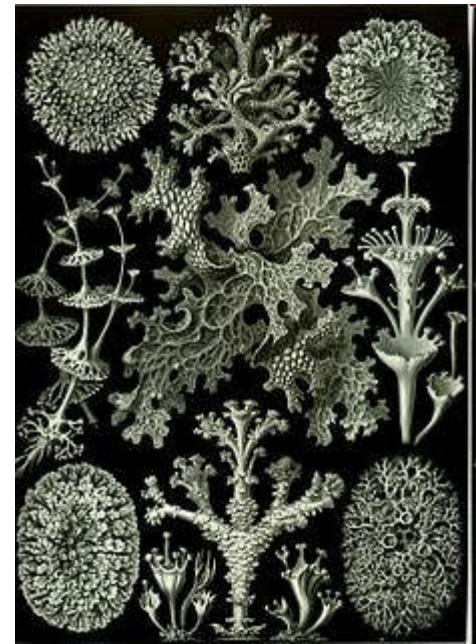


Mutualismo/Simbiose: Relação de benefício mútuo – é específica e dependente de co-evolução por longo período.

-Micorrizas

-Saúva – Fungos Basidiomicetos

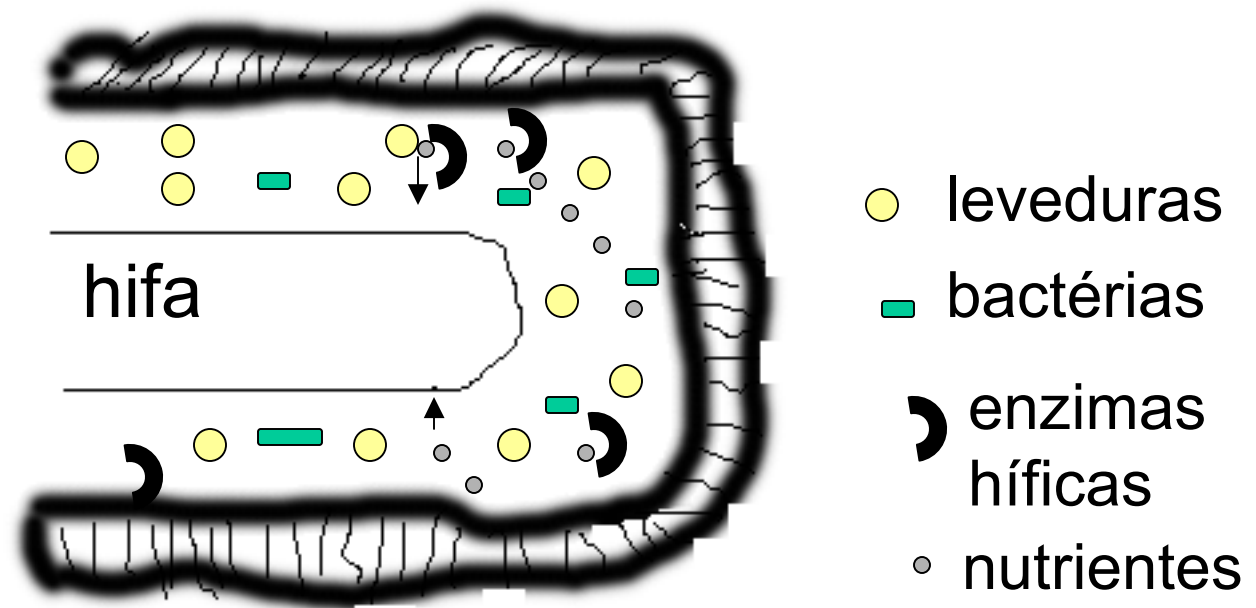
- Líquens – associação entre algas, ou cianobactérias com ascomicetos (98% casos) ou basidiomicetos (2%)



Lichenes" de Ernst Haeckel: *Artforms of Nature*, 1904

Competição:

Embora haja diferenças nos tipos de substratos que os microrganismos são capazes de explorar em determinadas situações há disputa pelo mesmo substrato.

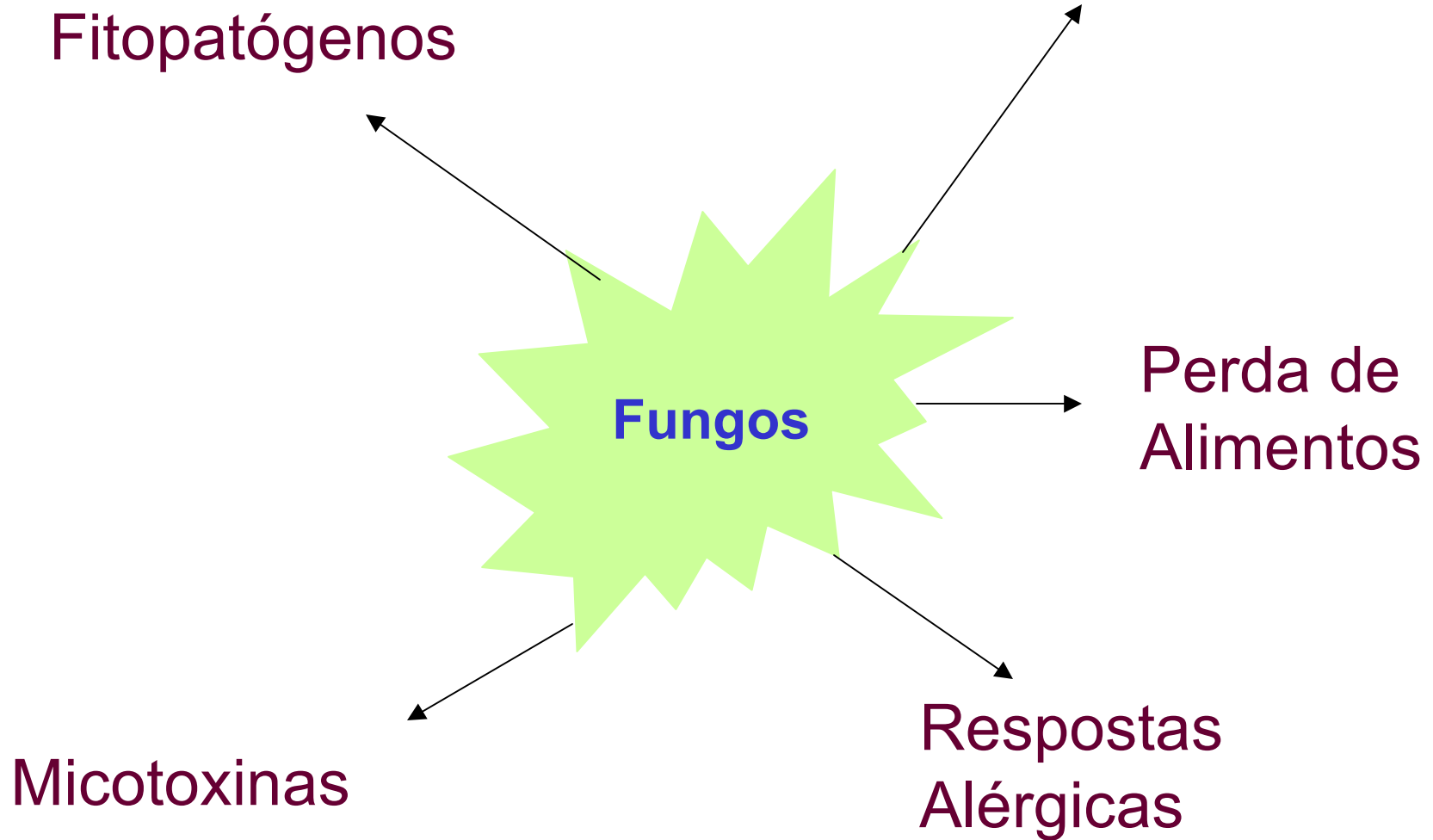


INTERAÇÕES POR COMPETIÇÃO

ANTAGONISMO ATIVO

**INIBIÇÃO POR CONTATO: PLASMÓLISE DO
MICRORGANISMO ANTAGONIZADO ; PRODUÇÃO DE
ANTIBIÓTICOS, ÁCIDOS, etc**

Micoses em humanos e animais (Aumento pacientes imunocomprometidos)



Micoses → são doenças causadas por fungos parasitas nos animais

Tinea barbae



Tinea barbae causada por *T. rubrum*. (Imagem Dr. G. Hunter and Dr. J. Nicholson, Adelaide, S.A.)

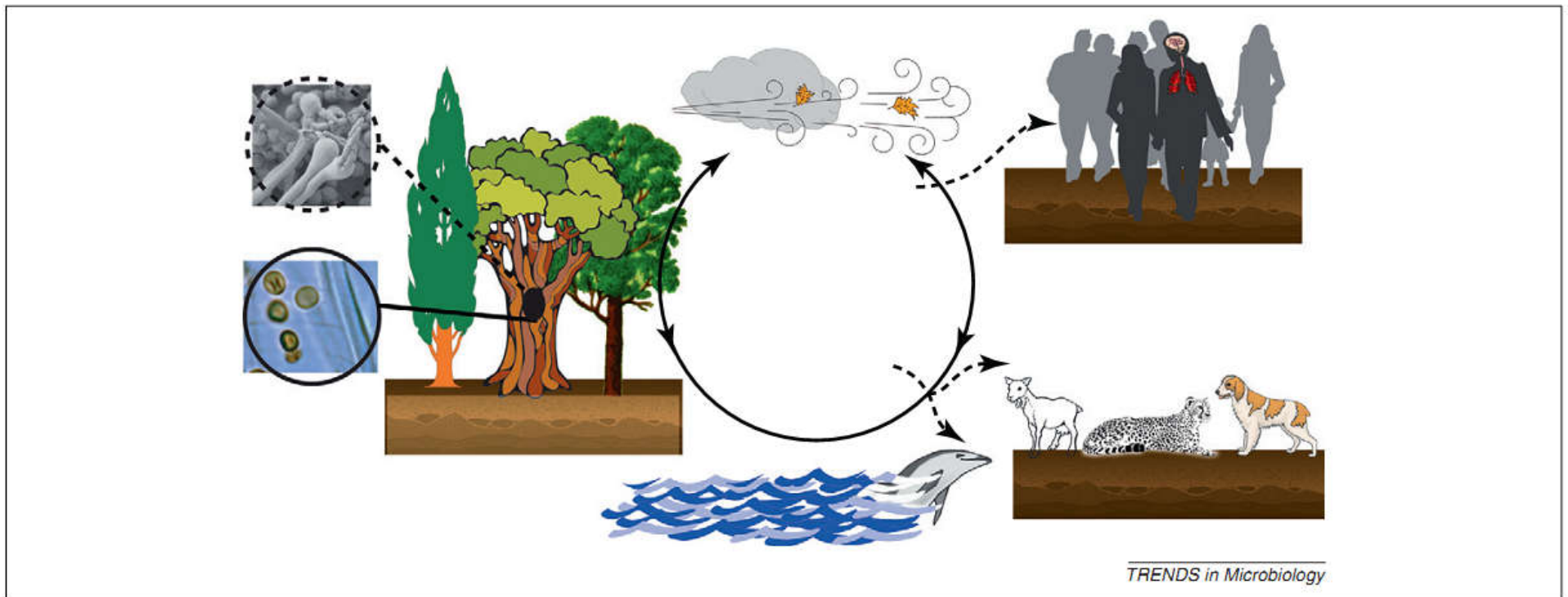


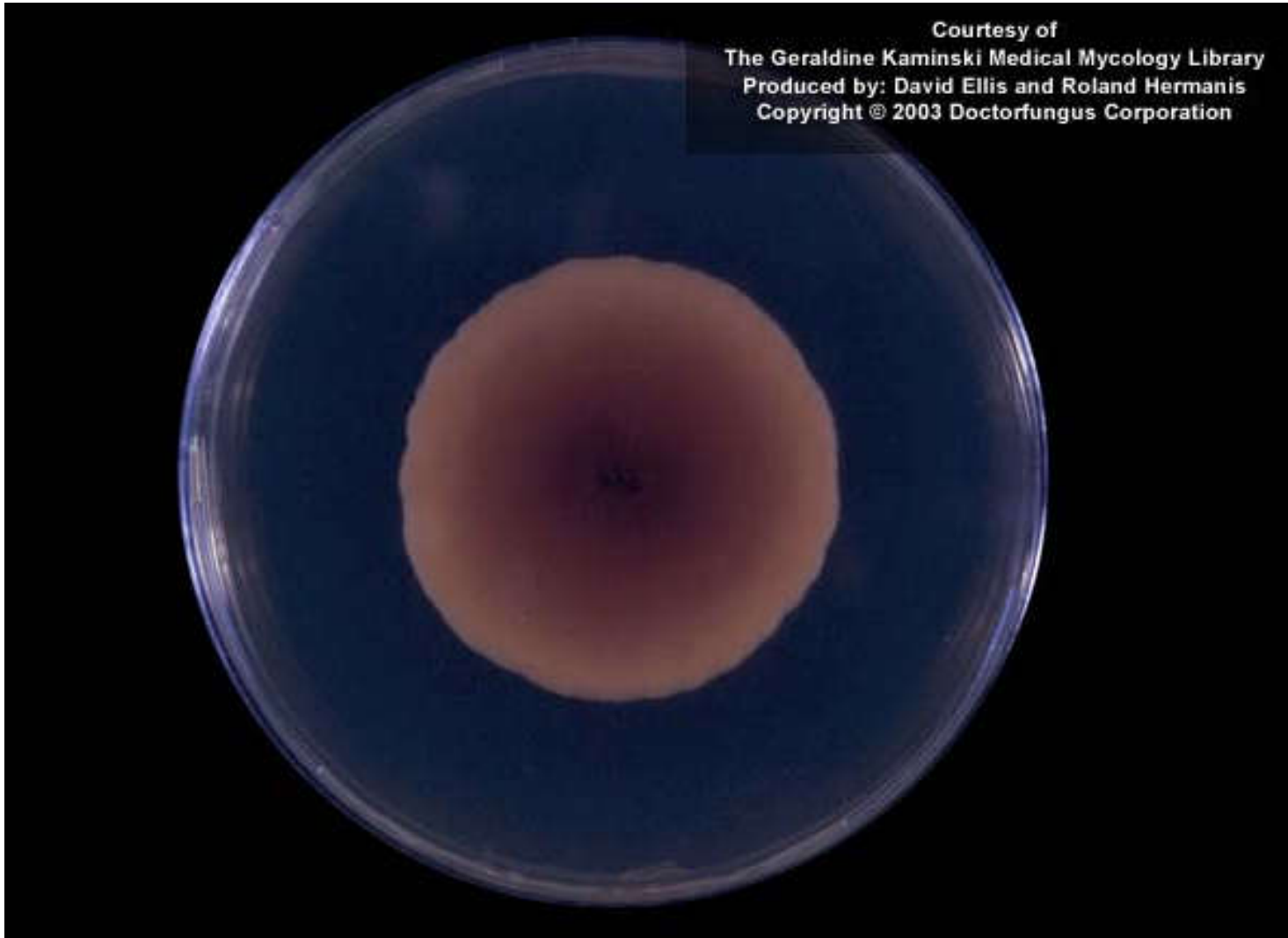
Figure 3. Suggested natural cycle of *Cryptococcus gattii* and events leading to cryptococcosis. The available information indicates the pathogen can cycle through plants, soil, air and water without any intermediate live hosts (solid line with arrows). Yeast cells of either mating type ($MAT\alpha$ or $MATa$) have been repeatedly isolated from trees, especially hollows (solid circle); it is not yet known if cells of *C. gattii* cells complete their sexual cycle in nature, as has been shown in the laboratory (dotted circle). Humans and animals (domestic and wildlife) coming in contact with fungal propagules (yeast cells or sexual spores) mostly remain asymptomatic (dotted lines with arrows), but a small number of infected humans and animals develop serious infections of the lungs and brain. These drawings are not to exact scale. Graphic artist: Andrew Bentley.



Fig. 1 - Exuberant injury in the face, similar to giant molluscum contagiosum.

Rev. Inst. Med. trop. S. Paulo
48(6):353-358, November-December, 2006

Courtesy of
The Geraldine Kaminski Medical Mycology Library
Produced by: David Ellis and Roland Hermanis
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Histoplasma capsulatum – causador histoplasmose

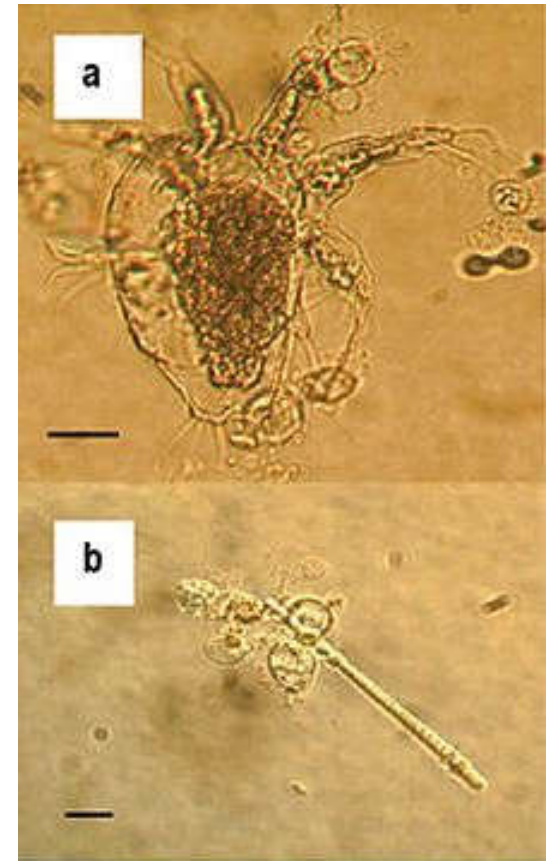




Candida albicans – presente na microbiota da maioria da população, normalmente estabelecendo relação comensal.

Chitridiomycetos – *Batrachochytrium dendrobatidis*

- Infecção pele anfíbios
- Letal
- causador de extinção de espécies



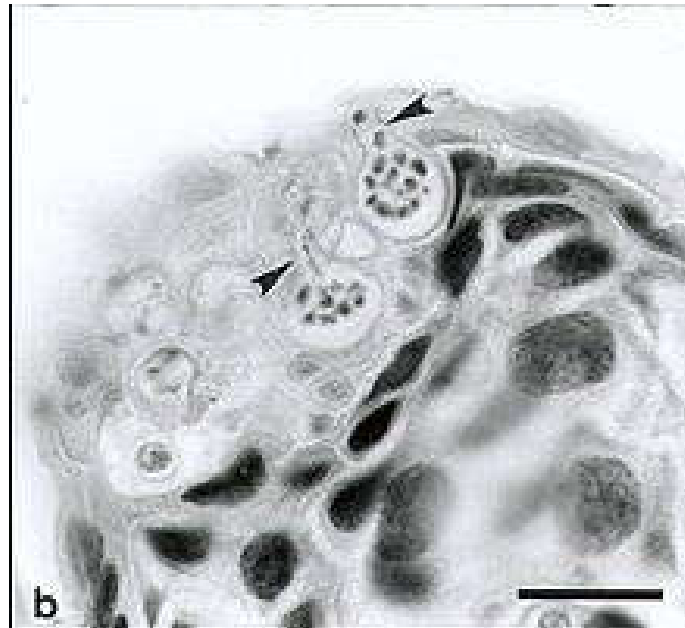


Worldwide distribution of *Batrachochytrium dendrobatidis* (Bd), the amphibian chytrid fungus: Credit: Fisher et al (2009); DOI: [10.1146/annurev.micro.091208.073435](https://doi.org/10.1146/annurev.micro.091208.073435)

→ Cresce entre 4 e 25°C – seu desenvolvimento é interrompido a 28°C.

→ Ciclo de vida : fase sésil → Esporângio (Zoo-esporângio)
fase móvel → Esporangiósporos (zoósporos)
flagelados

→ Zoósporo se instala na pele do anfíbio e dele se desenvolve um novo esporângio



→ Secreta enzimas proteolíticas e esterases que degradam a pele do hospedeiro

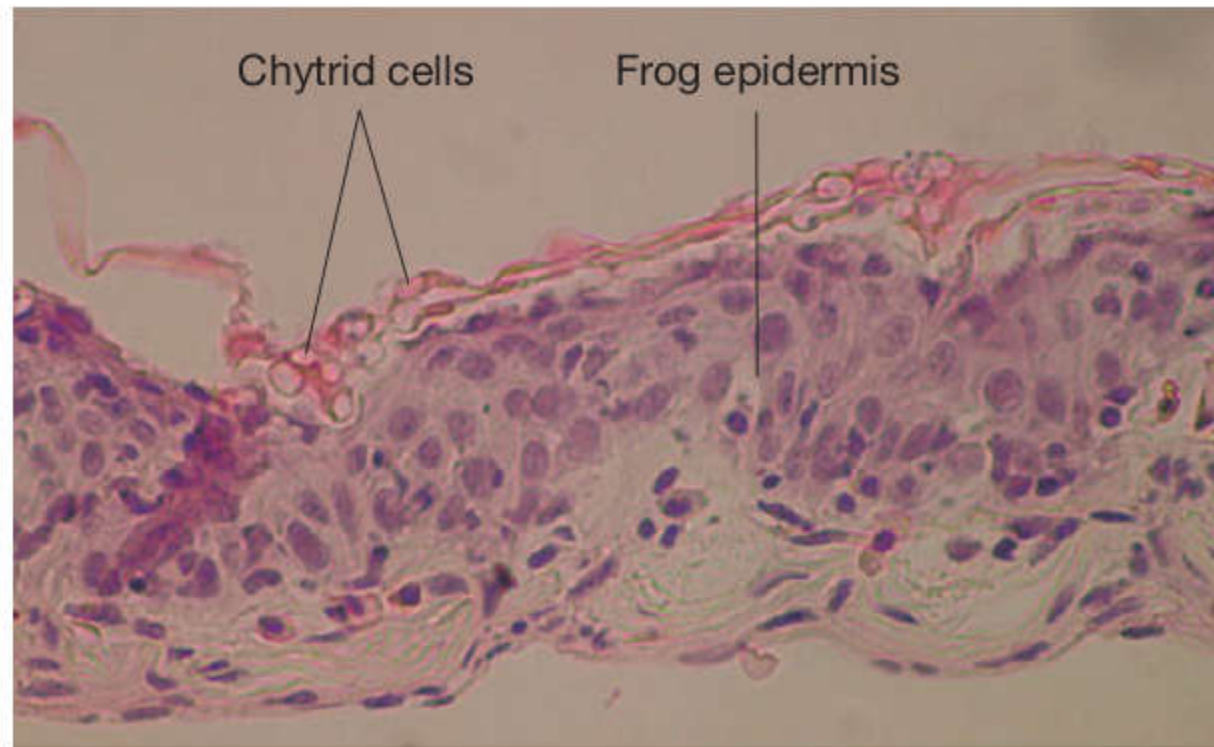
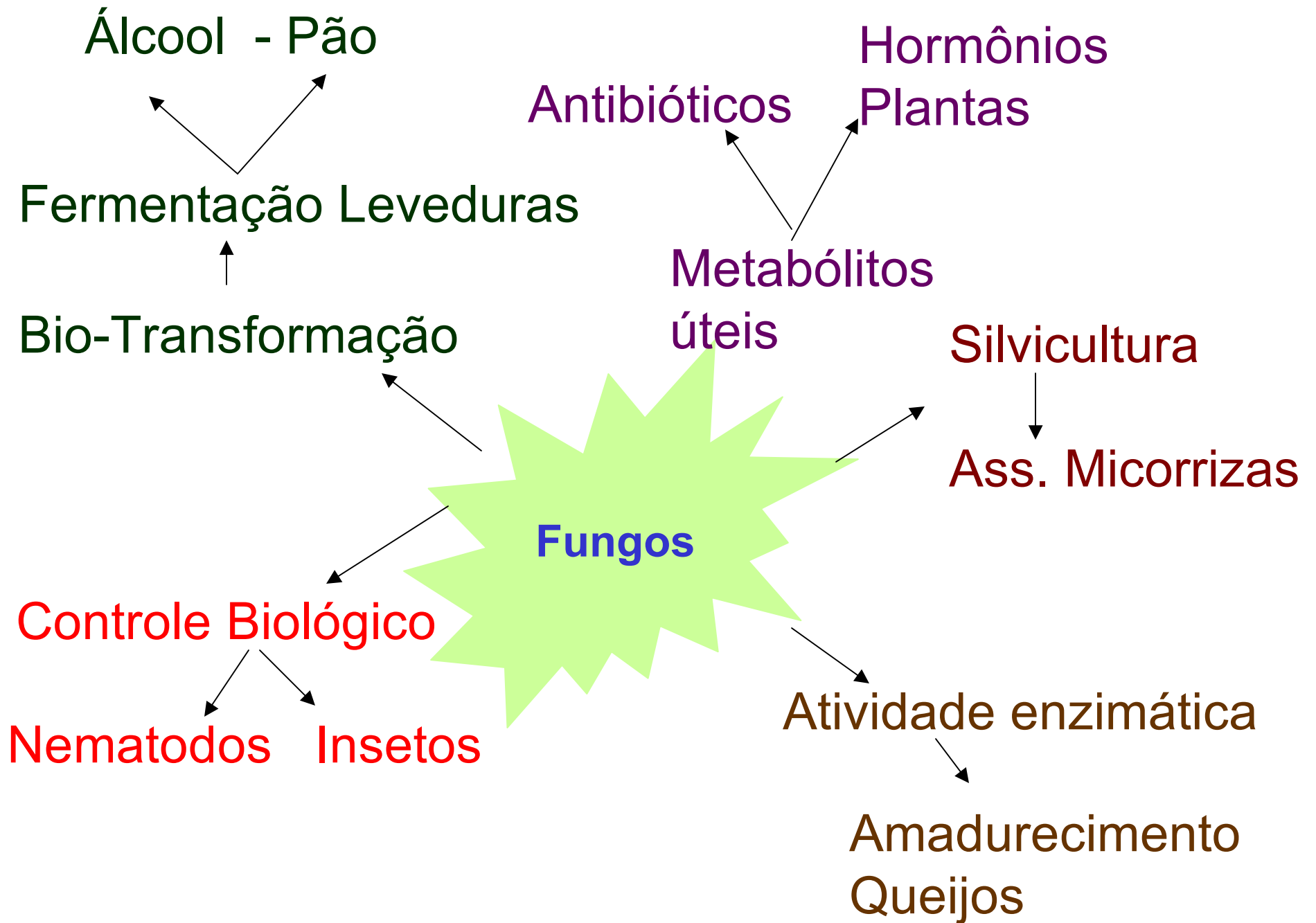


Figure 20.32 Chytridiomycetes. Cells of the chytrid *Batrachochytrium dendrobatidis* stained pink growing on the surface of the epidermis of a frog.

Micotoxicoses

PRODUTOS COM ALTO RISCO DE CONTAMINAÇÃO PELAS PRINCIPAIS MICOTOXINAS

MICOTOXINA	PRODUTO
Aflatoxinas	Amendoim, castanha do Brasil, semente de algodão, farelo de peixe, côco, milho
Alternariol	Sementes de girassol, tomate, sorgo, trigo
Ocratoxinas	Café, milho, cacau, trigo, centeio, aveia e cevada
Zearalenona	Milho
Toxina T-2	Trigo
Patulina	Frutas (maçãs)
Fumonisinias	Milho





Desenvolvimento das mudas *Scutellospora gilmorei* (pimenteira), micorrizadas (FMA) e não micorrizadas (cont) 90 dias após a inoculação. (Elizabeth Ying Chu -Embrapa)

Bioremediação – Bactérias e fungos remoção extratos orgânicos -



Seleção de biodegradadores: (*Mycobacterium*, *Anhtrobacter*, *Nocardia*, *Bacillus* e *Aspergillus*) :Utilização poluentes como fonte de carbono. Metabolização e transformação do poluente em CO₂ e H₂O

Material de Estudo

Brock – Unidade 6 – os fungos

Questões :

→ Que características biológicas permitem reunir os fungos como um Reino à parte?

→ Como o metabolismo fúngico se adequa a sua ecologia?

→ Quais as implicações que os fungos tem para os seres humanos?