

# FUNGOS

Estima-se que existam cerca de 1,5 milhão de espécies  
70 000 espécies descritas  
1000 – 2000 novas espécies por ano  
Classificação em andamento

a grande maioria é terrestre  
a grande maioria filamentosa, alguns unicelulares (leveduras)



**HETEROTRÓFICOS** – secretam enzimas digestivas e absorvem os produtos da digestão

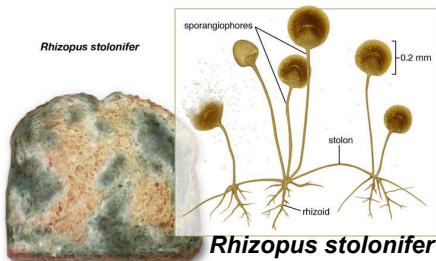
Decompositores – saprófitas (digerem matéria orgânica)

Simbiontes (formigas, plantas, algas eucarióticas, algas procarióticas, bactérias)

Parasitas

Patógenos

- plantas
- animais



# Fungos predadores

- formam alças com suas hifas que contraem por estímulo
- após a captura secretam enzimas digestivas para dentro da presa



Denise Dagnino, LBT, CBB, UENF

# Usos

**alimentação:**

- cogumelos
- fermentação
- flavorizante

**médico:**

- antibióticos
- imunomoduladores

**industrial:**

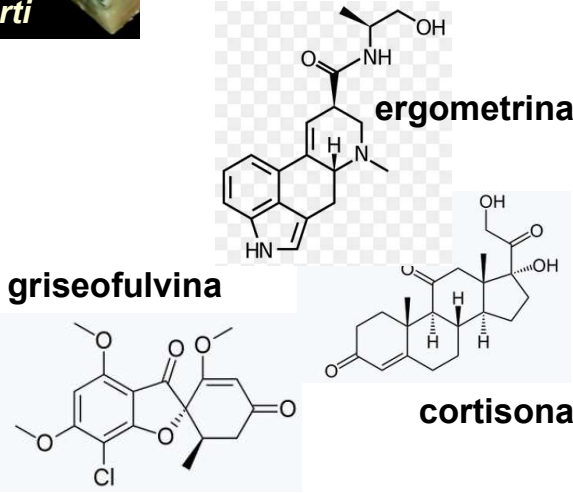
- substâncias diversas
- agrônômico

- micorrizas

- controle biológico

**toxinas:**

- halucinógenos



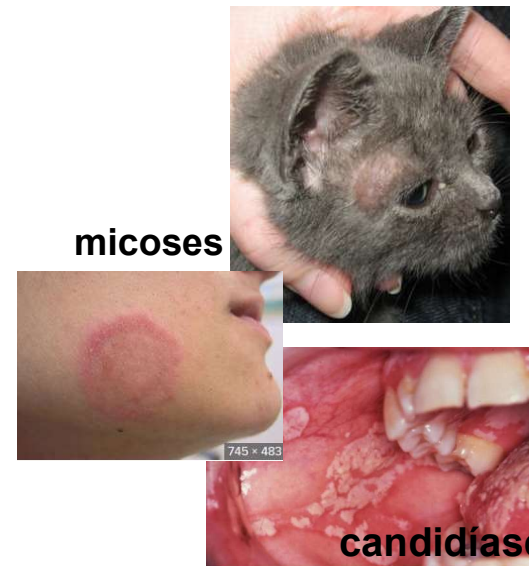
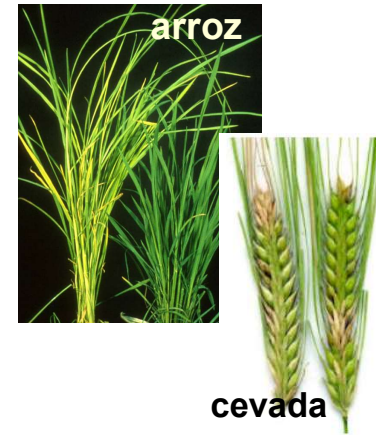
**pragas:**

- ambientes úmidos
- lavoura
  - patógenos
- silagem
  - toxinas

**patógenos de animais:**

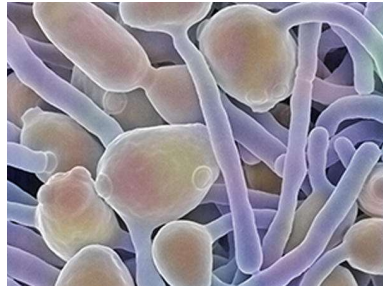
- micoses
- infecções hospitalares

plantas infectadas por *Gibberella*



## Formas de crescimento:

- unicelulares (leveduras, fermento\*)
- filamentosos multicelulares (mofos)
- filamentosos multicelulares macroscópicos (cogumelos)
- mista



### *Candida albicans*

hifas, pseudohifas e levedura



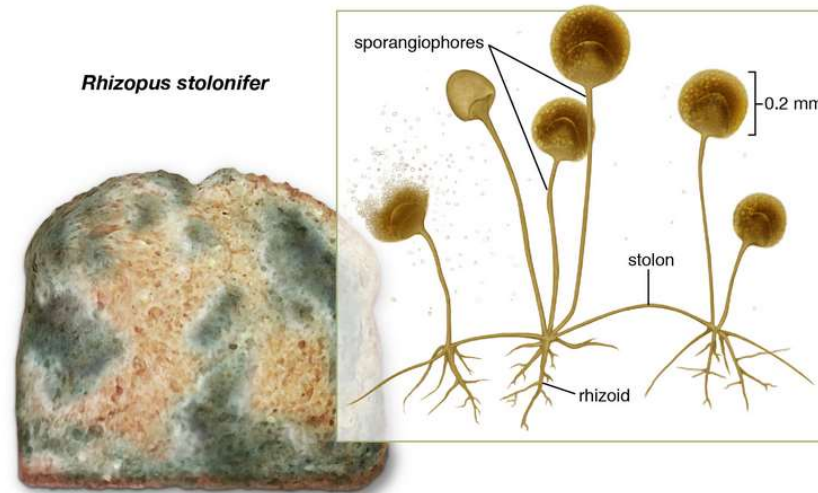
cogumelo  
corpo de  
frutificação



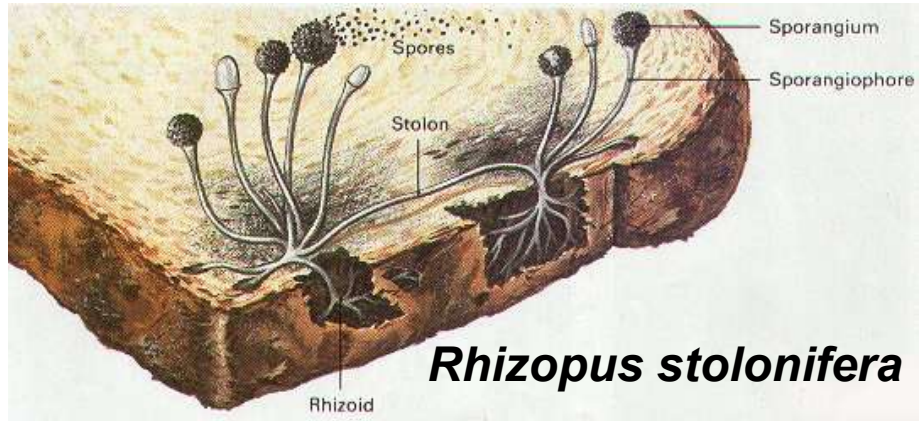
Hyphae



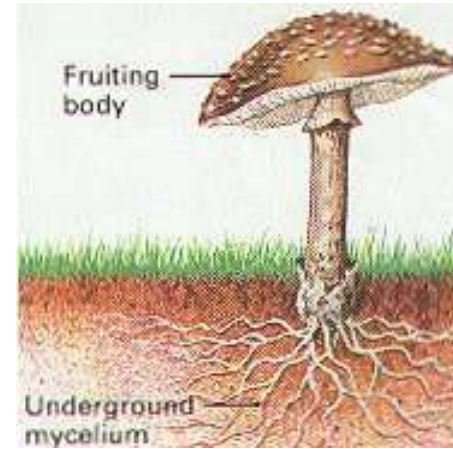
### *Rhizopus stolonifer* mofo



\*[https://www.youtube.com/watch?v=iyWtp\\_L0Kzc](https://www.youtube.com/watch?v=iyWtp_L0Kzc)



[http://www.silverfalls.k12.or.us/staff/read\\_shari/chapter\\_28\\_AB.htm](http://www.silverfalls.k12.or.us/staff/read_shari/chapter_28_AB.htm)

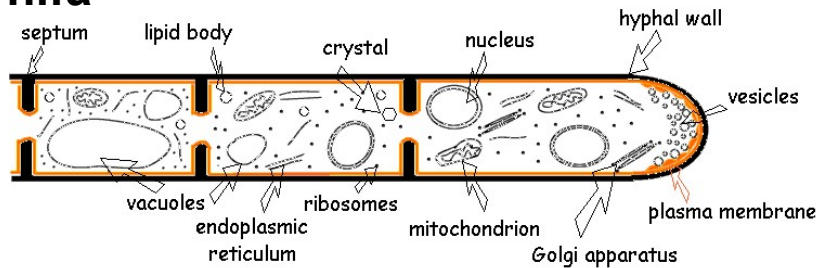




# Hifas e micélios

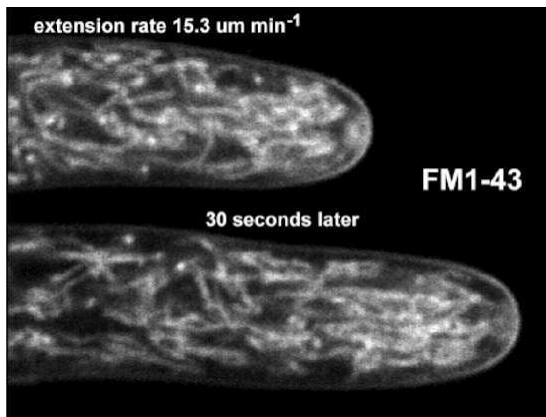
- parede celular rígida de quitina (polímero de N-acetilglicosamina)
- acúmulo de glicogênio
- crescimento e absorção de alimento principalmente na região do ápice da hifa
- umas das formas de reprodução assexuada: fragmentação das hifas

## hifa



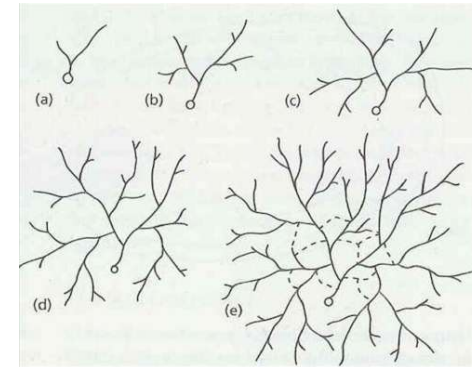
## Tipos de hifas:

- septadas
- asseptadas (cenocíticas)

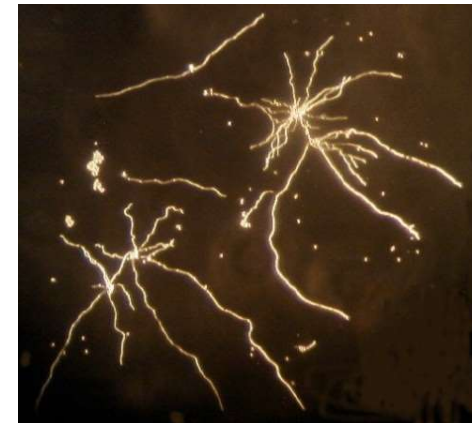


***Neurospora crassa***  
crescimento: 1 mm/h

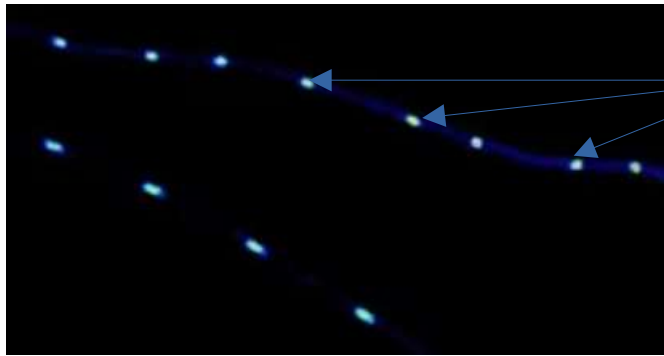
hifas exploram o ambiente na busca de alimento formando um micélio.



estágios de desenvolvimento de uma colônia a partir da germinação de um esporo. Linhas tracejadas representam anastomoses, próximas ao centro da colônia





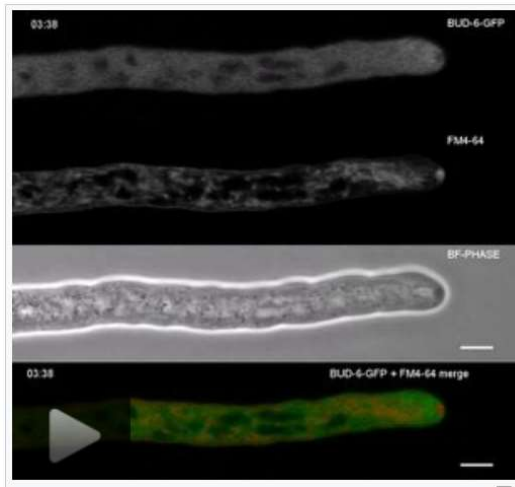
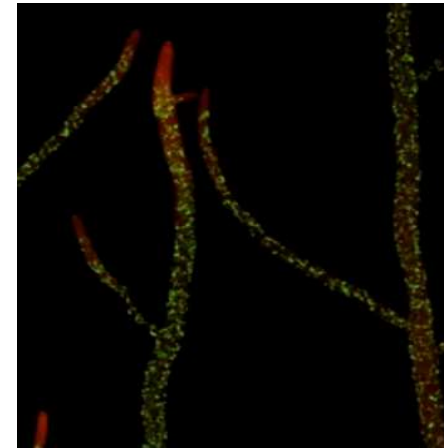


núcleos da hifa

## Time-Lapse: Growing Mycelium of *Neurospora crassa* by Dr. Patrick Hickey

Canal Olympus Life Science

<https://www.youtube.com/watch?v=PbZjET6qQMk>



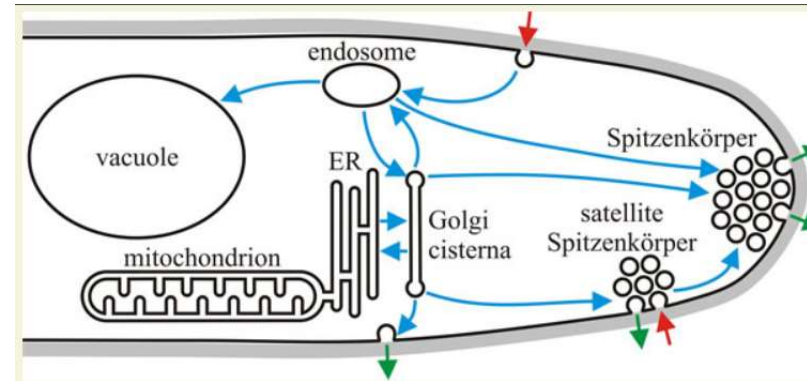
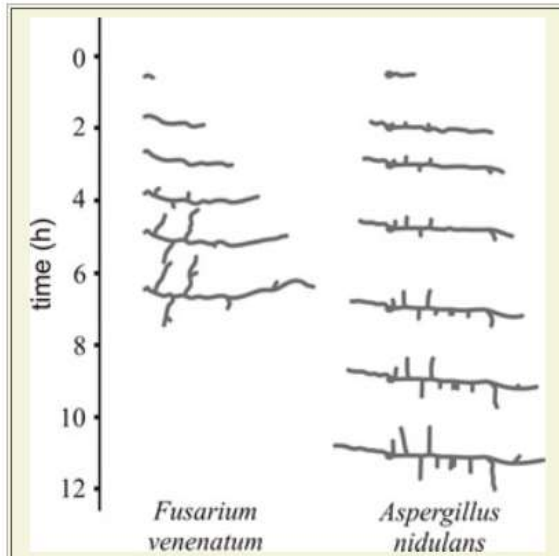
## Spitzenkörper *Neurospora crassa*

<https://commons.wikimedia.org/w/index.php?title=File%3AComparative-Live-Cell-Imaging-Analyses-of-SPA-2-BUD-6-and-BNI-1-in-Neurospora-crassa-Reveal-Novel-pone.0030372.s007.ogv>

Denise Dagnino, LBT, CBB, UENF

# Hifa e micélio

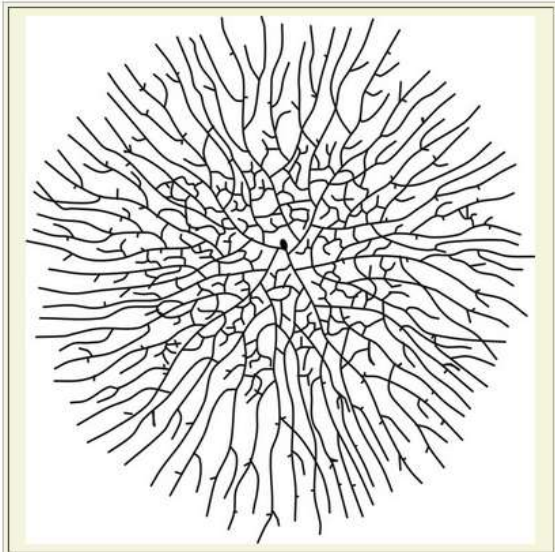
25°C em agar



**Time lapse** drawings showing development of young germlings of *Fusarium venenatum* and *Aspergillus nidulans*. Note that the majority of the first-formed branches are oriented at close to 90° to the long axis of the main germ tube hypha, as new hyphal tips grow directly away from their parent hypha to explore the substratum.

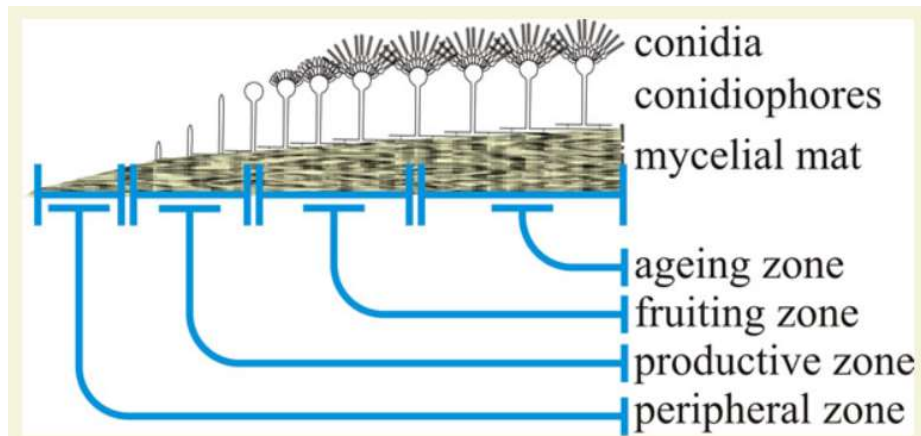
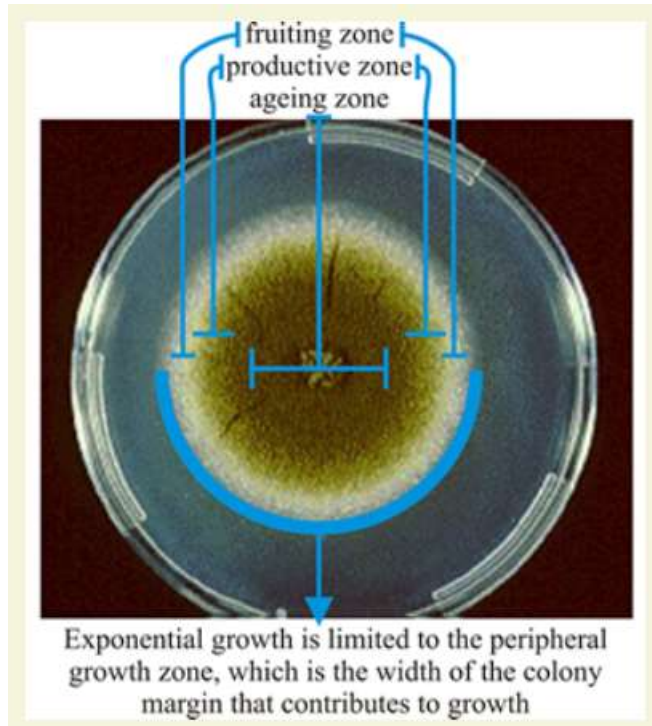
**A maturing fungal colony.** Notice how the growing hyphae are oriented outward into uncolonised regions whilst the production of branches and hyphal fusions centrally ensures the mycelium becomes a network that efficiently exploits available substrate. *Coprinus sterquilinus*, A.H.R. Buller's, *Researches on Fungi* (Buller, 1909-1934).

**a extensão de dá nas pontas das hifas e é sustentada pelo crescimento ao longo de todo o micélio**

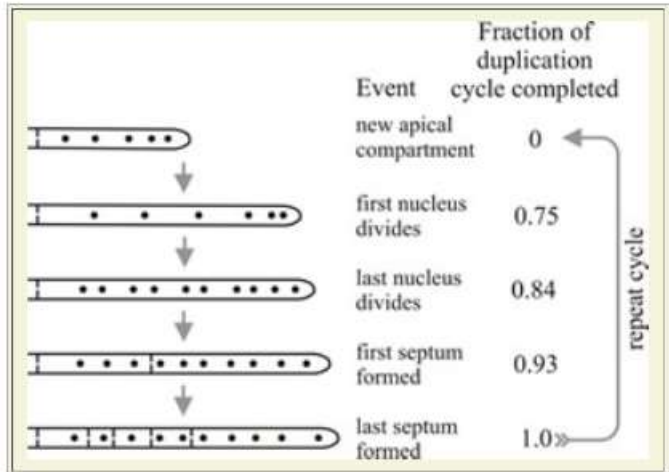


# Diferenciação no micélio

as diferentes zonas da colônia estão em estados fisiológicos específicos



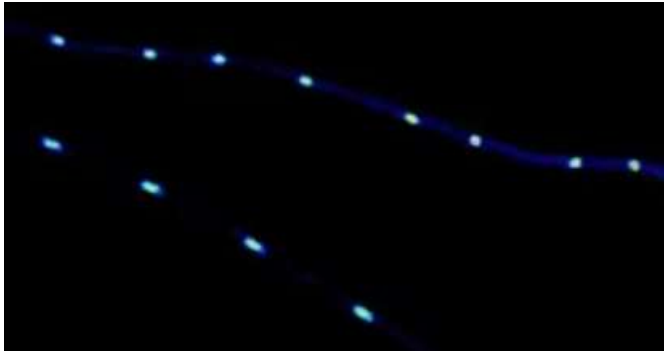
Morphological differentiation of colonies of *Aspergillus* shown in a diagrammatic radial section



etapas:

- extensão da hifa e aumento de volume/núcleo
- divisão aproximadamente síncrona de todos os núcleos
- formação de septos

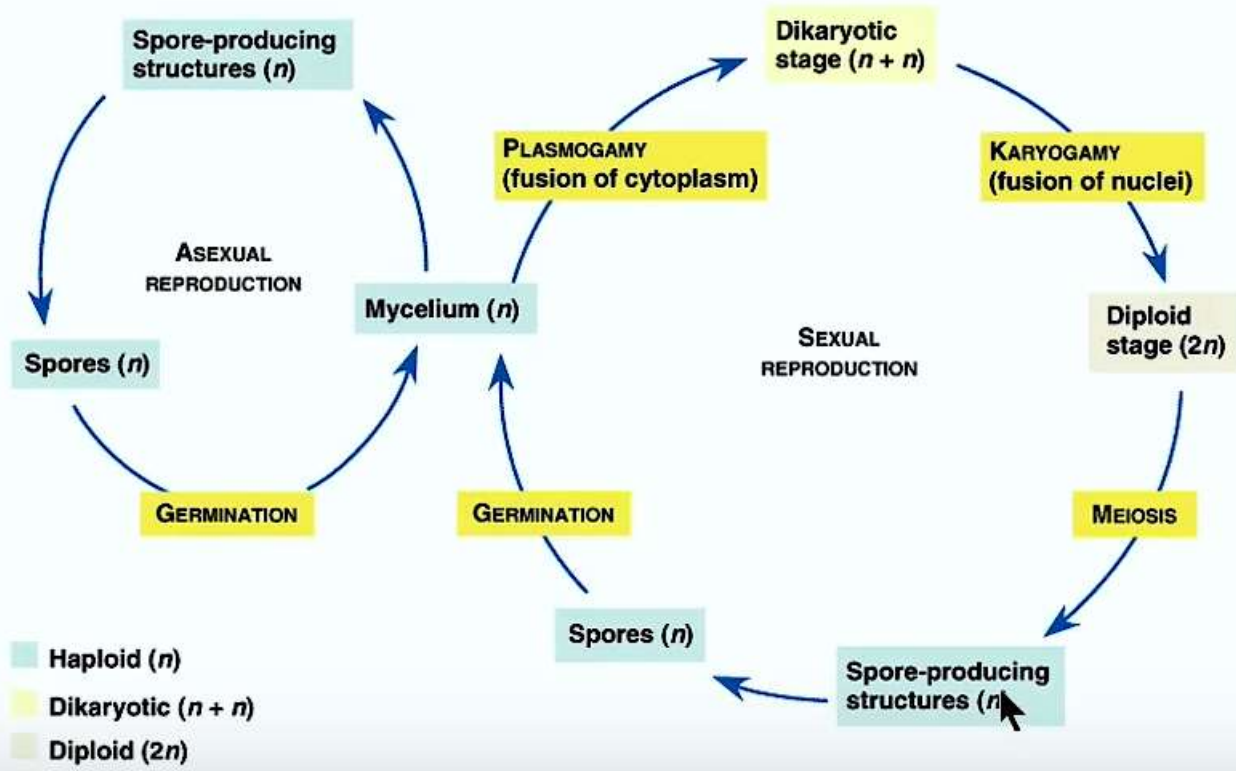
Diagrammatic representation of the **duplication cycle** in a leading hypha of *Aspergillus nidulans* extending at a linear rate on solid medium. On average, completion of a duplication cycle takes 2.1 hours.



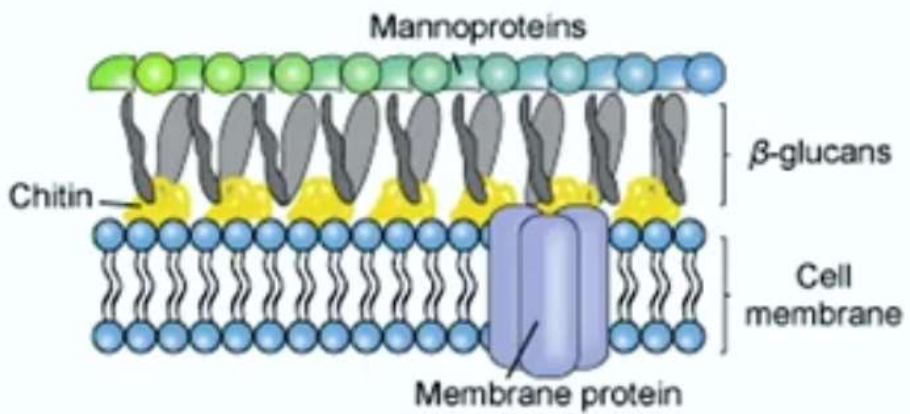
## ***Aspergillus* mitosis Timelapse by Dr. Patrick Hickey**

Canal Olympus Life Science  
<https://www.youtube.com/watch?v=wggx3i3cmd0>

# Ciclo de vida



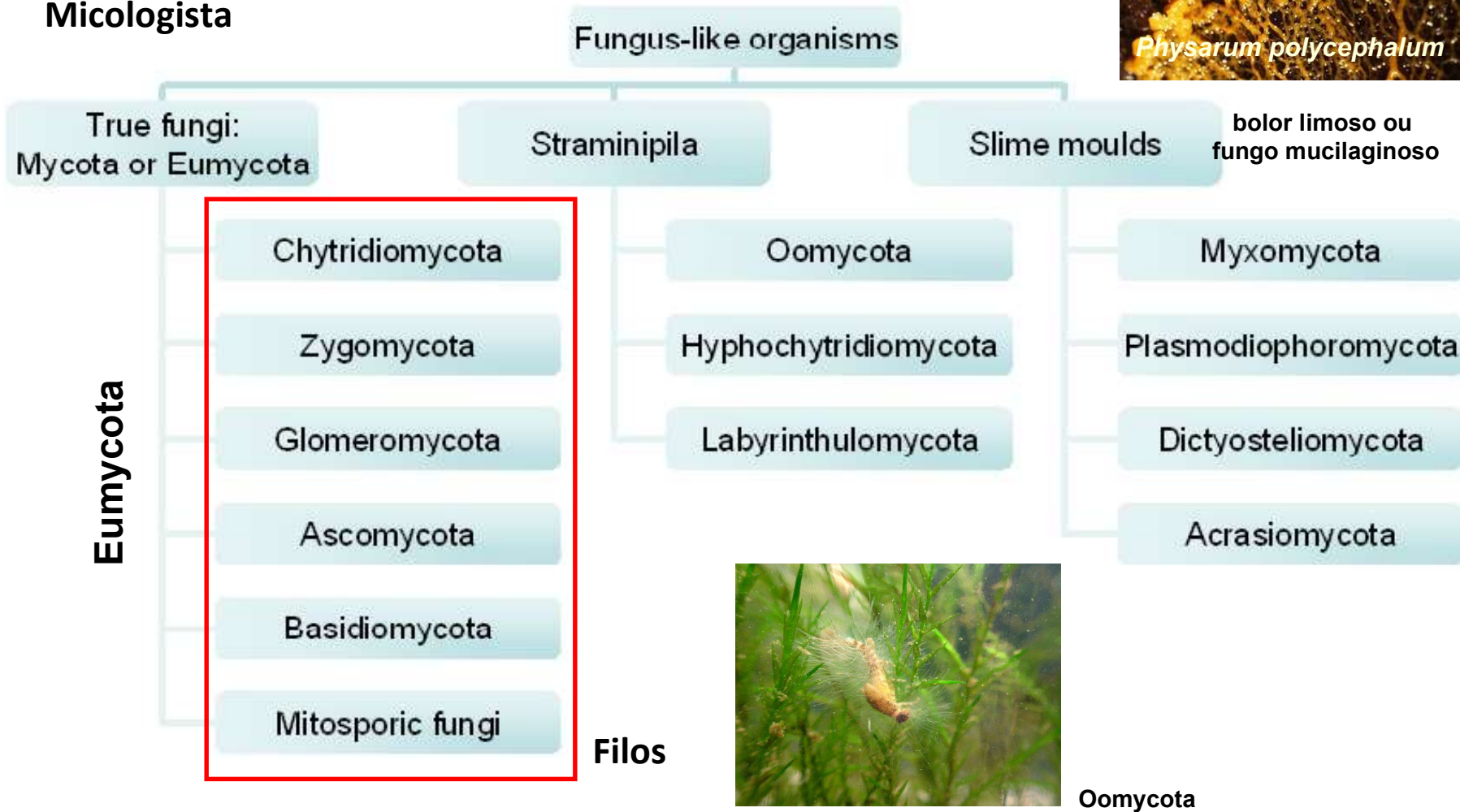
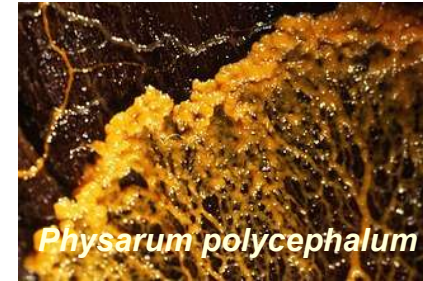
# Pared celular



# Classificação

histórico

Micologia  
Micologista



# Classificação utilizada pelo livro *Biologia Vegetal* (Raven)

**Chytridiomycota**

**Zygomycota**

**Ascomycota**

**Basidiomycota**

**outros**

# Chytridiomycota

- produzem zoóporos
- zoósporos com flagelo único posterior
- alguns produzem gametas flagelados
- NÃO é monofilético

Filogenia molecular:

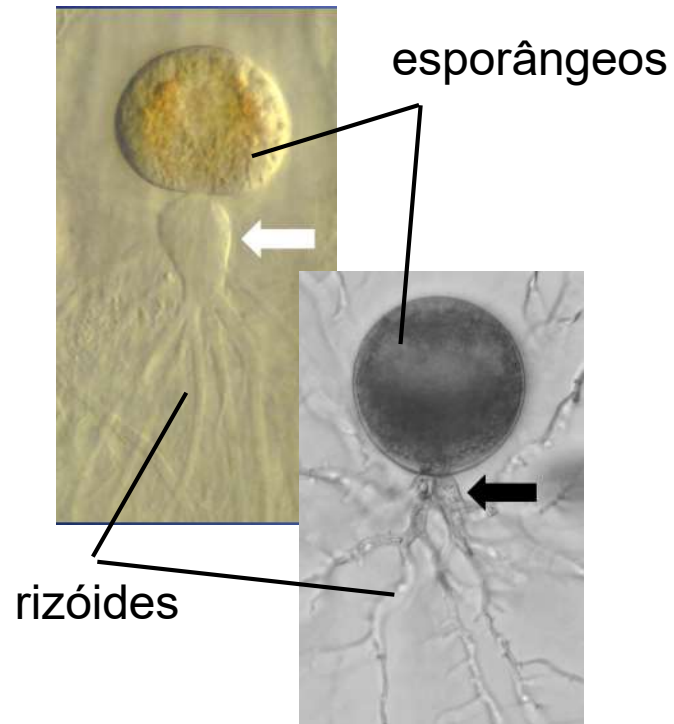
- classe Monoblephridomycetes
- classe Chytridiomycetes

Morfologia não é indicativa de filogenia pois difere:

- no meio ambiente e em cultura
- nos diferentes meios de cultura

Hábitos:

- predominantemente aquáticos
- habitam também solos
- alguns parasitas animais, plantas, protozoários
- patógenos de plantas e anfíbios

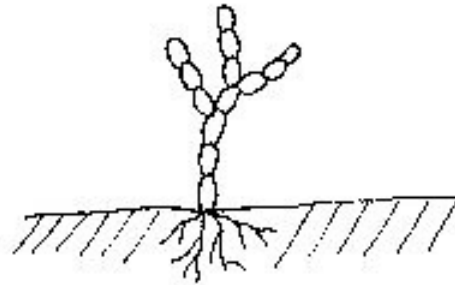
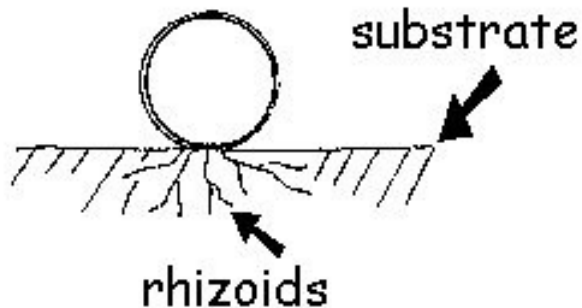




# Chytridiomycota

cerca de 800 espécies  
(o filo NÃO é monofilético)

formas de vida



Fungi belonging to the Chytridiomycota exist as either **single round cells** (unicellular species) or **primitively branched chains of cells**. In either case, the fungus may be anchored to its substrate by structures called RHIZOIDS

Únicos que possuem durante o ciclo de vida células flageladas!!  
(gametas e zoósporos com flagelos posteriores)

ciclos de vida diversos

mais conhecido: Allomyces – alternância de gerações heteromórficas

responsáveis pela morte de  
anfíbios em todo mundo  
**RISCO DE EXTINÇÃO** de  
várias espécies



<https://www.youtube.com/watch?v=7RFK9KNC8FA>

batata



*Synchytrium*

<https://alchetron.com/Synchytrium>

milho



*Physoderma  
maydis*

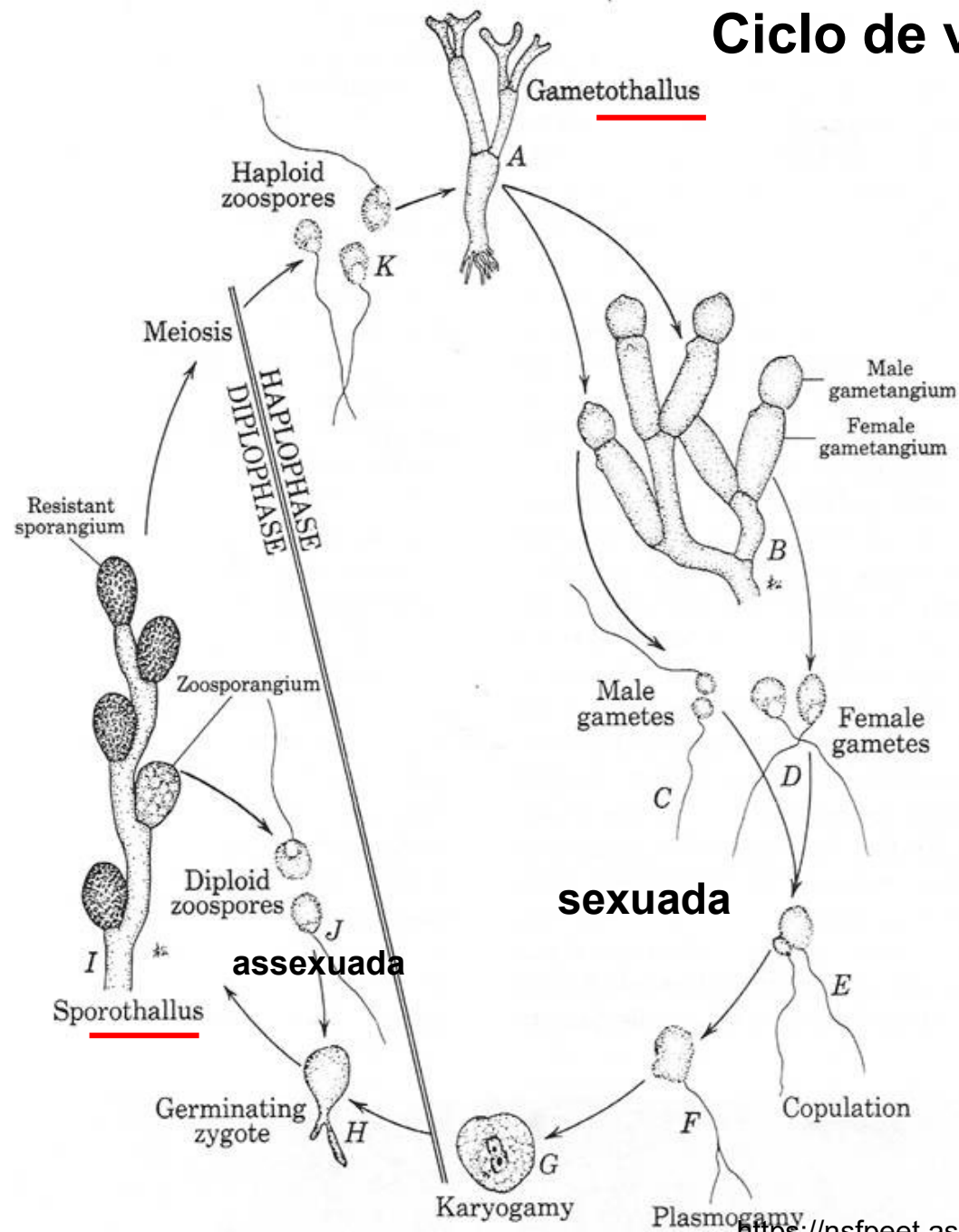
A

B

E.O.SABATO, 2014. Doenças do Milho. SOCIEDADE BRASILEIRA DE FITOPATOLOGIA (SBF)

# Ciclo de vida de Blastocladiomycota

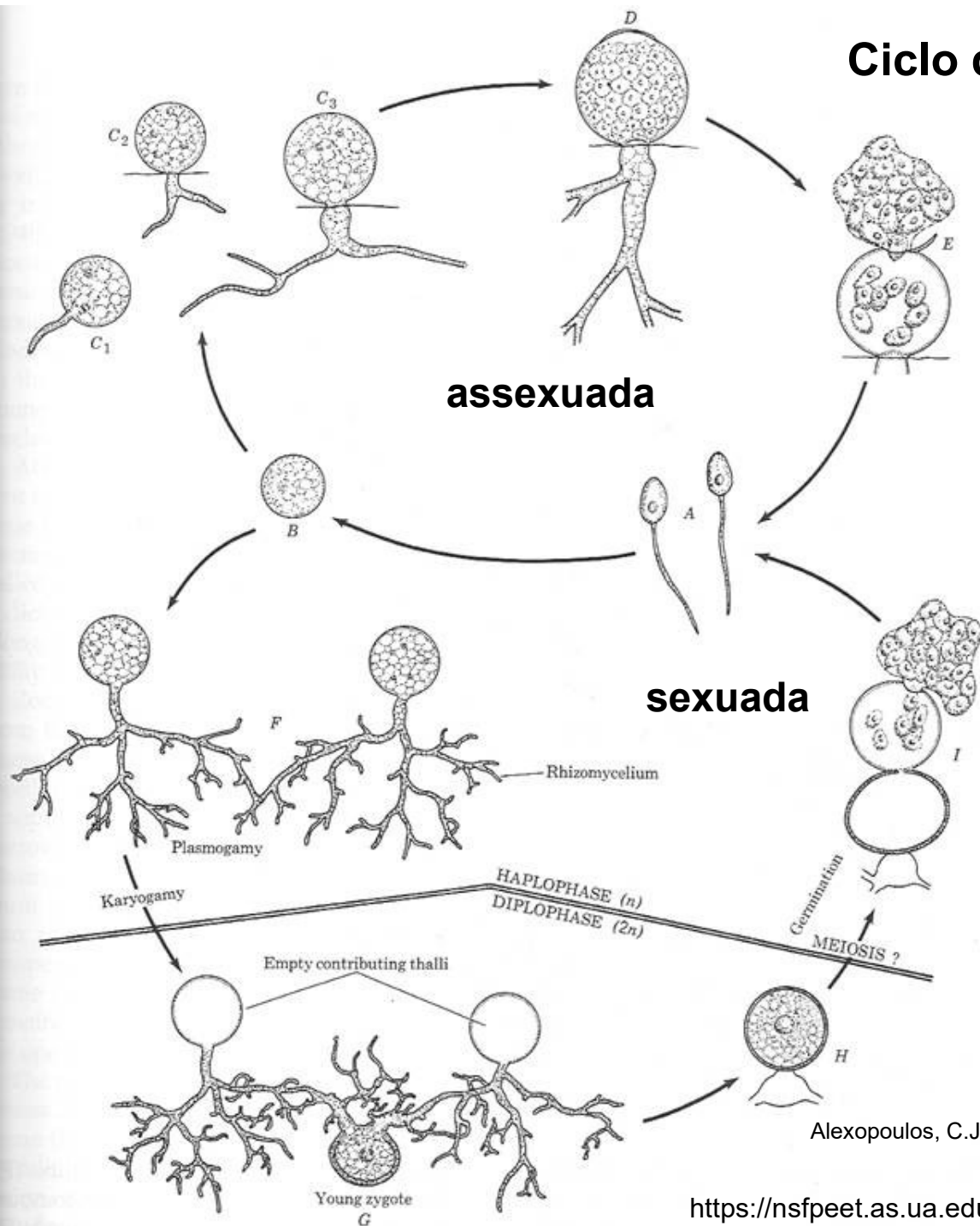
(Alexopoulos *et al.* 1996)



alternância de:  
 •gametotalo  
 •esporotalo

**Allomyces arbuscula**  
 gerações formando cadeias  
 ramificadas de células

# Ciclo de vida de Chytridiomycetes (Alexopoulos *et al.* 1996)

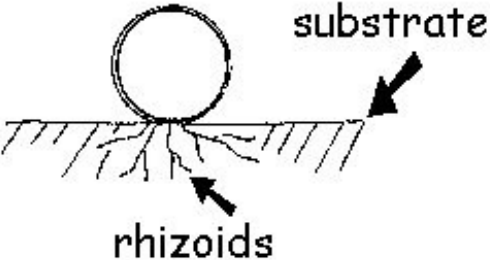


plasmogamia  
e  
cariogamia  
ocorrem em tempos diferentes

Alexopoulos, C.J., C.W. Mims, and M. Blackwell. 1996. *Introductory Mycology*. 4th edition. Wiley, NY. 868 pgs

<https://nsfpeet.as.ua.edu/Teaching%20with%20Basal%20Fungi%20lab.htm>

# Germinação do zoósporo



Rabern Simmons, PEET trainee, University of Maine  
Mycological Society of America Annual Meeting (2009)

Denise Dagnino, LBT, CBB, UENF

# Zygomycota

o filo NÃO é monofilético

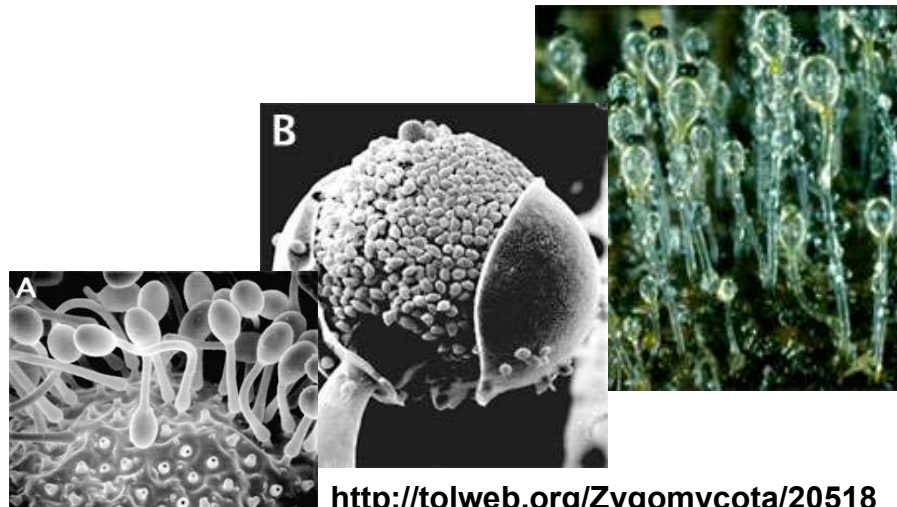
- representam cerca de 1% dos fungos (cerca de 1500 espécies)
- terrestres ou aquáticos sendo que muitos passam despercebidos
- habitam o trato intestinal de certos artrópodos
- patógenos de animais, plantas, amebas e mesmo de outro fungos
- hifas cenocíticas
- não formam corpos de frutificação



distinguidos dos demais fungos devido à formação de zigospórângios e zigósporos durante a reprodução sexuada

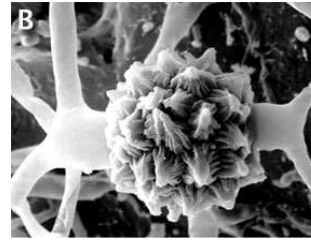
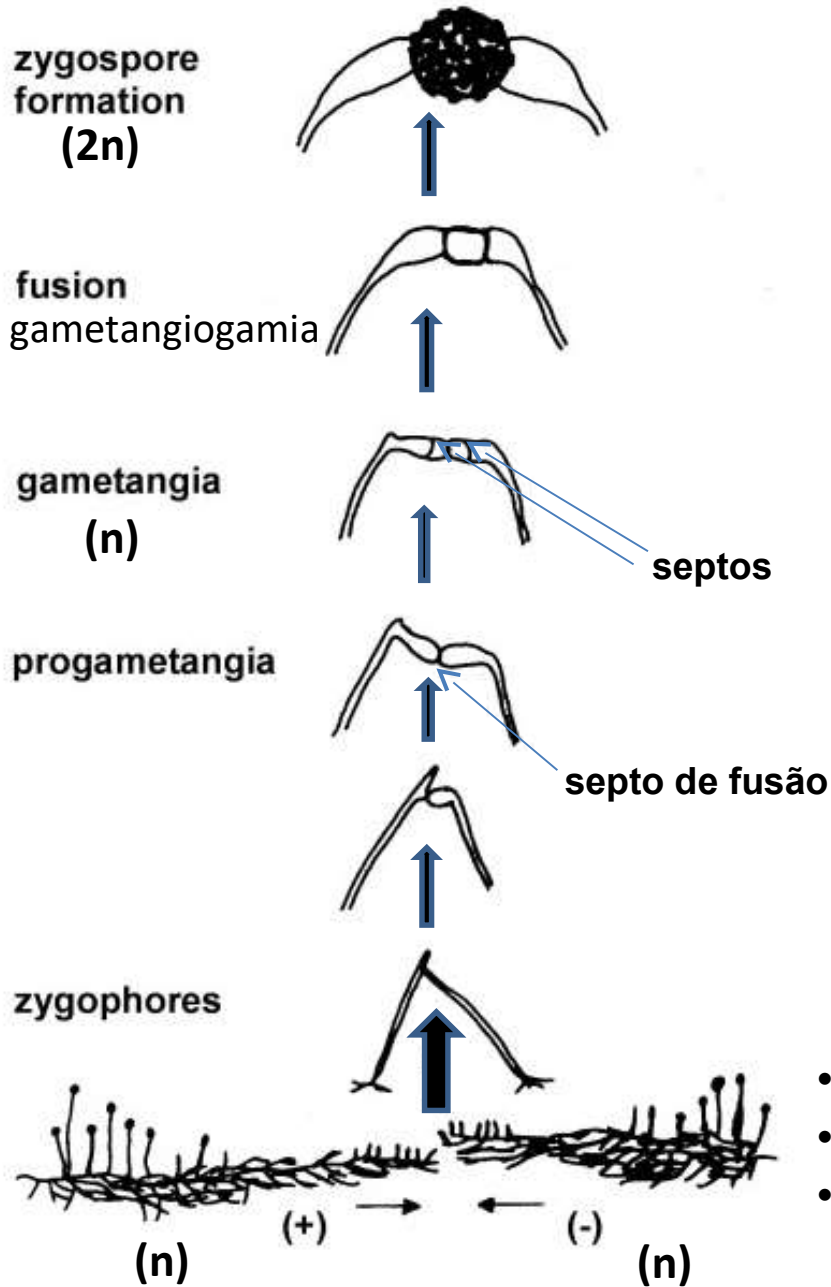
digestão de amido

Ordens mais proeminentes:  
Mucorales  
Entomophorales

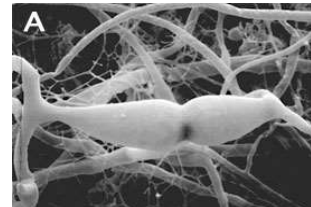
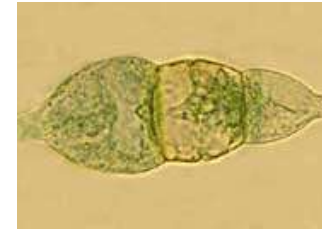
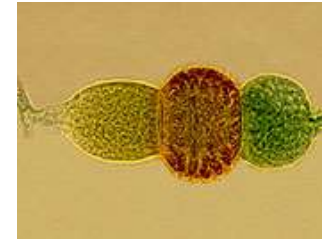


<http://tolweb.org/Zygomycota/20518>

# Formação do zigósporo



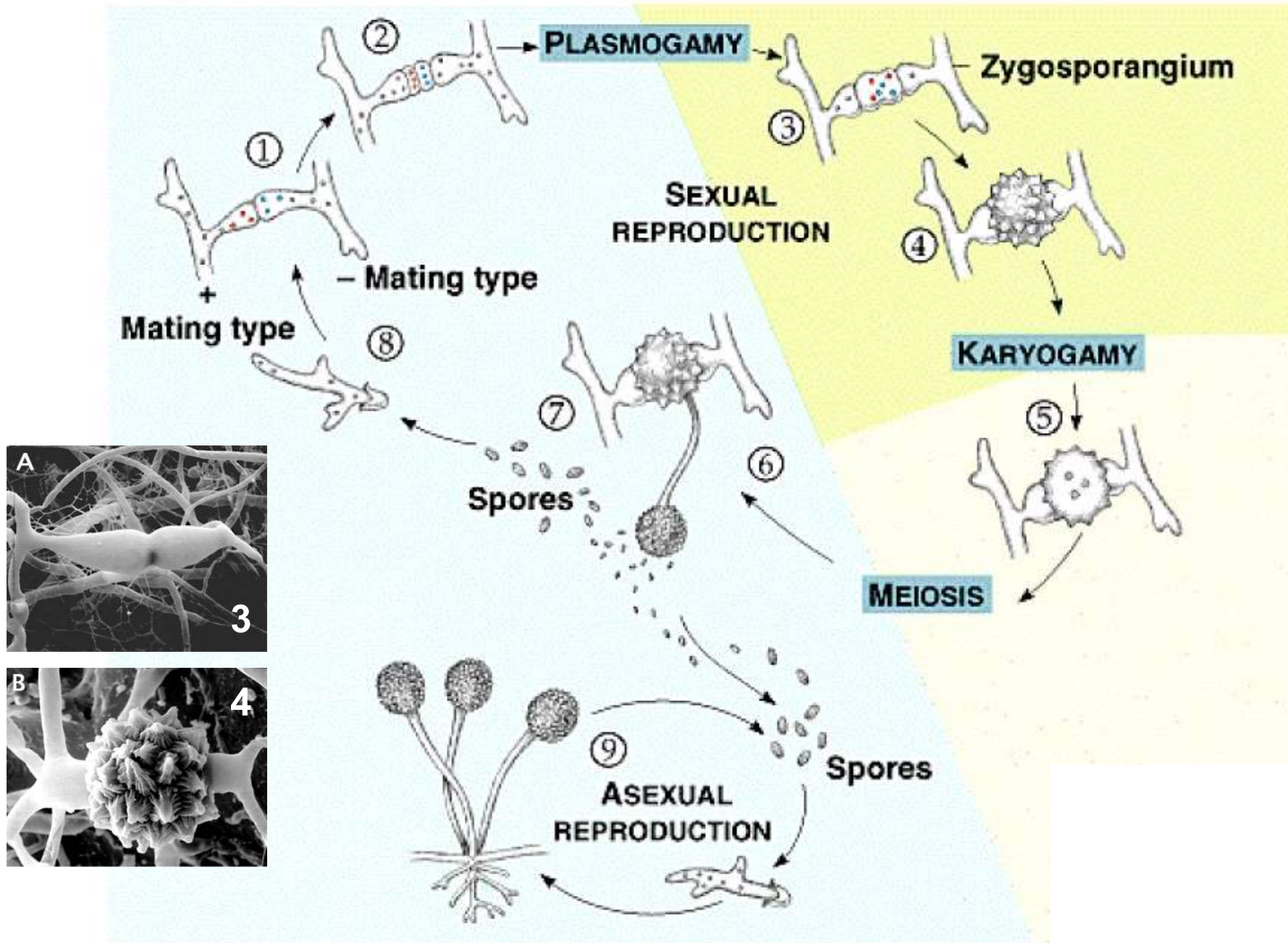
(2n)



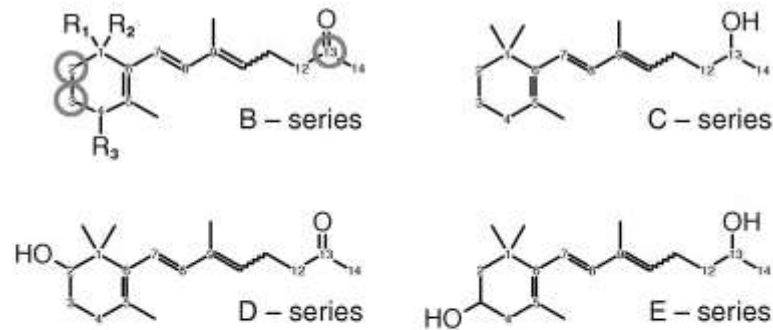
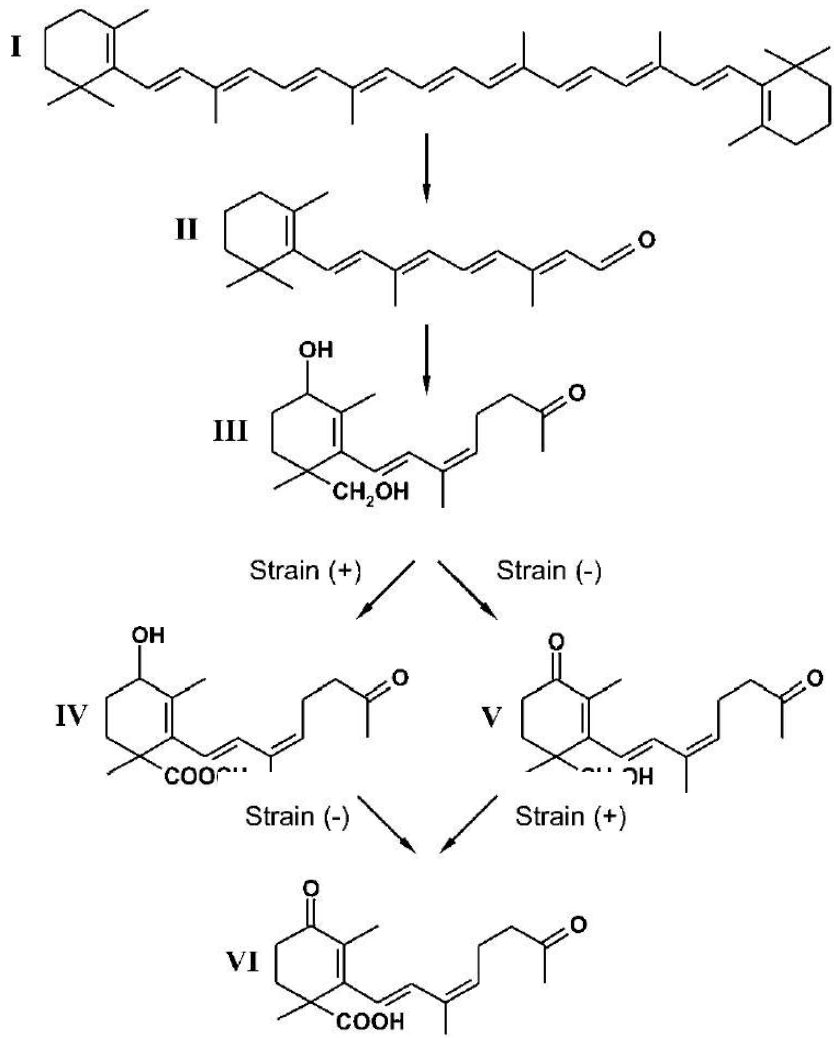
(n)

- única fase diplóide do ciclo de vida é o zigósporo
- zigósporo tem uma fase de dormência obrigatória
- meiose ocorre durante a germinação

Figure 28.3 The life cycle of the zygomycete *Rhizopus*







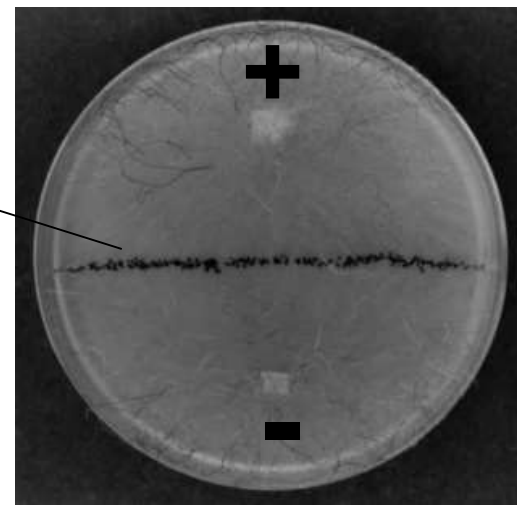
4-dihydrotrispোরin:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{CH}_3$ ;  $R_3 = \text{OH}$   
 trispোরin:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{CH}_3$ ;  $R_3 = \text{O}$   
 trispোরol:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{CH}_2\text{OH}$ ;  $R_3 = \text{O}$   
 trispোরic acid:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{COOH}$ ;  $R_3 = \text{O}$   
 4-dihydrotrispোরic acid:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{COOH}$ ;  $R_3 = \text{OH}$   
 methyltrisporate:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{COOCH}_3$ ;  $R_3 = \text{O}$   
 4-dihydromethyltrisporate:  $R_1 = \text{CH}_3$ ;  $R_2 = \text{COOCH}_3$ ;  $R_3 = \text{OH}$

trispোরoides – estrutura geral

**biossíntese colaborativa do ácido trispórico com liberação de intermediários para o meio**

Denise Dagnino, LBT, CBB, UENF

zigósporos



Schimek 2009, Phytochemistry

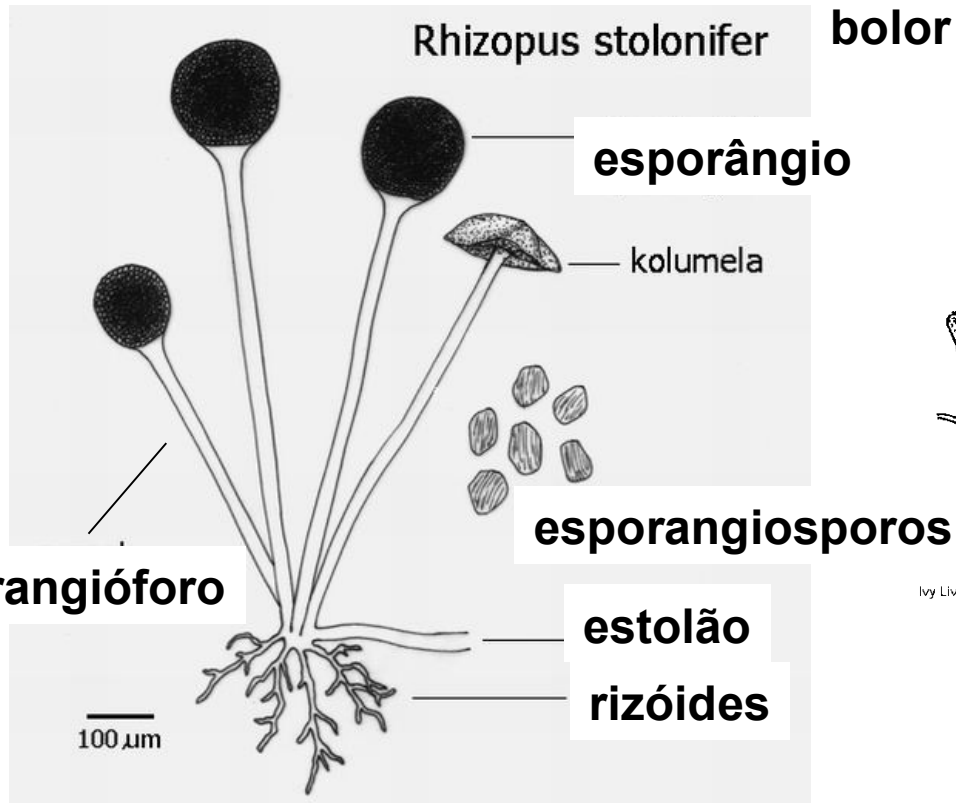
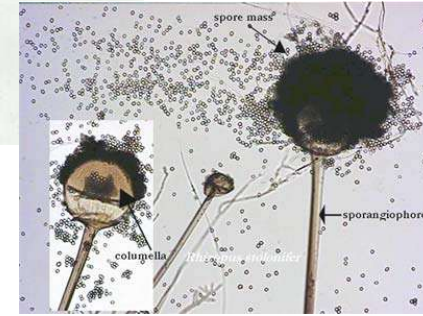
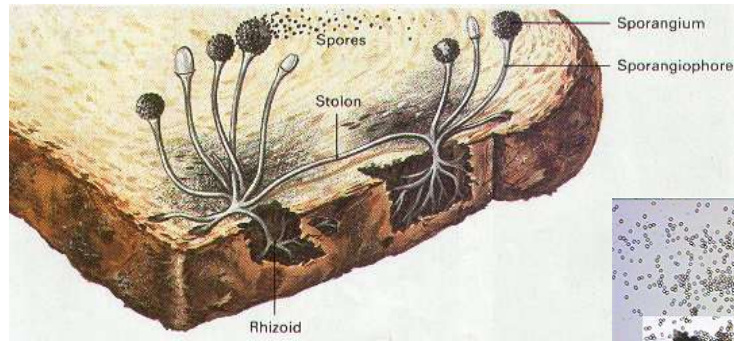
# ZYGOMYCOTA

## Muscorales

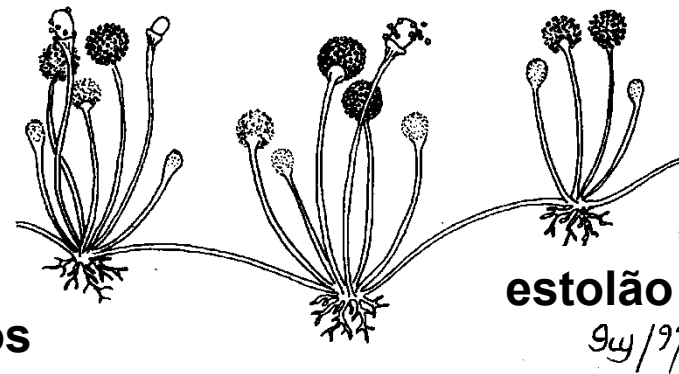
hifas cenocíticas

anastomoses raras

parede celular de quitina e quitosana



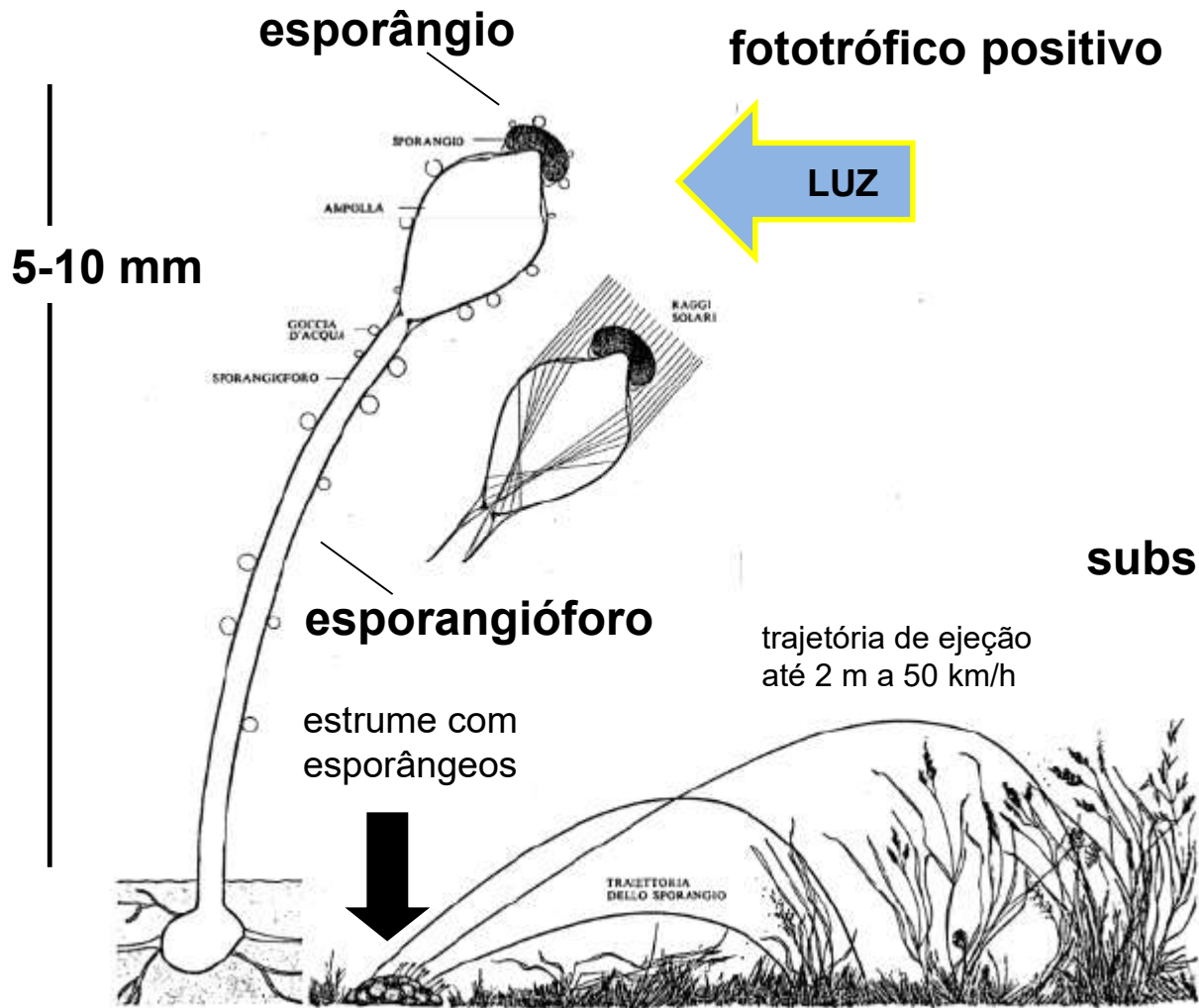
bolor no pão



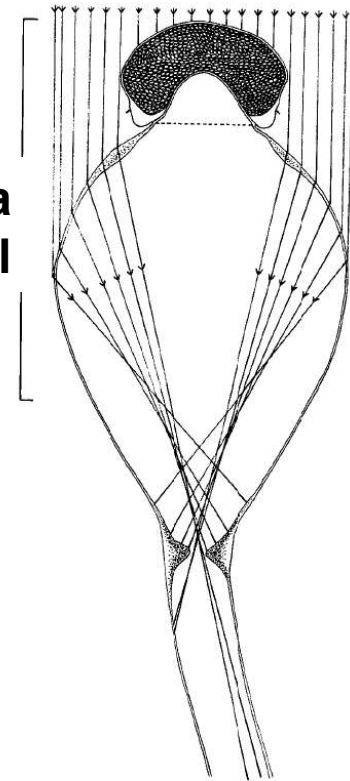
Ivy Livingstone ©BIODIDAC

esporangiolos e merosporângios

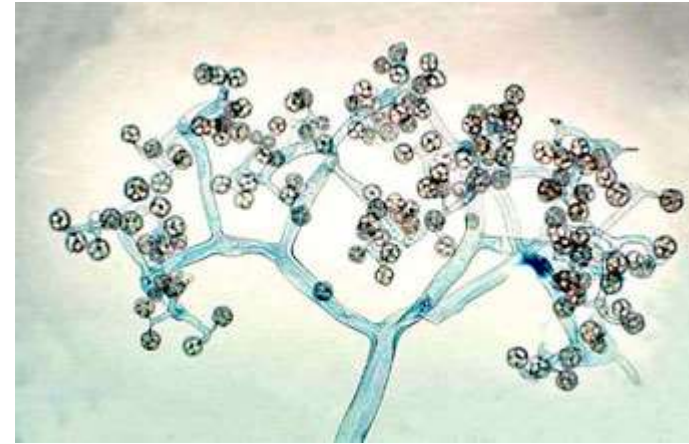
# Pilobolus



vesícula subsporangial

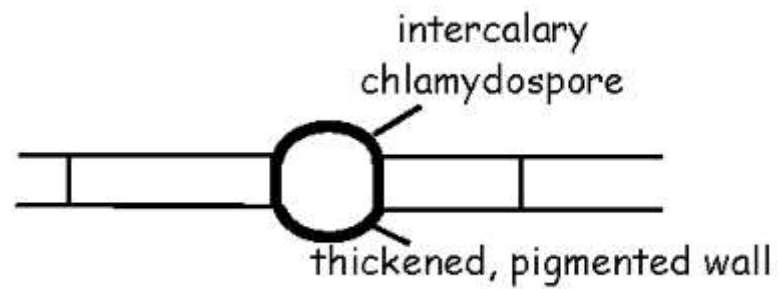
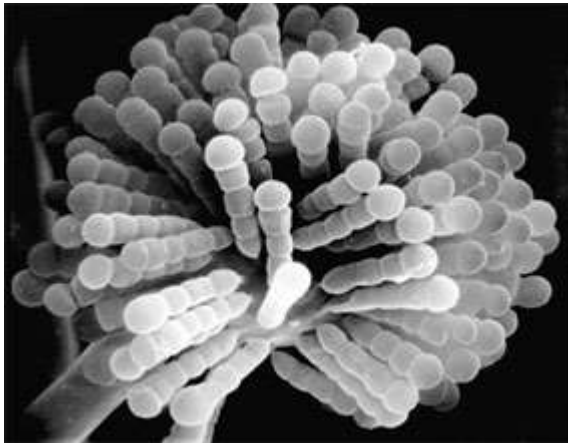


# Outros tipos de esporângeos



esporangiólos

meroesporângeos



Coleta e identificação de cogumelos

Fresno Mycology Society - <https://www.youtube.com/watch?v=xXCVgRYIT4g>

Pilobolus – velocidade de liberação dos esporos

- <https://www.youtube.com/watch?v=T8OAmcUnm4g>

- <https://www.youtube.com/watch?v=b646LTmzTu8>

Fungos da Austrália

<https://www.youtube.com/watch?v=8tGXFZmndCY>

Naturalistas – muitos musgos e samambaias nesta busca por fungos!

Mushroom wonderland: [https://www.youtube.com/watch?v=H\\_xOEbWogU4](https://www.youtube.com/watch?v=H_xOEbWogU4)

Comunidade de registro e identificação de seres vivos

<https://www.inaturalist.org/>

Vídeo - História e evolução: Fungus: The 3rd kingdom -

[https://www.youtube.com/watch?v=ZGEdHxiWo\\_Y](https://www.youtube.com/watch?v=ZGEdHxiWo_Y)

**Livro:** 21st Century Guidebook to Fungi, SECOND EDITION

by David Moore, Geoffrey D. Robson and Anthony P. J. Trinci

[http://www.davidmoore.org.uk/21st\\_Century\\_Guidebook\\_to\\_Fungi\\_PLATINUM/](http://www.davidmoore.org.uk/21st_Century_Guidebook_to_Fungi_PLATINUM/)

index.htm