3 Major Clades - Subphyla - of the Basidiomycota

**Agaricomycotina**
mushrooms, polypores, jelly fungi, corals, chanterelles, crusts, puffballs, stinkhorns

**Ustilaginomycotina**
smuts, *Exobasidium, Malassezia*

**Pucciniomycotina**
rusts, *Septobasidium*
Ustilaginomycotina (Ustilaginomycetes)

Ustilaginomycetes
  Urocystales
  Ustilaginales
Exobasidiomycetes
  Exobasidiales
  Malasseziales
  Tilletiales
Entorrhizomycetes

simple septum with septal pore cap, not like the dolipore septum with parenthosome of Agaricomycotina
Subphylum Ustilaginomycotina- smuts and relatives
Ustilaginomycetes
About 1500 species, 50 genera
Parasitic on about 4000 spp of angiosperms, 75 families
Economically important pathogens of cereals

Corn smut *Ustilago maydis*
Oat smut *U. avenae*
*Tilletia* spp. “smuts and bunts”
General life cycle of Ustilaginomycetes

Alternate between **saprobic**, monokaryotic yeast and **phytoparasitic**, dikaryotic filamentous phases
**Ustilaginaceae-smuts**

- mating between monokaryotic spores
- no specialized mating structures
- unifactorial and bifactorial mating systems
- monokaryons nonparasitic, saprobic
- dikaryon phytoparasitic
- heterothallic- mating of compatible spores
- dimorphic- yeast and filamentous phases
- teliospores
teliospores germinate, give rise to a short germ tube of determinate growth called the promycelium.

Promycelium: site of meiosis formation of sporidia
Corn smut, Ustilago maydis
Life cycle of *Ustilago maydis*

Yeast stage, monokaryon persists in soil as saprobe

Teliospores germinate to produce monokaryotic sporidia, equivalent to basidiospores
Monokaryotic sporidia can grow indefinitely as a budding yeast phase.

The filamentous, plant parasitic phase requires dikaryon formation.
Mating compatibility in *Ustilago maydis* is **bifactorial**
Two loci, a and b
Locus a controls mating pheromones (peptides and receptors)
Locus b controls dikaryon formation, hyphal growth
Compatible mating between two sporidia results in infection hypha
The dikaryotic infection filament forms appressoria allows fungus to grow into the plant.

Masses of teliospores develop in infected host tissue.
Galls form in the infected ovaries of the flowers and form masses of teliospores
Life Cycle of *Tilletia*
Life cycle of *Tilletia tritici* -- ‘stinking smut’
*Tilletia* (smut) teliospores form in large masses, sori, in developing flower heads of grasses.

The teliospores of Ustilaginomycetes functions as a dispersal propagule.
When bunt balls go through the harvester...
Mating of primary sporidia of Tilletia
Microbotryales

Formerly classified with the Ustilaginomycetes but shown to belong to Pucciniomycetes (rusts) based on DNA sequence data. Have teliospores and life cycle that are very similar to smut teliospores and life cycle.

Anther smut  
*Microbotryum violaceum*

Teliospores transported by pollinating insects to uninfected plants  
fungus grows systemically
Exobasidiomycetes - Exobasidium

Form a thin, superficial layer on leaves and stems of Rhododendron, Azalea, Vaccinium spp.
Exobasidium

Formerly classified in Hymenomycetes
thought to be a primitive Hymenomycete, reduced hymenium
No teliospores, basidia resemble holobasidia
Connected to Ustilaginomycotina by DNA sequences
Leaves of host plants form galls with thin fungal layer
Exobasidiomycetes - Malasseziales
Malasseziales

Yeasts related to Exobasidiomycetes, *Exobasidium*
Monokaryotic, sexual phase unknown
Lipophilic yeasts
Dikaryotic phase unknown
Superficial dermatomycoses of mammals
Malassizia is an important veterinary fungus
Causes skin irritation of dogs, goats, sheep

West highland terrier is a breed that is highly susceptible to Malassezia dermatitis
Human pathogens in Basidiomycota

Malassezia--Ustilaginomycotina

*Cryptococcus*, (teleomorph *Filobasidiella* Agaricomycotina)
Related to Tremellales (jelly fungi)
Cryptococcosis, 2\textsuperscript{nd} most important AIDS related disease in Africa
*C. neoformans* a common soil yeast
often a harmless lung infection, but can cause fungal meningitis
*Cryptococcus neoformans* (Filobasidiella)  
Related to Tremallales (jelly fungi)

A basidiomycetous yeast associated with pulmonary infections meningococcal disease, fungus attacks nervous system tissue, also skin, bones

Formerly rare, an increasingly common disease in AIDS and organ transplant patients

Yeast cells are encapsulated in a carbohydrate capsule  
Common inhabitant of bird droppings, e.g. pigeons, common in urban environments

Encapsulated cells  
C. neoformans in lung tissue
Cryptococcus gattii

A species of *Cryptococcus* introduced to the Pacific Northwest?
Found in soil and bark of many native trees
Recent cluster of reports of C. gattii infections in humans and animals ~215 since 1999

Prior to 2000, distribution of *C. gattii* thought to be only tropical, associated with *Eucalyptus* in Australia

First reported on Vancouver Island in 1999
several cases from Oregon and Washington
affects immunocompetent individuals
contracted by inhalation of spores
pulmonary and central nervous system
disease
predisposing factors include steroid therapy, lung disease

also several veterinary cases reported, dogs and cats and marine mammals
Distribution Map of Human and Animal Cryptococcosis in BC by Place of Residence 1999-2006*
Cryptococcus gattii, an emerging fungal pathogen in the PNW

Human cases from Vancouver Island, San Juan Islands and Seattle Area

First cases from Vancouver Island in 2000s but retrospective analysis confirmed C. gattii from 1970s in Seattle
20 cases in Oregon confirmed since 2004

Genotype of C. gattii in Oregon is different from the VI strain

Animal cases include dogs, cats, ferrets, llamas, porpoises, 1 horse, 1 parrott