

# Sample questions based on lectures and labs in Diversity of Plants and Fungi

## Exam-type questions for PMB102/IB101 Fungi

These questions are examples of the type that will be asked on exams. I cannot promise that they will be the exact questions, but they will be similar. On exams, there will be some questions requiring diagrams with labels, some questions about the nuclear condition of fungi (haploid, diploid or dikaryotic;  $n$ ,  $2n$  or  $n+n$ ), and some short answer questions. I am particularly fond of questions that combine information from several different fungi; you should design some of these yourself.

## Introduction and Summary -- These questions may not make sense until the final lecture.

It is important to keep the big picture in mind. How many years ago did the radiation of higher eukaryotic groups occur?

In what other type of life, or associated with what other type of life, was the first fossil fungus found? What was the likely ecological role of this fungus? How old was the fossil?

In the big radiation of higher eukaryotes what groups were involved?

From the perspective of fungi, what large group is their nearest relative?

How does the human life cycle compare to that of each fungal group? Which one is most similar? Is it in the kingdom Fungi?

How do fungi contribute to the cycling of carbon? With what substrates and in what locations are fungi most useful in this cycle?

There are three "life styles" that fungi adopt to obtain chemical energy from the biosphere; what are they? What is the ultimate source of nearly all of this chemical energy?

When you see a mushroom, you are seeing only one of three important parts of the whole fungus. What are the other two parts?

Describe the form of the basic unit of most fungal vegetative and reproductive thalli. Where does growth occur?

How does a fungus obtain food from the substrate? What is exported and what is imported?

How is fungal nutrition similar to animal nutrition? How is it different?

Discuss three genera from different phyla (division) of fungi that are mycorrhizal and have hypogeous fruiting bodies. What features do they have in common?

How do fungi move long distances? Tell me about fungi with spores that are self-propelled, shot, carried by elements, carried by animals.

Compare chitin to cellulose.

Every plant has fungal parasites. Why don't we notice most of them? What conditions make us take notice?

How do fungi communicate? Can you think of specific examples from each phylum?

What is a biological assay? Give me an example of one.

## Basidiomycota

What features do Basidiomycota have in common with other fungi?

What are the evolutionary lineages in the Basidiomycota?

Which lineage has fruiting bodies? What is a basidioma?

Which lineages lack fruiting bodies?

What is a teliospore? How does it function?

Diagram the generalized basidiomycete life cycle. Be sure to include nuclear condition and nuclear behavior. What nuclear condition is dominant in the basidiomycetes? How does this life cycle compare to that of ascomycetes?

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What feature of some basidiomycete hyphae might remind you of croziers? Compare the two types of structures.

Asci are variable and so are basidia. Describe the several types of basidia. Be sure to comment on septa formed following meiosis.

Describe the basidiocarp of *Tremella*, including the form and development of the basidia and germination of basidiospores.

Do the same for *Dacrymyces*. What is interesting about the basidia of this fungus and all the members of its order, *Dacrymycetales*?

Describe fruiting body development in *Phallus*. How are the basidiospores dispersed?

What do basidia of *Phallus* and *Ustilago* have in common?

Why does the cap of *Coprinus* autodigest?

## Ascomycota

What is the morphological hallmark of the Ascomycota?

In terms of numbers, how important are the ascomycetes to the fungi?

What are the three main phylogenetic lineages of the Ascomycota?

It has been said that yeast is the most famous fungus. Can you support this assertion with some facts?

If you collect *Saccharomyces cerevisiae* in nature, what is the likely nuclear condition of the fungus? Why?

Although mating switching and pheromone production are fascinating, they are not the reason that *Saccharomyces* is famous. What is fermentation? Why does the cell rely on it? What does it do for industry? What 6 carbon molecule does yeast use? Why does yeast convert pyruvate to ethanol? What carbon-containing molecule is released as a gas?

What are the phylogenetic lineages found within the Ascomycota that make fruiting bodies, or ascoma, that is, in the Pezizomycotina?

What was the ascoma of the ancestral Pezizomycotina?

## Apothecial Pezizomycotina (Pezizomycetes et al.)

Draw and label an apothecium including all of its parts.

What is unique about discharge in the apothecial Pezizomycotina and why might it confer an advantage in spore dispersal?

Draw the ascospores and asci of *Tuber* and speculate on the method of spore dispersal. How are the ascospores of *Tuber* like the basidiospores of *Ustilago* or *Phallus*?

How might *Tuber* manipulate animals to be effective spore-dispersal agents? Might this method also explain the intense human interest in this fungus? What agent is responsible for this interest?

## Lichenized Pezizomycotina

What phylum of fungi accounts for the most lichens? How many species of lichens are there? What fraction of described ascomycetes are lichens? Why might this fraction be an over estimate?

Which symbiont, the fungus or the alga, supplies the name of the lichen?

What does the fungus get from the alga? What does the alga get from the fungus? How do the hyphae and algal cells interact?

What evidence is there that lichens can grow where conditions are too extreme for all other plants?

What are three different thallus forms of lichens? For each form, diagram a cross-section of the thallus showing the cortex, medulla, algal layer and any modifications to help keep the thallus attached to the substrate.

## Cleistothecial Pezizomycotina (Eurotiomycetes)

What are the parts of an *Aspergillus* conidiospore producing structure? Draw and label it.

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Compare the life cycles of *Eurotium rubrum* and *Saccharomyces cerevisiae*.

What do brie and roquefort cheese have in common, in terms of fungi?

What is a mycotoxin? What is an example of a beneficial mycotoxin from the perspective of humans? How about a bad mycotoxin? How might mycotoxins affect human population growth?

Why would a fungus invest energy in a mycotoxin?

What is aflatoxin? What fungus produces it?

What is penicillin? What fungus produces it?

What is *Coccidioides immitis* and why should Californians know about it?

## **Perithecial Pezizomycotina (Sordariomycetes)**

Compare the ascocarps of *Neurospora* and *Eurotium* in terms of the development of asci, their shape and function, and the form of the ascocarp.

What evidence is there that the trichogyne makes a pheromone that acts on conidia? What does the pheromone do to the conidia?

What evidence is there that conidia under the influence of trichogynes make another pheromone? What does the trichogyne do?

After karyogamy, what happens to the fertilizing nuclei in *Neurospora*? Describe and diagram the fate of the nuclei up to the formation of asci?

What do the conidia of *Neurospora* look like? How are they formed?

Diagram and label a longitudinal section of a *Xylaria* perithecium and associated tissue.

In *Claviceps purpurea*, what spores form on the sclerotium and what spores form on the stroma?

What two types of alkaloids are found in the sclerotium of ergot? What are three pharmacological effects of these alkaloids?

Who was St. Anthony and what was his fire?

## **Fissitunicate Pezizomycotina (Dothidiomycetes)**

If you were looking at a fungus with a flask shaped ascocarp, what clues would you use to classify it in either the Sordariomycetes or the Dothidiomycetes of the Pezizomycotina?

Draw and label a *Neurospora* and *Sporormiella* ascus, include a drawing of spore discharge. How do they differ?

What features of ascospore form are used to infer classification in the Fissitunicate Pezizomycotina?

## **Mucoromycotina**

Draw and label the life cycle of *Gilbertella persicaria*. Pay particular attention to the location of cytoplasmic fusion (plasmogamy), nuclear fusion (karyogamy) and meiosis.

What is the evidence that a pheromone is involved in Mucoromycotina mating?

If you were to attempt to isolate this pheromone, what bioassay would you use?

What is a bioassay?

It has been said that one compound, trisporic acid, acts as the pheromone for both mating types (+, -) in the Mucoromycotina. Explain the logical problem with this idea and the practical resolution of the problem.

What is the model for the genetic basis of mating compatibility in the Mucoromycotina.

What is the nuclear condition of a germinating zygospore in the Mucoromycotina?

What is tempeh? Why hear about it in a mycology class?

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What is the English translation of *Pilobolus*? Why does it fit in the tree of life? Where would you find the fungus in the East Bay?

## **Entomophthoromycotina**

What is the English translation of *Entomophthora*?

Why is the mitotic spore in *Basidiobolus* called a condium instead of a sporangium?

What can the conidia of *Basidiobolus* or *Entomophthora* do if they land where there is not food?

What evidence is there that *Entomophthoromycotina* can manipulate animal behavior?

## **Glomeromycota**

How might you argue that *Glomus* is the most important fungus on the planet?

How does a fungus growing in the roots of plants help the plant? What does it cost the plant?

Describe the differences between the two main types of mycorrhizae, ectomycorrhizae and arbuscular mycorrhizae. Which phyla of fungi form each type?

## **Chytridiomycota**

Species of *Chytridiomycota* account for approximately what percentage of described fungal species?

What feature of the chytrid life cycle and morphology caused biologists to consider the chytrids to be protozoa?

One group of chytrids is symbiotic. What is the other partner in this symbiosis? What special environment do these chytrids require? What gas is toxic to these chytrids?

Draw and label the asexual cycle of chytrids. Where in the life cycle does the number of cells increase?

Part of the chytrid life cycle relies on single cells without walls. What are these cells called? When do they get walls?

A zoospore of the *Chytridiomycota* is a power plant moving a nucleus. Using labeled diagrams, tell how the power plant works by tracing the flow of energy from the fuel to the propulsion system.

When *Chytriumyces* mates, how do the nuclei reach each other?

## **Blastocladiomycota**

In *Allomyces macrogynus*, can you distinguish a young haploid thallus from a young diploid thallus? If so, what features do you use? Can you distinguish old thalli? Again, if so, what features do you use?

Can you distinguish zoosporangia from resistant sporangia? How?

Can you distinguish mitospores from meiospores? How?

Can you distinguish male and female gametes? How?

What is sirenin? What bio-assay did Berkeley scientists Ralph Emerson and Leonard Machlis use to purify sirenin? Which cells make sirenin and which perceive it?

Describe the swimming patterns of *Allomyces* male gametes in the absence of and in the presence of mature female gametes. How do the male gametes note the presence of the females and then locate them?

What part of the life cycle of *Allomyces* is missing from the life cycle of *Coelomomyces*? What are the social implications of this missing part?

## **Oomycota**

Where do the *Oomycota* fit in the tree of life and to what organisms are they most closely related? What biochemical and morphological features correlate with this relationship?

# Sample questions based on lectures and labs in Diversity of Plants and Fungi

Diagram and label the life cycle of *Achlya*. Where does meiosis occur?

Draw and label the two types of sex organs of a member of the Oomycota.

*Achlya* in lab was heterothallic. What does this term mean? What is the evidence that a fungus is heterothallic?

Using *Achlya ambisexualis*, two famous mycologists, John Raper and Alma Barksdale, unravelled the details of mating. What bio-assay did Barksdale use to characterize antheridiol?

What is the genetic model to explain mating compatibility in *Phytophthora infestans* (i.e., loci and alleles)? How is this model similar to the human model?

Why can't we apply the simple *Phytophthora* model to *Achlya*?

What does *Phytophthora* do inside the plant in terms of obtaining food?

What is the specialized hypha made inside plant cells by *Phytophthora*?

What crop is destroyed by *Phytophthora infestans*? What social upheaval was caused by this epidemic?

## **Myxomycota**

How are the Myxomycota related to the kingdom Fungi?

How does the thallus of a myxomycete compare to that of a hyphal fungus?

How does a myxomycete obtain food?

What morphological interconversions is a myxamoeba capable of?

Where does meiosis occur in the myxomycete life cycle? What happens to the meiotic nuclei?

What is the genetic basis of mating compatibility in myxomycetes (how many loci, how many alleles), which was deduced by Berkeley mycologist Ray Collins?

How do myxomycete plasmodia cause their cytoplasm to stream?

How many different ways can a myxomycete move?

## **Dictyosteliomycota**

How do *Dictyostelium* amoeba feed? What do they feed on?

What happens to *Dictyostelium* amoebae when the food runs out and the population density is high?

How do *Dictyostelium* amoebae synchronize their behavior? What changes occur in *Dictyostelium* amoebae upon perceiving cAMP? How do these changes allow them to cooperate?

Do *Dictyostelium* amoebae fuse to form a plasmodium?

Is *Dictyostelium* sporulation an example of altruism? Why or why not?

How can cheaters exploit reproduction in *Dictyostelium*? What limits the cheating?

## **Questions spanning groups.**

Fungi or fungi are heterotrophs. Some live on dead organic material (saprobes), some on live material that they have just killed (necrotrophs) and some live on other living organisms (biotrophs), either as parasites or as mutualists. You probably can give examples of saprobes from every phylum or subphylum. Some phyla or subphyla are famous for their biotrophs. We have not seen many necrotrophs, can you name one?

Most Basidiomycota and Ascomycota disperse their spores in the air. Tell me about some that do not because their fruiting bodies are beneath the soil surface? How do these fungi earn a living? Is there a Glomeromycota with the same means of earning a living? If so, what is it named? How do these fungi disperse their spores? How do they attract the dispersal agents?

Fungi communicate by chemicals. What is the general term for these compounds. What are the compounds involved in sexual communication of Mucoromycotina, Ascomycota and Basidiomycota?

# Sample questions based on lectures and labs in Diversity of Plants and Fungi

Other pheromones are used to aggregate or to disperse Fungi or fungi. Give an example of each.

Using a phylogenetic tree of Fungi and fungi studied in PMB 102, can you associate the pheromones discussed above with their phyla or subphyla?

Fungi or fungi can have nuclear conditions that range from N to N+N to 2N. Which fungi are predominately 2N? Which have a short N+N stage? Which have a long N+N stage. Which have no N+N stage and a very short 2N stage?

Plants and animals are predominately 2N. There is some evidence that Chytridiomycota are also mainly 2N, and we saw that Blastocladiomycota have a prominent 2N stage. Where, therefore, on the phylogenetic tree of the Kingdom Fungi would the shift from 2N to N taken place? Where would N+N have arisen?

Most fungi or Fungi have two sexes and most are haploid. But, there are exceptions where there are more than two sexes. Tell us about the situation for each phylum or subphylum covered in class, Basidiomycota, Ascomycota, Mucoromycotina, Oomycota, Myxomycota, Dictyosteliomycota.

When two fungi mate, the fusion of two individual hyphae, gametangia or gametes leads to the production of zygotes, each with an independent meiosis, and the number of zygotes varies from one to hundreds of thousands. Give a phylum or subphylum with just one zygote per fusion of two gametangia? Give one with hundreds? One with hundreds of thousands? What is the biological relevance of having many, independent meioses?

Complex, multicellular fruiting bodies have evolved from fungi that lack fruiting bodies at least twice. How can you use a phylogenetic tree of fungi to demonstrate your answer? Which two subphyla comprise fungi with multicellular fruiting bodies?

How are arbuscules a haustoria alike? What is their form? What is their function? How does their form relate to their function?

Most of the fungi that we have seen in lab or heard about in lecture enjoy life in the presence of oxygen. Tell me about one that cannot live in the presence of oxygen. Where would you find it? Tell me about another that can live with or without oxygen. What must both fungi do to earn a living from sugar when there is no oxygen? What key biological molecule must be oxidized or the whole system will collapse?

## Genetics

How many different genotypes are found in the eight ascospores of a Neurospora ascus?

How many different genotypes are found in the four ascospores of a Saccharomyces ascus?

How many different genotypes are found in the four basidiospores on a Coprinus basidium?

How many different genotypes are found on twenty conidiospores collected from a Penicillium conidiophore?

If you surveyed all eight ascospores from one Neurospora ascus, what would be the maximum number of alleles at each locus?

If you surveyed 50 ascospores from a Neurospora perithecium, what would be the maximum number of alleles at each locus?