**Biol 342**

**Fungi, Environment, People**

Biology, Ecology, Application

**Course Director:** Prof Susan Kaminskyj

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**Office Hours:** By Appointment

**Lectures:** Susan Kaminskyj MWF 12:30 pm Agric 1E79

**Labs:** Jacey Bell Tuesday 1:30 pm - 5:20 pm, 213 Biol

**Email**: jacey.bell@usask.ca

We are fortunate to have additional help from Dr Andrès Posso and Dr Zakia Boubakir, both on a volunteer basis. Contact them by emailing me (Skj)

**Course Description**

**Prerequisite(s): BIOL 120 and 121**

**Course Outcomes**

This course will consider fungal growth and reproduction, the ecological and economic roles of fungi, fungi in agriculture and in medicine, and applied mycology. Successful completion of Biology 342 will also provide you with practice in techniques for isolating, identifying, and examining filamentous fungi. We will compare and contrast how fungi contribute to ecological stability, and how they explore and exploit the environment for their own needs.

**By the end of the course, you should be able to:**

Define and discuss cellular and genetic characteristics of fungi and fungus-like organisms.

Classify major groups of true fungi, with examples.

Describe modes of fungal growth and nutrition, reproduction, and genetic exchange.

Describe symbiotic and pathogenic relationships of fungi with plants and animals.

Describe and discuss the importance of fungi as detritivores

Describe fungal roles in agriculture: crop yields, food production and storage.

Describe and explain how fungi are used in industrial and traditional biotechnology.

Describe and explain how fungi can be used in bioremediation.

**Course Introduction**

Fungi have major impacts on the environment, human health, agriculture, and biotechnology. In this course we examine fungal diversity, cell biology and development, physiology, ecological roles. We will also consider applied aspects including the biotechnology applications in this diverse and successful group.

Biology 342 Fungi, Environment and People will extend the brief survey of fungi provided in Biology 121. We will consider fungal relationships with their environment, and with other organisms. Fungi affect many aspects of our daily lives. Mycorrhizal fungi were essential for land colonization by plants (~450 million years ago), which was necessary for colonization by animals. Yeasts and filamentous fungi have been used by humans since antiquity, although the details were not understood until much later. The air we breathe contains spores that are potential pathogens or allergens. Fungi are part of the normal microbiological community living on our skins. Some fungi are symbionts with plants or animals; others provide essential recycling services. Some fungi are parasites or pathogens of animals or plants. In all, people compete with fungi for food resources, contend with them as pathogens and agents of decay, and exploit them in applied to produce drugs and specialty chemicals. Fungal cells are small, and many do not form macroscopic communities. So, unless occurring as aggregates (for example mushrooms) or in pure culture, they can be difficult to detect without microscopy. Biology 342 will consider these and other aspects of fungi, their relationships with the environment, and their relationship with people.

**Text**: **The 21st Century Guidebook to Fungi** (D Moore, GD Robson, APJ Trinci)

***Strongly Recommended***

http://www.davidmoore.org.uk/ ***Free online access*** Kindle version ~$85. Paperback is $550

* Lab protocols – Blackboard
* Lab exercises – pending on Blackboard

**Grading –** *each* *part* is graded as x/100

*Practical* (lab) – 30 % of final grade

* Lab reports; Journaling.
* Essay and seminar on your Self-Guided proposal.

*Lecture* – 70 % of final grade

Exams written in a computer lab; submitted electronically, plus a print copy

Midterm exam (20 %) in Lecture time

Final exam (75 %) 3 hours

Participation (5 %) Based on your e-journal entries

* Lecture Midterm exam
  + Lecture material up to Oct 11th -- short essay answers.
* Lecture Final exam
  + Essay on your Self-guided proposal (45%)
  + Essays on *two other self-guided projects* of your choice (2 x 7.5% = 15 %).
  + Essays on topics from *Ecology* and *Application* (40 %)

***USask Grading*** https://students.usask.ca/**academics**/**grading**/**grading**-system.php

***USask Academic Integrity*** https://library.usask.ca/academic-integrity#AboutAcademicIntegrity

***Academic Student Misconduct*** secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php

***Complaints and Appeals*** https://secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php#IXXIIAPPEALS

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| 1 | Sept 4-6 | Biology | **Course intro**  **Course Introduction**  **Fungi and the Fungal Union** | **Sept 3** |
| 2 | Sept 9-13 | Biology | **Origin, Systematics, Taxonomy**  In the beginning (as per Moore), the big picture (systematics), naming (taxonomy). What’s in a name?  Perfection vs imperfection vs stable dikaryons (*The third stage of life*)  Morphology *vs* molecules | **Sept 10**  ***1***. *Safety, lab rules and protocols; how to handle, open/close, and put down a Petri plate; Micropore tape; Parafilm*  ***2***. Electronic journals 🡪 use, value, expectation, grading [part of participation]  ***3****. Discuss Library Proposal*  ***4***. ***Proj1****:* Inoculate PDA and PDA+RB plates with a] 100 µL peppercorn wash water, b] fresh ground pepper, c] commercial ground pepper.  ***5.*** Discuss ***Proj2****:* sidewalk plant collection *with roots* 🡪 bring your samples for Sept 17. |
| 3 | Sept 16-20 | Biology | **Growth, exploration, exploitation.**  “For a fungal hypha, life is at the tip” IBH  Trophism (food), tropism (wayfinding and differentiation)    Roles of enzyme secretion.  Motor, frame, fuel, traction, driver  Primary metabolism  Secondary metabolism | **Sept 17**  ***1. Submit*** 1-page outline for library proposal. To be returned Sept 23rd.  ***2.******Proj1***:Examine, describe, sketch, photograph PDA plates from Sept 10. Isolate pure colonies on fresh PDA or PDA+RB. Archive pure cultures in dry silica at 4 °C.  ***3.*** ***Proj2***: Sidewalk plants: [shake in ddHOH, plate 100 µL on PDA], surface sterilize, rinse, pat dry, [shake in ddHOH, plate 100 µL on PDA]; culture root/ crown/ shoot/ leaf for 3 plants 🡪 10 % PDA + antibiotics. |
| 3 | Sept 23-27 | Biology | **Triangle of Life**  Why many fungi have two names. Life cycles – why have sex? The value of being asexual. Sexual and asexual spores, *Mycelia sterilia* | **Sept 24**  ***Proj1*:** Observe, draw, image, isolate, .  ***Proj2*:** Observe, draw… fungal colonies growing from plant segments; isolate. *Projects 1 and 2*: *Slide mounts* |
| 4 | Sept 30-Oct 4 |  | **Genetics and adaptation**; stem nuclei  Adaptive advantages of having multiple haploid nuclei and rapid mitotic cycles. | **Oct 1**  ***Submit lab report for Project 1***  ***Proj2*:** Inoculate PDB plus antibiotics with pure cultures, incubate with shaking until colonies 2-3 mm diameter.  Prep gDNA using QuantBio; freeze |
| 5 | Oct 7-11 | Biology | **Symbiosis** (*The Good*) most herbivores and very many plants. | **Oct 8**  ***Proj2:*** as per Oct 1st lab |
| 6 | Oct 14-18  Oct 14 is Thanksgiving Day | Ecology | **Oct 16: Plant Disease** (*The Bad*) **The symbiont 🡨🡪 pathogen continuum** | **Oct 15 PCR, send for sequencing**  As per Oct 1st lab  ***Start Proj3****: Moist chamber* (500 mL plastic snap container, moistened paper towel,horse manure). Discuss fungal succession  ***Start Proj4****: Twinkies vs Timbits* |
| 7 | Oct 14-18 | Ecology | ***Oct 18***: **Midterm Lecture exam**, **written in a computer lab -- to Oct 11** | **Oct 15 lab**  Overview re Fungal Biology |
| 8 | Oct 21-25 | Ecology | **Biotrophs, necrotrophs, hemibiotrophs.** Breeding for resistance, resistance pyramids, tolerating disease. Antifungals in agriculture. | **Oct 22**  *Sequence analysis?* |
| 9 | Oct 28-Nov 1 | Ecology | **Human/Animal Disease** (*The Bad and Ugly*) Surface, subcutaneous, systemic. Prevention? Geographical hotspots. Iatrogenic disease. Drugs from amphotericin to caspofungin. The fungal wall as shield and camouflage | **Oct 29**  *Sequence analysis?* |
| 10 | Nov 4-8 | Ecology | **Drug targets, drug resistance**. White nose, frogs  Fungicides and Drugs 🡪 Agriculture from Bordeaux mixture to azoles.  **Food and drink.** Specialty enzymes;. | **Nov 5**  Inoculate enzyme assay plates  ***Submit lab report for Project 2*** |
| 11 | Nov 11-15 | Break week | Complete? polish? your proposal | Nov 12 |
| 12 | Nov 18-22 | Application | **Bioremediation** **1** – Above and below the surface. Revegetation; tree harvest; toxic chemical cleanup | **Nov 19** |
| 13 | Nov 25-29 | Application | **Bioremediation 2 –** Bio-prospecting *without* genetic modification. | **Nov 26 Seminars 1-18**  ***Submit lab report for Project 3*** |
| 14 | Dec 2-6 | Review | Student driven, targeted questions, submitted by email by Nov 25th | **Dec 3**  **Seminar 19-36**  ***Submit lab report for Proj4*** |

***Approach and Rationale***

I have been studying fungi since I was about 8 years old. In part, this was because my mother, a nurse, wouldn’t let me keep stream water (or an anthill or a beehive). However, she never found the fungal cultures I was growing in my drawer. It would have been easier using agar than gelatin, but I couldn’t afford it, nor would I have wanted to explain to my parents.

Two people in particular helped me tremendously. In highschool, Mr John Norman, Biology teacher, North Albion Collegiate, Toronto) let me borrow a compound microscope complete with a 100 x oil objective and immersion oil. What a tremendous difference! In 3rd year undergrad, Prof Michèle Heath taught fungal cell biology and physiology. She let us design our own experiments (wow!). Over time, I learned and thought and taught (seldom well, but always with great enthusiasm). Now, still at UofS, and back from being away, I am updating Biol 342 for the 21st century.

Old questions that are still interesting: What is it called? Can I eat it? [Sure, you can eat *anything* once.] What can I do with it? In 2001 we couldn’t afford DNA sequencing, so we studied mold and mushroom identification, *Aspergillus* mating and transmission genetics, and (of course) students designed their own experiments. In 2010, *Aspergillus nidulans* was declared a level 2 Biosafety hazard, which threatened my research program *and* my teaching. Now, DNA-based methods are approachable and affordable. My group has pivoted to environmental microbiology, particularly related to inducing tolerance to abiotic stresses like heat, salt, dryness.

Overall, It’s not what you have, and it’s not who you are; it’s how you behave and what you produce.

**So… What is it? Why does it matter? Who should care? Let’s find out together.**