# BIOL 401/631 – PLANT-MICROBE INTERACTIONS
## Course Outline - Winter 2005


**Instructors:** Keith Egger room 8-341, phone: 960-5860
email: egger@unbc.ca Office Hours: T 1:00-2:00pm; R 2:30-3:30pm
Kathy J. Lewis room 8-212, phone: 960-6659,
email: lewis@unbc.ca Hours: T, W 1:30pm – 2:30pm


**Time:** Lecture Tues & Thurs 11:30-12:20, room 5-159
Lab Tues 8:00-10:50, room 8-321 **/** Tues 8:00-8:50, room 5-159

**Text:** R.L. Peterson, H.B. Massicotte & L.H. Melville. 2004. Mycorrhizas: Anatomy and Cell Biology. NRC Research Press, Ottawa.
Reading Package – available in bookstore

**Course Description**: Parasitic and mutualistic associations of plants, especially forest trees. Emphasis will be placed on the ecology and phylogeny of fungal plant pathogens and mycorrhizal symbionts, and the physiology of plant-microbe interactions.

**Course Objectives:**
1. To understand the biology of pathogenic and mutualistic agents.
2. To understand the epidemiology and etiology of major groups of plant-microbe relationships.
3. To understand, and be able to apply, the major concepts underlying the management of plant diseases, including the beneficial effects of mycorrhizal symbionts.
4. To understand the relevance of plant-microbe interactions to people and ecosystems.

**Evaluation:**

| | **Due Date** | |
|---|---|---|
| Midterm | Thurs. Feb. 3th | 15% |
| Lab book | Tues. April 5th | 30% |
| Scientific paper – evaluation and presentation | | 25% |
| - Approval of the paper | Tues. Jan 25th | |
| - Part I: Abstract mapping exercise | Thurs. Feb. 10th | (4%) |
| - Part II: Written summary | Thurs. Feb 24th | (5%) |
| - Revision based upon comments | Tues. Mar 15th | (3%) |
| - Seminar | Tues. Mar 29th | (8%) |
| - Evaluations with instructors | Tues. Apr 5th | (5%) |
| Final exam | TBA | 30% |

**Course Requirements:** Lab book - bound

**Scientific Paper Assignment – comprehension and presentation**
This exercise is adapted from an exercise developed by Dr. Kate Frego, University of New Brunswick. It is a series of sequenced exercises designed to assist with development of comprehension, integration and presentation (written and oral) skills.

Each student will select one relatively current paper from a scientific journal on a topic of plant-microbe interactions relevant to the course. The paper must be reporting the results of a scientific study; a review paper is not appropriate. **The paper must be approved by one of the instructors to ensure that it is appropriate for the assignment** (approval by Jan 25th). The assignment will have two parts:

**Part I:** By Feb 10th, each student will map the different parts of the abstract onto the main body of the paper (4% of your grade). The purpose of this exercise is to ensure that you see the connection between the points as summarized in the abstract and the main body of the paper, and that you can identify how these points were derived from the scientific study. This exercise can be completed on a photocopy of the

paper -- for each line of the abstract highlight the section of text in the main body of the paper where the points originated.

**Part II:** By Feb 24th, each student will summarize the main points of the paper in 1 page (maximum – double spaced) (i.e. the goal is to be concise!). Your written summary should include the following:

- The **background** of the problem (i.e. why did the authors do this research?)
- The **objectives** of the study (i.e. what were they trying to do?)
- The **methods** used to achieve the objectives (i.e. how did they do it?)
- The **main findings** (conclusions) (i.e. what did they find out?)
- The **significance** of the results (i.e. what does it mean to the world?)

The written summary will be marked (5% of your grade), comments provided and returned for correction.

Based upon the comments, each student will hand in a revised version by Mar 15th, which will be marked (3% of your grade) and then circulated to the other students prior to the seminar sessions on Mar 29th.

The seminar sessions simulate scientific conferences except that students will present the work of other scientists. The format for the seminars and the evaluation standards (developed by the class) will be established during the discussion section of the lab on Tues. March 15th. Seminars will be presented on Tues. March 29th (we will use the full 3-hour lab period for seminar presentations). In the first session, half the class will present a 15 minute seminar on the paper and the other half will evaluate the seminars (using the criteria developed on March 15th). We will have a short coffee break, then the second session will begin and the roles will be reversed. The mark for the seminar (8% of your grade) will be based upon peer and instructor evaluations.

On Tues. April 5th, **each student will meet with the instructors for an evaluation of his or her assignment and the ability of the student to discuss some basic components of other student's presentations** (approximately 15 minutes per student). This will begin immediately after the discussion paper that day. The instructors will assign a mark (5% of your grade) based upon this meeting.

**Lab Book and Reports**

For each lab activity, a section of your lab book should be reserved to record methods, observations (results), and a discussion of the results. Make sure you leave enough pages to record observations that take place over several weeks. You should be able to do most of the work in the scheduled lab period. The discussion should be 1 paragraph to 1 page long depending on the exercise, and needs to be concise and informative. Incorporation of other research into the discussion is encouraged and should be properly referenced. The discussion should include an interpretation of the results, and possible sources of error.

**Policy on late/missed assignments or exams**

Students are expected to attend class, complete assignments by the due date, and write exams on the scheduled date. Exceptions will be made for students who have a scheduled and important event (e.g. surgery, family wedding) providing that the student informs the instructor PRIOR to the event, and makes an effort to hand in assignments BEFORE the scheduled due date. Exceptions will also be made for students who encounter an unexpected event providing that the student, or someone acting on the student's behalf, notifies the instructor as soon as possible. In most cases, written documentation will be required before provision for the missed assignment or exam will be made. Exceptions will not be made for lack of good time management or muddled priorities.

*IF THERE ARE STUDENTS IN THIS COURSE WHO, BECAUSE OF A DISABILITY, MAY HAVE A NEED FOR SPECIAL ACADEMIC ACCOMMODATIONS, PLEASE COME AND DISCUSS THIS WITH THE INSTRUCTOR, OR CONTACT DISABILITY SERVICES LOCATED IN ROOM 7-103.*

**Lecture Schedule**

| DATE | 8:00-9:00 SLOT Room 5-159 | 9:00-11:00 SLOT Room 8-321 | LECTURE TOPIC | PRE-LECTURE READING |
|---|---|---|---|---|
| Tue Jan 4 | No Lab | | Interactions between organisms; The parasitic-mutualistic continuum; Introduction to plant-associated microbes (KE & KL) | |
| Thu Jan 6 | | | Interactions between microbes and indirect effects on plants (KL) | **RP:** Kloepper, 1993 |
| Tue Jan 11 | Come directly to the lab.<br>Lab 1. Symbiotic N fixers; Acetylene Reduction Assay for nitrogen fixation. | | Interactions between microbes and their environment and indirect effects on plants (KL)<br>Discussion: Latty et al. 2003 | **RP**: Latty et al. 2003 |
| Thu Jan 13 | | | Introduction to mycorrhizas (KE) | |
| Tue Jan 18 | Discussion Paper: Sapp 2004 The dynamics of symbiosis: an historical overview. | Lab: No lab this week; discussion paper only. | Ectomycorrhizas; Ectendomycorrhizas (KE) | **Text** Chapters 1 and 2 |
| Thu Jan 20 | | | Ericoid mycorrhizas; Arbutoid mycorrhizas (KE) | **Text** Chapters 4 and 5 |
| Tue Jan 25 | Come directly to the lab.<br>Lab 2. Ectomycorrhizas; Ericoid mycorrhizas; DNA extraction & PCR | | Discussion Paper: Read et al. 2004. Mycorrhizal fungi as drivers of ecosystem processes in heathland and boreal forest biomes (KE) | |
| Thu Jan 27 | | | Arbuscular mycorrhizas (KE) | **Text** Chapter 3 |
| Tue Feb 1 | Come directly to the lab.<br>Lab 2. Restriction digestion; Gel electrophoresis<br>Lab 3. Koch's postulates I. Isolation.<br>Lab 4. Pseudomonas I. Cell-free filtrate and fungal inoculation | | Discussion Paper: Sanders 2002. Ecology & evolution of multigenomic AM fungi (KE) | |
| Thu Feb 3 | | | **Midterm Exam** | |
| Tue Feb 8 | Come directly to the lab.<br>Lab 2. PCR-RFLP fingerprinting and Gene Profiler<br>Lab 3. Koch's postulates II. Subculturing. | | Discussion Paper: Leake et al. 2004 Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agroecosystem functioning (KE) | |
| Thu Feb 10 | | | Introduction to plant pathology; historical impacts (KL) | **RP**: Schumann, Ch. 1 |
| Tue Feb 15 | WINTER BREAK | | WINTER BREAK | |
| Thu Feb 17 | WINTER BREAK | | WINTER BREAK | |
| Tue Feb 22 | Come directly to the lab<br>Lab 3. Koch's postulates III. Inoculation<br>Lab 4. Pseudomonas II. Bacterial inoculation<br>Lab 5. Agrobacterium I. Inoculation | | Physiology of the host-parasite relationship (KL) | |

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|---|---|---|---|---|
| Thu Feb 24 | | | Pathogenicity mechanisms (KL)<br>Discussion: Dothistromin | **RP**: Manners, Ch. 8<br>Shain & Franich, 1981,<br>Bradshaw et al. 2000<br>Jones et al. 1995 |
| Tue Mar 1 | Come directly to the lab<br>Lab 3. Koch's postulates IV. Observation and reisolation<br>Lab 4. Pseudomonas III. Colony measurments<br>Lab 5. Agrobacterium II. Observation | | Resistance mechanisms - nature and types (KL)<br>Discussion: Richael and Gilchrist, 1999 | **RP**: Agrios, Ch. 5<br>Richael & Gilchrist, 1999 |
| Thu Mar 3 | | | Genetics of the host-pathogen relationship (KL)<br>Discussion: Burdon, 1993 | **RP**: Burdon, 1993<br>Hirst et al. 1999 |
| Tue Mar 8 | Come directly to the lab<br>Lab 3. Koch's Postulates V. Observation<br>Lab 4. Pseudomonas IV. Colony measurements<br>Lab 5. Agrobacterium III. Final observation<br>Lab 6. Hypersensitive Response I. Inoculation | | Development of epidemics (KL) | **RP**: Manners, chp. 15<br>Woods, 2003 |
| Thu Mar 10 | | | Discussion on Case Study: Physiology and genetics of host-parasite interaction – *Dothistroma* (KL) | **RP**: Bradshaw 2002 and other *Dothistroma* papers |
| Tue Mar 15 | Discussion: Seminar format and evaluation | Lab 4. Pseudomonas V. Final colony measurements<br>Lab6. Hypersensitive Response II. Observation | Control and management of plant diseases (KL)<br>Discussion: Brasier, 2001 | **RP**: Brasier, 2001 |
| Thu Mar 17 | | | Discussion Paper: Whipps 2004. Prospects and limitations for mycorrhizas in biocontrol of root pathogens (KE & KL) | |
| Tue Mar 22 | Discussion Paper: Jones & Smith 2004 Exploring functional definitions of mycorrhizas: Are mycorrhizas always mutualisms? | No Lab | The symbiotic continuum revisited: conditional outcomes and evolutionary exploitation (KE) | |
| Thu Mar 24 | | | Monotropoid mycorrhizas (KE) | Text: Chapter 6 |
| Tue Mar 29 | Student presentations | | Orchid mycorrhizas (KE) | Text: Chapter 7 |
| Thu Mar 31 | | | Dark Sepate Endophytes (KE) | Text: Chapter 8 |
| Tue Apr 5 | Discussion Paper: Jumpponen 2001 Dark septate endophytes – are they mycorrhizal | Scientific Paper Assignment – review and evaluate with instructors | Scientific Paper Assignment – review and evaluate with instructors (continued) | |
| Thu Apr 7 | | | Course review, evaluations | |

**KE Readings (will be distributed to students as pdf files):**


Jones, M.D. and Smith, S.E. 2004. Exploring Functional Definitions of Mycorrhizas: Are Mycorrhizas Always Mutualisms? Canadian Journal of Botany **82:** 1089-1109.

Jumpponen, A. 2001. Dark Septate Endophytes - Are They Mycorrhizal? Mycorrhiza **11:** 207-211.

Leake, J.R., Johnson, D., Donnelly, D.P., Muckle, G.E., Boddy, L., and Read, D.J. 2004. Networks of Power and Influence: the Role of Mycorrhizal Mycelium in Controlling Plant Communities and Agroecosystem Functioning. Canadian Journal of Botany **82:** 1016-1045.

Read, D.J., Leake, J.R., and Perez-Moreno, J. 2004. Mycorrhizal Fungi as Drivers of Ecosystem Processes in Heathland and Boreal Forest Biomes. Canadian Journal of Botany **82:** 1243-1263.

Sanders, I.R. 2002. Ecology and Evolution of Multigenomic Arbuscular Mycorrhizal Fungi . American Naturalist **160:** S128-S141.

Sapp, J. 2004. The Dynamics of Symbiosis: an Historical Overview. Canadian Journal of Botany-Revue Canadienne De Botanique **82:** 1046-1056.

Whipps, J.M. 2004. Prospects and Limitations for Mycorrhizas in Biocontrol of Root Pathogens. Canadian Journal of Botany-Revue Canadienne De Botanique **82:** 1198-1227.

**Biol 401/601 Reading Package**


Agrios, G.N. 1988. Plant Pathology, 3rd edition. Academic Press. ISBN 0-12-044563-8. Chapter 5.

Bradshaw, R., Bhatnagar, D., Ganley, R., Gillman, C., Monahan, B. and Seconi, J. 2002. *Dothistroma pini*, a forest pathogen, contains homologs of aflatoxin biosynthetic pathway genes. Applied and Env. Microbiol. 68: 2885-2892.

Bradshaw, R., Ganley, R., Jones, W. and Dyer, P. 2000. High levels of dothistromin toxin produced by the forest pathogen *Dothistroma pini*. Mycol. Res. 104:325-332.

Brasier, C. 2001. Rapid evolution of introduced plant pathogens by interspecific hybridization. Bioscience 51: 123-133.

Burdon, J. 1993. Genetic Variation in Pathogen Populations and its Implications for Adaptation to Host Resistance. In: T. Jacobs and J. Parlevliet (eds), Durability of disease resistance. Kluwer Academic Publishers.

Hirst, P., Richardson, T., Carson, S. and Bradshaw, R. 1999. *Dothistroma pini* genetic diversity is low in New Zealand. New Zealand J. of For. Sci. 29: 459-472.

Jones, W., Harvey, D., Jones, S., Sutherland, P., Nicol, M., Sergejew, N., Debnam, P., Cranshaw, N. and Reynolds, P. 1995. Interaction between the phytotoxin dothistromin and *Pinus radiata* embryos. Phytopathology 85: 1099-1104.

Kloepper, J.W. 1993. Soil Microbial Ecology. Applications in Agriculture and Environmental Management. Edited by F. Blaine Metting Jr. Marcel Dekker Inc. ISBN 0-82478-7374.Chapter 10.

Latty, E.F., Canham, C.D. and Marks, P.L. 2003. Beech bark disease in northern hardwood forests: the importance of nitrogen dynamics and forest history for disease severity. Can. J. For. Res. 33: 257-268.

Manners, J.G. 1993. Principles of Plant Pathology, 2nd Edition. ISBN 0-521-43402-5. Chapts. 8, 15

Richael, C. and Gilchrist, D. 1999. The hypersensitive response: A case of hold or fold? Physiological and Molecular Plant Pathology 55: 5-12.

Schumann, G. 1991. Plant Diseases: Their Biology and Social Impact. APS Press, St. Paul, Minn. ISBN 0-89054-116-7. Chapter 1.

Shain, L. and Franich, R. 1981. Induction of Dothistroma blight symptoms with dothistromin. Physiological Plant Pathology 19: 49-55.

Woods, A. 2003. Species diversity and forest health in northwest British Columbia. Forestry Chronicle 79: 892-897.