1. **Course Subject**: PEPS
2. **Course Number**: 606
3. **Effective Term (semester & year)**: Spring 2016
4. **Frequency (check all that apply)**: Fall semester
5. **Offering Status (check one)**: Regular
6. **Full Course Title**: Biology of Plant Pathogens: Bacteria and Viruses
7. **BANNER Course Title**: Bio Pl Path: Bact & Viruses
8. **Gen Ed Core or Hawaiian/Second Language Requirement Designation (check one)**: Do not consider for Core or Hawaiian/Second Language designation.
9. **Letter Grade**: Satisfactory/Unsatisfactory
10. **Number of credits (if variable, specify range)**: 8
11. **Repeat Limit (Do NOT write "None")**: 0
12. **Credit Limit (Do NOT write "None")**: 4
13. **Schedule**: Lecture (LEC)
14. **Type (check all that apply)**: Laboratory (LAB)
15a. **Major Restriction (as it should appear in Catalog)**: none
15b. **Banner codes of acceptable majors**: n/a
16. **Class Standing Restriction**: none
17a. **Prerequisite Course(s)**: none
17b. **Minimum required grade for prerequisites**: B
18. **Catalog Description (Limit 35 words; 85 words for alpha courses)**: Principles and concepts in pathogen biology, epidemiology and management of plant diseases caused by bacteria and viruses. Laboratory techniques for isolation and identification of pathogens and disease diagnosis.
19. **Justification**: Attach separate sheets and indicate the rationale for the request, expected course enrollment, program learning objectives and institutional learning objectives that the new course will cover, and a course syllabus specifying student learning objectives for the course. Syllabi are not required for "-99" courses.
20. **Cross-listed or Honors Course(s)**
21. **Requested By**: Mark Wright
   **Department/Unit**: Chair/Director
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**1st College or School**: Signature
**2nd College or School**: Signature
**General Education (Undergraduate courses numbered 100-199)**
**Director**: Signature
**Graduate Division (600 level and above)**
**Dean**: Signature
**Mānoa Chancellor's Office**: Signature
**Vice Chancellor for Academic Affairs**: Signature
PEPS 606: Biology of Plant Pathogens: Bacteria and Viruses
St. John 302
Tues and Thurs 12:30 to 4:30 pm
Lecture/Lab

Course Description
Principles and concepts in pathogen biology, epidemiology and management of plant diseases caused by bacteria and viruses

Pre-requisite Courses
PEPS 605 or instructor approval.

Rationale: This course provides the basic foundations in plant pathology at the graduate level and is second part of a two-semester course on the biology and management of plant pathogens (see general justification for course changes in the Tropical Plant Pathology Graduate curriculum)

Instructor(s): Anne Alvarez (module on bacteria) and John Hu (module on viruses)
Plant and Environmental Protection Sciences (PEPS), St. John Plant Sciences Bldg.

Alvarez: St. John 315, Tel: 956-7764
Hu: St. John 310, Tel: 956-7281

Description and Requirements

The course will cover principles and concepts in pathogen biology, epidemiology and management of plant diseases caused by bacteria and viruses. The class will be taught in two modules: the first 8 weeks will cover biology and management of bacterial pathogens; the second eight weeks will cover biology and management of plant viruses.

The class is worth 4 credits of lecture/lab. Each four-hour session will consist of one hour of lecture and three hours of lab. Depending on the nature of the material and protocols to be followed for the day, the meetings may start with laboratory work. Specific assays will require waiting periods, during which instructors will give lectures covering principles and concepts. Analysis and discussion of results also will take place during class periods. Students are expected to attend every lecture/lab session (eight hours per week) and will need two to three additional hours per session for preparation and readings.

Course Objectives

At the end of the course, students will be able to:

1. Identify major tropical and temperate zone plant diseases caused by bacteria and viruses.
2. Understand and discuss the major differences and similarities of selected economically important plant diseases caused by bacteria and viruses in tropical and temperate zone agriculture.
3. Describe species of plant pathogens associated with these diseases.
4. Understand and describe the distinct types of bacteria and viruses that affect plants.
5. Identify the key characteristics of plant pathogenic species associated with these diseases.
6. Describe the key epidemiological factors associated with distinct pathogen groups.
7. Describe and analyze disease management strategies associated with the distinct pathogen groups (genera and species).
8. Present results of laboratory exercises clearly and concisely.
9. Analyze and critique current scientific literature.
10. Make clear oral presentations of scientific studies related to plant diseases caused by fungi and nematodes.

Course Materials

Current textbooks are not available for this subject. As background material for the course, students will be expected to know relevant chapters in the textbook, Plant Pathology, Fifth Edition (2005), by G.N. Agrios, Academic Press. Additional textbooks to be used as background materials for Module I: Plant Bacteriology by Clarence I. Kado, APS Press, 2010 Plant-Associated Bacteria, S.S. Gnanamanickam, ed. Academic Press, 2006. Background materials for Module II: Experimental Plant Virology by Jishuang Chen, 2011. Links to research publications and review articles will be posted on Laulima at https://laulima.hawaii.edu/portal. Students should either print the assigned articles and bring to class or bring a laptop to access them during the sessions.

Course Grade

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in laboratory sessions</td>
<td>20</td>
</tr>
<tr>
<td>Written reports and analysis of laboratory exercises</td>
<td>20</td>
</tr>
<tr>
<td>Oral presentation and analysis of research methods</td>
<td>20</td>
</tr>
<tr>
<td>Quizzes (four 10-point quizzes)</td>
<td>40</td>
</tr>
<tr>
<td>Midterm exam (bacterial pathogens)</td>
<td>50</td>
</tr>
<tr>
<td>Final Exam (plant viruses)</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

Final grades will be based on the percentage of total points earned during the semester. Letter grades will be given on the following scale:

90-100%     A  
80-89%      B  
70-79%      C  
60-69%      D  
<60%        F
Class participation
Students will be expected to keep a laboratory book and write summary reports of experiments. They will be expected to participate in discussions of laboratory and lecture materials and present work in both oral and written formats. Students will be expected to discuss the principles, protocols, and pitfalls associated with the laboratory experiments and to relate their results to work presented in published papers.

Exams
All exams will be completed during the class. Four announced quizzes will be given (two on bacteria and two on viruses). The midterm exam will cover laboratory and lecture materials on bacterial pathogens. The final exam will cover lab and lecture materials on plant viruses.

Module-specific objectives and class schedule

Specific objectives for Module I:

1. Distinguish among taxonomic phyla that contain bacterial pathogens, and recognize bacterial pathogens to the genus, species, and where applicable, subspecies and pathovar levels;

2. Recognize representative agriculturally important bacterial plant pathogens and understand key aspects of their biology, life cycles, epidemiology, and control strategies;

3. Understand the principles of disease management of bacterial pathogens;

4. Master basic technical skills in bacterial isolation, maintenance, identification, infection and disease quantification.
<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Lecture Topic</th>
<th>Lab Topic/methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tu</td>
<td>Global impacts of diseases caused by bacteria. Necrotrophic and biotrophic pathogens and the diseases they cause</td>
<td>Identification methods for bacteria: media, streaking, detection and identification of pathogens in mixed populations</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Overview of major groups of phytopathogenic bacteria and symbionts; general characteristics of the bacterial species, detection and identification; taxonomy; and classification</td>
<td>Rapid identification using Physiological/biochemical tests and differential media</td>
</tr>
<tr>
<td>2</td>
<td>Tu</td>
<td>Soft rots, necrogenic and pectolytic bacteria: <em>Erwinia, Bremneria, Dickeya</em> Diseases of potato, pineapple, and maize</td>
<td>Plant inoculations; methods used for six bacterial genera: <em>Erwinia, Pseudomonas, Xanthomonas, Clavibacter, Ralstonia and Agrobacterium</em></td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Leaf spot diseases caused by <em>Pseudomonas</em> and <em>Xanthomonas</em>: genera, species, sub-species and pathovars; host-specificity</td>
<td>Distinguishing diseases of tomato and ornamentals; Hypersensitivity response</td>
</tr>
<tr>
<td>3</td>
<td>Tu</td>
<td>Black rot of Crucifers (<em>Xanthomonas campestris</em> pv. <em>campestris</em>); Systemic blight diseases; the infection process, epiphytic colonization, entry, latent infections</td>
<td>Use of metabolic profiles to identify bacteria</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Other foliar and vascular diseases caused by xanthomonads: citrus canker, blight of rice cotton and mango</td>
<td>Serological methods: ELISA and Immunoblots</td>
</tr>
<tr>
<td>4</td>
<td>Tu</td>
<td>Anthurium blight: visualization of the infection process using bioluminescence; use of beneficial bacteria for biological control</td>
<td>Autophotography using a bioluminescent strain of <em>Xanthomonas</em></td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Resistance and susceptibility: breeding plants for resistance</td>
<td>Development of autophotographs and quantification of leaf areas colonized</td>
</tr>
<tr>
<td>5</td>
<td>Tu</td>
<td>Wilt diseases caused by <em>Ralstonia solanacearum</em>: global impacts, biology and disease management practices</td>
<td>Detection/identification methods: immunostrips and LAMP</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Bacterial wilt and other soil-borne diseases: chemical and biological control; integrated pest management strategies</td>
<td>Symptom development on tomato compared using six bacterial genera: <em>Erwinia, Pseudomonas, Xanthomonas, Ralstonia, Clavibacter, and Agrobacterium</em></td>
</tr>
<tr>
<td>6</td>
<td>Tu</td>
<td>Canker diseases caused by <em>Clavibacter michiganensis</em> and related diseases of potato, and ornamentals</td>
<td>Distinguishing <em>Clavibacter, Xanthomonas, and Ralstonia</em> using rapid diagnostic tests</td>
</tr>
<tr>
<td>Day</td>
<td>Activity</td>
<td>Notes</td>
<td></td>
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<td>-----</td>
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<td>--------------------------------------------</td>
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</tr>
<tr>
<td>7</td>
<td>Genetic methods of identification</td>
<td>PCR and 16S sequence analysis; lab books due</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student presentations</td>
<td>Analysis of results and discussion of experiments</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Student presentations</td>
<td>Summary of laboratory results/lab books returned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summary and review</td>
<td>Midterm exam: bacterial diseases</td>
<td></td>
</tr>
</tbody>
</table>

Module 1. Bacteria

Specific objectives for Module II: Viruses

1. Distinguish among taxonomic phyla that contain plant viruses and identify the major classes.

2. Recognize representative agriculturally important viruses and understand key aspects of their biology, life cycles, epidemiology and control strategies;

3. Understand the principles of disease management of plant viruses and the insect vectors that transmit them.

4. Master basic technical skills in isolation, maintenance, identification, infection and disease quantification.

Specific aspects of virus biology, life cycles, epidemiology and control strategies will be covered with each group of pathogens. When the same genus is covered in several crops, key species will be highlighted and differentiated.
<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Lecture Topic</th>
<th>Lab Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Tu</td>
<td>Virus detection, identification, purification</td>
<td>Mechanical inoculation: TMV and GFP</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Virus transmission</td>
<td>Mechanical inoculation</td>
</tr>
<tr>
<td>10</td>
<td>Tu</td>
<td>Virus diseases: Papaya ringspot virus</td>
<td>Virus purification</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Development of transgenic plants (PRS)</td>
<td>Virus purification (continued)</td>
</tr>
<tr>
<td>11</td>
<td>Tu</td>
<td>Virus diseases of tropical plants</td>
<td>Polyacrylamide gel electrophoresis (PAGE)</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Immunology and serological approaches; monoclonal antibodies; ELISA</td>
<td>ELISA (Quiz 3)</td>
</tr>
<tr>
<td>12</td>
<td>Tu</td>
<td>Immunology and serological approaches (continued); immunoblots</td>
<td>Tissue blot immunoassays (TBIA); ImmunoStrip</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Molecular methods for identification: PCR</td>
<td>PCR I (BBTV)</td>
</tr>
<tr>
<td>13</td>
<td>Tu</td>
<td>Molecular methods for identification: PCR</td>
<td>PCR II (BBTV)</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Diseases caused by DSDNA viruses</td>
<td>RT-PCR I</td>
</tr>
<tr>
<td>14</td>
<td>Tu</td>
<td>Diseases caused by isometric ssNDA viruses</td>
<td>RT-PCR II (Quiz 4)</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Sequence analysis and primer design</td>
<td>Sequence analysis I</td>
</tr>
<tr>
<td>15</td>
<td>Tu</td>
<td>Molecular approaches: molecular hybridization and dsRNA analyses</td>
<td>Sequence analysis II</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Virus-like diseases and viroids</td>
<td>Student presentations I</td>
</tr>
<tr>
<td>16</td>
<td>Tu</td>
<td>Virus disease control/management strategies</td>
<td>Student presentations II</td>
</tr>
<tr>
<td></td>
<td>Th</td>
<td>Summary and Review</td>
<td>Student presentations III</td>
</tr>
<tr>
<td>17</td>
<td>TBA</td>
<td></td>
<td>Final Exam</td>
</tr>
</tbody>
</table>
Justification

Rationale for the request: There is a need for a laboratory-intensive graduate level course in Plant Pathology that covers four major pathogen groups. The first course in the two-semester series covers plant pathogenic fungi and nematodes. Please also refer to the general rationale for PEPS courses 605 and 606.

Expected enrollment: 10 to 16 graduate students per year. Undergraduate students by permission only.

Additional resources (if any) that will be required to teach the course: Minimal funds required to teach laboratory sessions are currently provided by the college. Instructors will seek supplementary funds for equipment and supplies through federal capacity improvement grants.

Academic units for which the course is or will be a major or degree requirement: PEPS (Tropical Plant Pathology). The course will be of interest to other students in PEPS (Entomology) as well as students in Tropical Plant and Soil Science and Microbiology. Students in Molecular Biosciences and Biosystems Engineering often take our courses.

Confirmation of consultation with other academic units:

UHM-1 required documentation for CTAHR: 12 steps-February 6, 2014

1. What is the course addition/modification? N/A; this is a proposal for a new course.

2. Why is this course being requested or modified? There is a need for a laboratory-intensive course for training in identification, pathogen biology, etiology and epidemiology and disease management for diseases caused by fungi and nematodes.

3. How will the content be organized? Please refer to the syllabus (above).

4. What other courses at UHM closely parallel the proposed course and in what way will the latter make a distinct contribution? No other courses parallel the proposed course. The introductory plant pathology course (PEPS 405) provides general principles of pathogen identification and disease management but does not cover the essential morphological, genetic, or physiological properties needed for pathogen identification.

5. Where or how does the proposed course fit into the current and future curriculum? This course is the first in a series of two graduate-level plant pathology courses that cover basic elements of pathogen biology in four modules (fungi, nematodes, bacteria, and fungi). Students will acquire basic laboratory skills to prepare them for advanced classes and research. Please also refer to the general justification.

6. Why is the number of credits and level justified? Explain the prerequisites and the absence thereof. The class will be given as lecture/lab with an equivalent of one hour of
lecture and three hours of laboratory for each meeting (twice a week). This is equivalent to two hours lecture and six hours of lab per week or four credits. Some lab exercises require more than three hours to complete. Thus, the exercise may start first and the lecture and discussion materials will be intercalated into the class as most appropriate for each session.

7. **How will the course assist students to achieve the critical skills and competencies expected of CTAHR graduates?**

*Oral communications:* Each student will prepare and present an oral communication summarizing their results on a diagnostic topic assigned at the beginning of the class. They will be encouraged to speak clearly in front of their classmates, and respond to questions regarding their methods and conclusions.

*Analytical/Problem solving skills:* Students will be given unknown samples of pathogens and diseases that they will need to identify using skills demonstrated in class. Students will also be exposed to complex disease problems where multiple factors may influence their diagnosis. They will need to assess the entire situation and distinguish major from minor contributing factors.

*Personal characteristics:* Students will learn good laboratory practices including safety, care with expensive instruments, and biosafety protocols. Laboratories require extensive preparation before class, so students will be expected to be punctual and consistent in attendance. Team work will be coupled with independent investigation. Students will be required to present written homework assignments to supplement their lab work. Scientific integrity will be fostered throughout the course and proper citation of resources will be required.

*Human relations skills:* During class discussions and the oral presentations, students will be expected to respect the opinions of others and act in a professional and collegial manner.

*Business management skills:* not applicable

*"Real world experience":* not applicable

*Leadership skills:* not applicable

*Computer skills:* Students will learn the programs for programing laboratory equipment. They will also learn bioinformatic skills for identification of some fungi. Students will use a word processing program such as Word for written assignments, and a slideshow program such as PowerPoint for their oral presentations.

*Global perspective:* Plant diseases are global issues. Detection, identification methods are essential and are universally used. Diseases typical of tropical environments will be contrasted to diseases present mainly on temperate zone crops. Global understanding of
environmental factors influencing disease spread will be an integral part of pest management strategies learned in this course.

8. **How will students be evaluated?** Students will be evaluated by written quizzes, midterm and final exam. In addition, laboratory reports, oral presentations, and discussion will contribute to the assessment of their skills and knowledge.

9. **What are the minimum qualifications for teaching this course?** Is a qualified instructor now available? Minimum qualifications: a Ph.D. in Plant Pathology with additional coursework and research experience in the specific sub-discipline (fungi, oomycetes, and nematodes). Qualified instructors are currently on the staff, so no additional personnel will be required.

10. **How will the course be financed, assuming no further cutbacks?** The instructors will seek extramural funding for essential laboratory equipment to supplement the available funds for materials and supplies.

11. **Has the course been offered before? Is there a demand for it?** The course has not been offered previously. There is a demand for it based on student evaluations and discussions in the department. Well balanced students in plant pathology need exposure to all four pathogen groups, but they cannot obtain the essential basics because graduate courses are taught in alternate years. The proposed organization of materials will permit all graduate students to cover four pathogen groups in a single year.

12. **Is the course cross-listed with another department?** Not at present.

**UHM-1 required documentation for Graduate Division**

1. UHM-1 (Add) or UHM-2 (Modify or Delete): Please refer to the preceding pages.

2. **What are the expected learning outcomes?**
   a. **What are students expected to know before starting the class?** Students should have basic training in biology, chemistry, biochemistry, and microbiology. Students will be expected to know the general principles of plant pathology. The undergraduate introductory course in Plant Pathology (PEPS 405) will not be required but the students will be expected to know the information in the basic textbook, Plant Pathology, fifth edition, as background information for the class.
   b. **How are the students expected to learn the materials?** Students will absorb materials presented in lecture, read assigned materials, perform laboratory assays, report results, analyze and discuss results in class, and participate in small-team learning groups to discuss and synthesize the materials provided.
   c. **How will the students be evaluated?** Student participation in laboratory sessions, analysis of laboratory exercises and presentation of written reports, oral presentations and analysis of research methods in referred publications. Four 10-
point quizzes will be used as teaching aids. Each module will have a written exam.

d. **How will the success of the course in achieving the learning outcomes be assessed?** The success of the course will be evaluated by student performance in laboratory exercises, their ability to analyze and discuss their own as well as published data, examinations, and student evaluations at the end of the course.

3. **Where does the course fit in the present graduate program?**
   a. **What are the general qualifications for teaching this course?** Please see point 9 above. Minimum qualifications: a Ph.D. in Plant Pathology with additional coursework and research experience in the specific sub-discipline (fungi, oomycetes, and nematodes). Qualified instructors are currently on the staff: Brent Sipes is a plant nematologist and the PEPS department has recently hired Miaoying Tian, a plant pathologist with expertise in fungi and oomycetes. No additional personnel will be required.
   b. **Which old course will be deleted if a new course is approved?** no deletions
   c. **Justify the number of credits and the level of the course:** Formal class sessions are held from 12:30 to 4:30 pm on Tuesdays and Thursdays. This gives time for a one hour lecture and three hours of lab at each session. The course is given at the graduate level, enabling the instructors to cover material more intensively than at the undergraduate, upper division level.

4. **For new courses, list the programs that are either potentially or directly affected.**

Approval of the requested courses will result in submission of UHM-form 2 for minor changes in current advanced plant pathology courses. The biological, epidemiological and pest management topics will be presented in the new courses (PEPS 605-606) and removed from our advanced series (PEPS 616, 630, 646, 652). This will leave more time for the latter courses to cover recent advances in host-pathogen interactions and population biology. Most of the laboratory exercises previously associated with the advanced courses will now be covered in the 8-week modules (PEPS 605 and 606).

**UHM Form 2 will be submitted for the following course modifications to accommodate the new course PEPS 605:**

Molecular Plant Fungi Interactions (PEPS 652) The title of the advanced course will be changed to Plant Interactions with fungi and oomycetes. The diagnostic and plant disease management aspects will be covered in PEPS 605 rather than PEPS 652.

5. **Syllabus with all the appropriate components: course objectives, texts, schedule of subjects, grading methods, and assignments.**