Environmental and Molecular Analysis of a Disease
Professor Mary Killilea
Day and Time: Tuesday 2:00 – 4:45

Prof. Mary Killilea’s Contact Information
Office: Silver 602
Email: mek5@nyu.edu
Office Hours: Thursday 3pm-4pm or by appointment

Course description:
This is an upper-level undergraduate course that will teach students about the environmental determinants of disease vectors, and the molecular techniques used to measure prevalence of a pathogen in these vectors. Students will partake in a semester long research project on Lyme disease, the most prevalent vector-borne disease in the United States. The aim of the project is to determine the prevalence of Borrelia burgdorferi, the Lyme disease causative agent, in tick populations from New York forests. Students will collect ticks, bring them back to the lab and analyze them for the presence of the Borrelia burgdorferi bacteria. Then collected and analyzed data will be fed into epidemiological models to assess human risk of Lyme disease in the studied areas.

Learning outcomes:
Upon completion of this course, students will be able to:
• Develop and execute a research project
• Safely collect field samples of disease vectors
• Perform quantitative real time PCR to determine the bacterial load of a tick
• Organize, analyze and present their data

Prerequisites:
Introduction of Ecology (BIOL-UA 63) or Molecular and Cell Biology I (BIOL-UA 21)

Required Text: There is no required text.

Grades:
The final grade for the class will be calculated as follows:
Module One Paper Discussions 15%
Module One Exam: 25%
Website Development 20%
Field Collection (required field trip) 10%
Lab Preparation 15%
Presentation of Results 15%
Missed Exam Policy: An **unexcused** absence from an exam will be calculated as 0% for that particular test! If you miss an exam and present a legitimate excuse, a make-up test will be made available to you. There will be only one opportunity for such an exam; it could be an essay test, and the appropriate instructors will grade it. This situation will be dealt with partly on an individual basis.

**Academic Integrity:** We take academic integrity very seriously and will follow the CAS guidelines and procedures outlined on the following web page: [http://cas.nyu.edu/content/nyu-as/cas/academic-integrity.html](http://cas.nyu.edu/content/nyu-as/cas/academic-integrity.html)

**Disability Disclosure Statement:** Academic accommodations are available to any student with a chronic, psychological, visual, mobility, learning disability, or who is deaf or hard of hearing. Students should please register with the Moses Center for Students with Disabilities at **212-998-4980**. NYU's Henry and Lucy Moses Center for Students with Disabilities 726 Broadway, 2nd Floor New York, NY 10003-6675 Telephone: **212-998-4980** Voice/TTY Fax: **212-995-4114** Web site: [http://www.nyu.edu/csd](http://www.nyu.edu/csd)

**Course schedule**

**Module 1:** The first module of the course is designed for students to learn the foundational material on Lyme disease specifically and Disease Ecology in general. They will be introduced to the following topics through peer-reviewed literature, textbooks, and in class discussions:

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Sept. 3</td>
<td>Introduction to Lyme disease</td>
</tr>
<tr>
<td>Sept. 10</td>
<td>Ecology of <em>Ixodes scapularis</em></td>
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<tr>
<td>Sept. 17</td>
<td>Methods of collecting environmental samples</td>
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<tr>
<td>Sept. 24</td>
<td>Genomics of <em>B. burgorfery</em> spirochete</td>
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<tr>
<td>Oct. 1</td>
<td>Methods of detection and quantification of spirochetes in environmental samples and Website assignment</td>
</tr>
<tr>
<td>Oct. 8</td>
<td>Exam review and Website work</td>
</tr>
<tr>
<td>Oct. 15</td>
<td><strong>NO CLASS ADMINISTRATIVE DAY</strong></td>
</tr>
<tr>
<td>Oct. 22</td>
<td>Module 1 Exam</td>
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</tbody>
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Readings for Module 1:

- Introduction to Lyme disease

- Ecology of *Ixodes scapularis* and Lyme disease

- Collecting *Ixodes scapularis*
  - Ogden et al. 2016. *Ixodes scapularis* Ticks Collected by Passive Surveillance in Canada: Analysis of Geographic Distribution and Infection with Lyme Borreliosis Agent *Borrelia burgdorferi*

- Genomics of *B. burgdorferi* spirochete
  - Gilmore, R.D.Jr. and Piesman J. 2000. Inhibition of *Borrelia burgdorferi* migration from the midgut to the salivary glands following feeding by ticks on OspC-Immunized mice. Infect. and Immunity 68(1), 411-414.
• Methods of detection and quantification of spirochete in environmental samples.
  o Real time PCR vs. traditional PCR. Applied Biosystems White paper
  o Theory and practice of real time PCR. Applied Biosystem White paper
  o Introduction to PCR. BioRad White paper

Assignments for Module 1:
1. Come to class each week having read the articles and prepared to lead a discussion on assigned questions
2. Website development (assigned during module 1 but finalized at the end of class)
3. Module 1 Exam

Module 2: Collection of environmental samples

<table>
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<tr>
<th>Oct. 25</th>
<th>Field trip</th>
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• Field trips are scheduled for Friday October 25 with a rain date of November 1. This will be an all day trip leaving campus at 8:00 am and returning around 5:00 pm
• Failure to attend the field trip will result in a 0 for this portion of your grade. There is no make-up for the field trip. If you are ill or have a family emergency, you will need to provide documentation and your course grade will be based on the other 90% of the course.

During field trips, students will collect ticks, identify the species, count them, determine their life cycle stage and freeze them in preparation for the next molecular step.

Note: Professor Killilea is an expert in researching Lyme disease and other tick-borne diseases. She has supervised many undergraduate and professional staff on the safe collection of ticks. Students will be educated about the risks of tick bites and protocols for avoidance and treatment of tick bites. All students will be required to wear white suits to limit their exposure to tick bites, and there will be frequent tick checks.

Assignments for Module 2:
1. Field Data Collection Assignment – Field trip to collect ticks

Module 3:
• October 30 – December 4 Students will learn to isolate DNA from the ticks, quantify it and perform PCR with primers specific for 1-3 *Borrelia* genes. They will next perform quantitative real time PCR with the spirochete positive samples to determine the bacterial load per infected tick. The resulting data will be represented as percentage of infected ticks collected from the studied areas and spirochete genome equivalents per tick.

**Readings for Module 3:**
- Real time PCR versus regular PCR. Tutorial. Applied Biosystems
- Real time PCR. Application guide. BioRad

**Assignments for Module 3:**
1. Methods – Before beginning the PCR analysis, all students will be required to read the protocols and be prepared to answer questions at the beginning of lab.

**Module 4:**

| Dec. 11 | Data analysis and presentation |

• December 11 - The data from modules 2 and 3 will be analyzed, visualized, and discussed

**Assignments for Module 4:**
1. Final Results – Results produced during Module 3 will be analyzed and a course presentation will be developed.