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

Prof. Nikolai Kirov’s Contact Information  
Office: Silver 602  
Email: nk2@nyu.edu  
Office Hours: TBD

Prof. Mary Killilea’s Contact Information  
Office: Silver 602  
Email: mek5@nyu.edu  
Office Hours: TBD

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  
• Perform PCR and quantitative real time PCR to determine the bacterial load of a tick  
• Organize, analyze and present their data

In-Person versus Remote Attendance:  
Module one is focused on building a foundational understanding of Lyme disease, the tick vector and pathogen through reading and discussing scientific literature. Participation in these weekly discussions can be in-person or remote via zoom.

Module two provides hands-on experience testing ticks for various pathogens using multiple techniques. Since it is hard to gain hands-on experience remotely we encourage you to attend these classes in-person if possible. If you can not attend in person we provide an
alternative video and written assignment to assess your understanding of the techniques being performed in the class.

**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:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module One Paper Discussions</td>
<td>20%</td>
</tr>
<tr>
<td>Module One Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Website Development</td>
<td>20%</td>
</tr>
<tr>
<td>Lab Experiments</td>
<td>20%</td>
</tr>
<tr>
<td>Data Analysis Assignment</td>
<td>20%</td>
</tr>
</tbody>
</table>

**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](tel: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](tel:212-998-4980) Voice/TTY Fax: [212-995-4114](tel: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>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 8</td>
<td>Introduction to Lyme disease</td>
</tr>
<tr>
<td>Sept. 15</td>
<td>Ecology of <em>Ixodes scapularis</em></td>
</tr>
<tr>
<td>Sept. 22</td>
<td>Methods of collecting ticks</td>
</tr>
<tr>
<td>Sept. 29</td>
<td>Genomics of <em>B. burgdorferi</em> spirochete</td>
</tr>
<tr>
<td>Oct. 6</td>
<td>Methods of detection and quantification of spirochetes in environmental samples and Website assignment</td>
</tr>
<tr>
<td>Oct. 13</td>
<td>Website introduction</td>
</tr>
<tr>
<td>Oct. 20</td>
<td>Website completion</td>
</tr>
<tr>
<td>Oct. 27</td>
<td>Module 1 Exam Due</td>
</tr>
</tbody>
</table>

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

• Methods of detection and quantification of spirochete in environmental samples.
  - Real time PCR vs. traditional PCR. Applied Biosystems 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: The second module provides students with hands-on experience in the lab. Students will learn to isolate DNA from the ticks, quantify it and perform PCR with primers specific for 1-3 *Borrelia* genes. They will perform quantitative real time PCR with the spirochete positive samples to determine the bacterial load per infected tick. The resulting data will be analyzed and presented in a class discussion.

<table>
<thead>
<tr>
<th>Date</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 27</td>
<td>DNA isolation</td>
</tr>
<tr>
<td>Nov. 3</td>
<td>DNA isolation</td>
</tr>
<tr>
<td>Nov. 10</td>
<td>PCR</td>
</tr>
<tr>
<td>Nov. 17</td>
<td>PCR and qPCR</td>
</tr>
<tr>
<td>Nov. 24</td>
<td>PCR electrophoresis</td>
</tr>
<tr>
<td>Dec. 1</td>
<td>Introduction to data analysis</td>
</tr>
<tr>
<td>Dec. 8</td>
<td>Present the results</td>
</tr>
</tbody>
</table>
Readings for Module 2:
   Real time PCR versus regular PCR. Tutorial. Applied Biosystems
   Real time PCR. Application guide. BioRad

Assignments for Module 2:
   1. Weekly written assignments to assess understanding of lab techniques.
   2. Data analysis assignment which will be presented on the last day of class