Supplemental Materials

for

Design of a Lyme Disease Vaccine as an Active Learning Approach in a Novel Interdisciplinary Graduate-Level Course

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Appendix 1: Module 4 Syllabus

BIMD 502/Module 4

Module Topic: Lyme Disease as a Model for Microbiology and Immunology

Primary Faculty: Email Phone

Guest Faculty: Email Phone

Assessment and Grading:
Homework/activity assignments 100 points
Written assignments 100 points
Oral presentations 100 points
Final examination 100 points

Module Learning Objectives:
Successful completion of this Module should enable students to:

- Compare and contrast the structural similarities and differences between eukaryotes and prokaryotes,
- Outline the basic concepts of bacterial structure and classification,
- Illustrate the general mechanisms microbes use to cause disease,
- Evaluate how specific virulence factors (toxins, effectors) contribute to the disease process,
- Employ information about *Borrelia burgdorferi* and Lyme disease to thoroughly describe the pathogenic process of one bacterial disease,
- Discriminate the different aspects of the innate immune response as it relates to both function and structure
- Describe the function and structure of the adaptive immune response, with an emphasis on antigen presentation and immunoglobulin production
- Evaluate the interaction of innate and adaptive immune responses
- Assemble a normal host immune response to bacteria, as determined by the bacteria’s residence (intra vs. extracellular)
- Employ advanced peer teaching techniques to further group understanding of biomedical science concepts,
- Interpret and evaluate information acquired from actual data generated in the laboratory,
- Evaluate and review scientific manuscripts,
- Effectively communicate scientific information through informal “chalk talks”
- Effectively communicate scientific ideas and proposals to stakeholders,
- Provide accurate and relevant scientific information to the lay public.
Module Schedule:
Week 1: Basic Bacteriology

Week 2: Innate Immunity and Cells
Week 3: Adaptive Immune Response
Week 4: Bacterial Pathogenesis
Week 5: Lyme Disease and B. burgdorferi
Week 6: Host-Pathogen Interactions/Vaccine Development
Week 7: Intellectual Property and Biotechnology
Week 8: "The Pitch"

Journal club:
Theme: Research Techniques and Data Interpretation
Every Thursday

Important Dates:
– Final take-home exam, due
– Oral presentations of white paper
– White paper due
– Final exam due

GRADING
Oral presentations:
Chalk talks
- Week 2 10 points
- Week 3 10 points
- Week 4 10 points
- Week 5 10 points
- Week 6 10 points
White paper presentations 50 points

Written assignments:
Week 5 – Lay audience paper 25 points
Week 6 – “What’s Hot” (journal club assignment) 25 points
Week 8 – White paper 50 points

Knowledge-based assessment:
Quizzes or worksheets
- Week 2 10 points
- Week 3 10 points
- Week 4 10 points
- Week 5 10 points
- Week 6 10 points
Final exam 50 points

Activities (pre-class or in-class):
Week 1 15 points  
Week 2 15 points  
Week 3 15 points  
Week 4 15 points  
Week 5 15 points  
Week 6 15 points  
Week 7 10 points

**Week 1 Basic Bacteriology**

*Monday:* Structural similarities and differences between eukaryotes and prokaryotes, basic concepts of bacteria structure and classification

Faculty:

Activities:
- **Introduction to Module** – 15 minutes
  - Overview of objectives and goals, grading
  - Explain chalk talks
  - Introduction to major project (white paper for vaccine)
- **In class worksheet (individual)** – 20 minutes, no grade
- **Mini lecture** – 30 minutes
  - Prokaryotes vs Eukaryotes
  - Bacteria vs Viruses vs Fungi vs Protists
  - Structure of bacteria including Gram negative vs Gram positive
- **Activity** – 30 minutes
  - Diversity of bacteria e.g., hot springs vs artic

Homework: Beginning of bacterial virulence
- Group 1 – Prepare presentation about how bacteria encounter/enter host
- Group 2 – Prepare presentation about how challenges in different environments

*Wednesday:* How do bacterial encounter hosts? What are entry mechanisms? How do they become established?

Faculty:

Activities:
- **Presentations and discussion** – 45 minutes
  - Each group will present what they learned, faculty will supplement
    - Each student must present part, in chalk talk format
  - Discussion – what is a virulence factor?
- **Pathogen vs. host** – 45 minutes
  - Mini lecture– major factors that bacteria must overcome to establish infection
Groups – Brainstorm how bacteria that can overcome host protection
Discussion –

Homework: Compare and contrast bacterial life styles and characteristics and how these differences affect infection (e.g. Intracellular vs extracellular) (worksheet)
- Graded, 15 points per student

**Week 2: Introduction to Immunology**

*Wednesday: Overview of Innate Immune Response and Primary Cell Types Involved*

Faculty:

Activities:
- Overview of Innate immunity
  - Mini lecture chalk talk
  - Discussion - specific vs. nonspecific immunity
- Cells of the Innate Immune System
  - Groups (2) – structure/function of Group 1 = macrophages/dendritic cells; and Group 2 = neutrophils
  - Discussion compare and contrast origin/lineage and function of macrophages/dendritic cells and neutrophils (lead by the groups/facilitated by faculty)

Assessment:
- Up to 15 pts/student for group presentations of macs/dc or neutrophils

Homework:
- Read assigned review articles (provided at the end of Week 1).
- Read overview review of PRR’s/PAMP’s and prepare to discuss the PRR family assigned to group.

*Divide into 4 groups and assign 1 PRR family to each group before dismissing.*

*Thursday:*

2:30-3:30: Journal Club

Week 2 worksheet based on seminar (10 points; due Friday)

*Friday: Soluble factors of the Innate Immune Response*

Faculty:

Activities:
• Overview of Pathogen Receptor Recognition (PRR) and Pathogen Associated Molecular Pattern (PAMP) activity
  o Discussion – Advantages/disadvantages to the host of PRR systems
• PRR families (TLR, NLR, RLR, CLR)
  o Each group will provide chalk talk of the structure/function of its PRR family.
  o As a class – develop a summary table of all 4 PRR families to understand roles of PRRs in intracellular vs extracellular, bacteria vs viruses, etc.

Assessment:
  • Up to 10 points/student for chalk talks on PRR family

Homework:
  • Read assigned review articles

**Week 3: Adaptive Immune Responses**

*Monday: T cells: antigen presentation, activation and function*

Faculty:

Activities:
  • Mini chalk talk – antigen presentation
  • Groups (2): one generates list of antigen processing for an intracellular bacteria, the other for an extracellular bacteria
    o Discuss the differences as a class (lead by Groups)
  • Mini chalk talk – T cell function

Assessment: up to 10 points/group-chalk talk

Homework:
  • Read assigned review articles.
  • Individual students generate list of at least ways immune system generates diversity in immune responses.

*Wednesday: B cells: Genetics of Antigen Recognition and Immunoglobulin Production*

Faculty:

Activities:
• Discussion of why immune system needs great diversity; and how it then achieves this diversity (faculty facilitated)
• Mini lecture gene rearrangement - Ig and TCR development

Assessment: Up to 10 points/student for homework worksheet

Homework:
• Worksheet comparing B and T cell activity, diversity obtained, antigens recognized, etc.
• Read assigned review articles for anti-viral immunity.

Friday: Immune response against bacteria and viruses

Faculty:

Activities: Big picture virology chalk talk; presenting group lead chalk talk of the infection and subsequent clearance; class discussion of what an anti-virus immune response would look like; compare and contrast with immune response against bacteria. Design a virus activity.

Assessment: Up to 15 points/student—discussion/virus activity

Homework: Worksheet on host defenses to prepare for next week; Students read review articles on different aspects of virulence and present to class

Week 4: Bacterial Pathogenesis

Monday: Avoidance of host defenses I: Virulence factors that promote colonization of the host

Now that you’ve learned something about the immune system, let’s revisit how bacteria establish an infection.

Faculty:

Activities:
• Presentations and discussion – 45 minutes
  o Each group will present what they learned, faculty will supplement
    ▪ Each student must present part, in chalk talk format
  o Discussion – what is a virulence factor?
• Motility and adherence – 45 minutes
  o Mini lecture
  o Discussions: pros and cons of stick and stay vs dissemination
Homework: Read assigned review articles/primary literature. 2 groups prepare debate for or against metabolic genes as virulence factors.

**Wednesday: Avoidance of host defenses II: The ability to compete for iron and other nutrients**

Faculty:

Activities:
- Debate – 45 minutes
- Competition for nutrients– 45 minutes
  - Mini lecture

Assessment: up to 15 points per group for debate

Homework: Read assigned review articles/primary literature.

**Friday: Avoidance of host defenses III: resistance of innate and adaptive immune defenses**

Faculty:

Activities:
- Infection game activity – 45 minutes
- Students Peer Teaching with faculty mentor; discuss how bacteria resist innate and adaptive immune defenses, drawing on reading assignment and knowledge of immunology from weeks 2 and 3

Assessment: 10 points/group for chalk talk

Homework: Read assigned review articles/primary literature on Lyme disease. Complete take-home worksheet on avoidance of innate and adaptive immune defenses (10 points)

**Week 5: Lyme Disease and Borrelia burgdorferi**

**Monday: Introduction to Lyme Disease**

Faculty:

Activities: Mini-lecture on history, discovery, clinical manifestations of Lyme disease. Case study (NEJM) and discussion

Assessment: Up to 15 points/student for discussion.
Homework: Find at last 3 websites with information about Lyme disease. How reliable is this information? Is there an agenda? How does public perception potentially impact your development of a vaccine?

Wednesday: Spirochetes and Borrelia burgdorferi Part I

Faculty:

Activities: Mini-lecture on spirochete structure, phylogeny, introduction to B. burgdorferi; Class discussion about unique challenges posed by this bacterium/disease; compare/contrast to other pathogens/diseases

Assessment: Up to 10 points per student for Monday's homework.

Homework: Newspaper article on public misconceptions about Lyme disease; 25 points—due Friday next
Prepare chalk talks on non-borrelial spirochete of group’s choice

Friday: Spirochetes and Borrelia burgdorferi Part II

Faculty:

Activities: Chalk talks; discussion. Mini-lecture on other borreliae and implications for vaccine design.

Assessment: Chalk talks; 10 points

Homework: Read assigned literature on pertussis. Prepare for chalk talks. 1 group will consider bacterial targets, the other, immune responses elicited by Bordetella.

Week 6: Host-Pathogen Interactions/Vaccines

Monday: Host-Pathogen Interactions: Implications for Vaccine Design

Faculty:

Activities: chalk talks based on homework (vaccine targets and immune responses elicited); discussion of the acellular pertussis vaccine.

Assessment: Chalk talks; 10 points
Homework: Prepare chalk talks on Lyme vaccine for humans vs. dogs. Why is there a veterinary vaccine and why did the human vaccine get pulled?

*Wednesday: Challenges with Vaccine Design for Lyme disease*

Faculty:


Assessment: Up to 5 points/student for discussion and class activity: can each student come up with one unique strategy or target for a Lyme vaccine? Up to 10 points for chalk talk.

Homework: Sketch a 1-2 page outline of your vaccine strategy. Prepare chalk talk on vaccine that has been pulled from the market or failed—why?

*Thursday: “What’s Hot” paper (25 points); due next Thursday*

*Friday: Translational Research – Introduction to Scientific White Paper Assignment*

Faculty:

Activities: Discussion on the differences between grant proposals and white papers; Discussion of how to alter Scientific White paper to Layman; Chalk talks on vaccine failures.

Assessment: Chalk talks; up to 10 points

Homework: start white paper

**Week 7: IP and Biotech; preparing your white paper**

*Monday: IP*

Faculty: **Guests:**

Activities:

Assessment: 2 points per question asked; maximum 10 points/student from Monday and Wednesday.

Homework: work on white paper
**Wednesday: Biotech**

Faculty: **Guests:**

Assessment: 2 points per question asked; maximum 10 points/student from Monday and Wednesday.

Homework: work on white paper; STUDY

**Friday: EXAM: 50 points; Due next Friday**

Homework: Work on White Paper, prepare for Oral pitch
Week 8: The pitch

Monday: Oral presentation of white paper to potential investors

Faculty: Panel from Center of Innovation

Activities: Oral Presentation: 20 minutes per student

Wednesday: Oral presentation of white paper to potential investors

Faculty: Panel from Center of Innovation

Activities: Oral Presentation: 20 minutes per student

Assessment: Oral Presentation 50 points

Friday: White paper DUE 50 points
Appendix 2: Sample Primary Literature Reading Assignments


**Appendix 3: Example Homework**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Innate Immunity</th>
<th>Adaptive Immunity</th>
<th>Immune Evasion Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extracellular bacteria</td>
<td>Host innate defenses</td>
<td>Host adaptive defenses</td>
<td></td>
</tr>
<tr>
<td>Name three:</td>
<td>Name three:</td>
<td>Name three:</td>
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<tr>
<td>Intracellular Bacteria</td>
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<td>Name three:</td>
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Table 1.
What are some innate vs. adaptive immune responses against intra or extracellular bacteria? What are some strategies these bacteria use to avoid the immune response?
Table 2.
Non-specific defenses in different anatomical sites. Some examples are provided for you. Numbers in parentheses indicate minimum number I can think of; can you think of more? Why are certain cells ‘blacked out’?

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Skin</th>
<th>Respiratory Tract</th>
<th>GI Tract</th>
<th>Genitourinary tract</th>
<th>Eye</th>
<th>Blood</th>
<th>Mouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Barrier (1)</td>
<td>Cough (2)</td>
<td>Shedding (1)</td>
<td>(3)</td>
<td>(2)</td>
<td>(1)</td>
<td>(3)</td>
</tr>
<tr>
<td>Normal flora</td>
<td>Competition for receptors (2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Secretions</td>
<td>Lactic acid (1)</td>
<td>Mucus (3)</td>
<td>Lysozyme (6)</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td>(5)</td>
</tr>
<tr>
<td>Immune surveillance</td>
<td>Dendritic cells (3)</td>
<td>Alveolar macrophages (2)</td>
<td>(4)</td>
<td>(3)</td>
<td>(1)</td>
<td>(2)</td>
<td>(2)</td>
</tr>
</tbody>
</table>
Appendix 4: Example In-Class Worksheet

Bacteria can grow in a variety of hostile environments, but they must have special adaptations to do so. Research the following conditions and be prepared to describe to the class how the bacteria are able to survive and grow. Be thorough and scientific in your answer, include descriptions of experiments to demonstrate the survival mechanism.

1. Radiation
   a. Condition – some bacteria can survive extreme radiation (500,000 rad – 1000x the amount that will kill a human)
   b. Problem – that much radiation is expected to introduce hundreds of double-strand breaks into the DNA, which should be lethal.
   c. Solution – how do these bacteria survive?

2. Osmolarity
   a. Condition – some bacteria can grow in >5.0 M NaCl (in the laboratory, this is above the saturation level)
   b. Problem – high salt concentrations tend to make proteins denature and aggregate
   c. Solution – how do these bacteria keep their proteins soluble and active?

3. Extreme cold temperatures
   a. Condition – some bacteria can grow at temperatures as low as -15°C (below freezing of water)
   b. Problems – at these temperatures, lipid bilayers lose their flexibility, proteins lose activity, and DNA becomes unstable.
   c. Solution – how have these bacteria adapted to live in this condition?
Instructions on preparing your chalk talks:

Each group will meet outside of class to plan presentations of the specific assigned content area. Each member of the team MUST orally contribute material to the chalk talk presentation. The group can decide how to divide up the material. For instance, if your group is assigned to prepare a presentation about how bacteria encounter and enter a host, each person could talk about strategies used by a particular bacterial species (e.g., *Salmonella typhi* vs. *Mycobacterium tuberculosis*) or group (e.g., general strategies used by gram positive vs. gram negative), or the group could arrange the talk by body system (e.g., how bacteria enter through oral cavity vs. skin).

Plan an initial session to decide how you are going to divide the work load. You should plan on doing a dry run of your presentation prior to class.

Each group will present a 20-min chalk talk to the class, using the white board to draw illustrations and emphasize important points. Don't write all the words, just the important concepts. Your goal is to teach what you've learned. Be creative. Use props.

The first half of each class session with an assigned chalk talk will be devoted to team teaching; during the second half, the lead faculty for that class will discuss details left out, drive home the most important concepts, and provide perspectives.

Students' individual performance in the team-teaching sessions will be graded by the faculty present based on the attached rubric.
CHALK TALK ASSESSMENT

Evaluation of ____________________________________________

Evaluation by ___________________________________________

Date ___________________________________________________

Title of Presentation _____________________________________

Comments:
<table>
<thead>
<tr>
<th>CRITERIA</th>
<th><strong>-A-</strong> EXPECTS EXCEEDS EXPECTATIONS (1 point)</th>
<th><strong>-B-</strong> MEETS EXPECTATIONS (0.75 point)</th>
<th><strong>-C-</strong> NEEDS IMPROVEMENT (0.5 point)</th>
<th><strong>-D-</strong> INADEQUATE (0.25 point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content/Organization</td>
<td>• Organization of presentation (1 point)</td>
<td>• Presentation has logical and clear flow</td>
<td>• Presentation mostly well organized, occasional jumps in logic</td>
<td>• Presentation doesn’t follow logical order, skips from topic to topic</td>
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<td></td>
<td>• Knowledge of topic (1 point)</td>
<td>• Demonstrates full knowledge by answering all class questions with explanation and elaboration</td>
<td>• Is at ease with expected answers to all questions, without elaboration</td>
<td>• Is uncomfortable with information and is able to answer only rudimentary questions</td>
</tr>
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<td></td>
<td>• Composure (1 point)</td>
<td>• Able to answer questions fully without losing flow of presentation</td>
<td>• Questions occasionally disrupt flow of presentation</td>
<td>• Questions distract presenter</td>
</tr>
<tr>
<td></td>
<td>• Relevance of information to assignment (1 point)</td>
<td>• Presentation clearly and thoroughly addresses assignment</td>
<td>• Presentation mostly addresses assigned topic</td>
<td>• Presentation does not clearly and completely address assigned topic</td>
</tr>
<tr>
<td>Delivery</td>
<td>• Enthusiasm (1 point)</td>
<td>• Demonstrates strong enthusiasm about topic during entire presentation</td>
<td>• Shows some enthusiastic feelings about topic</td>
<td>• Shows little or mixed feelings about the topic being presented</td>
</tr>
<tr>
<td></td>
<td>• Volume/Inflection/Pace (1 point)</td>
<td>• Speaks with fluctuation in volume and inflection to maintain audience interest and emphasize key points</td>
<td>• Speaks with satisfactory variation of volume and inflection</td>
<td>• Speaks in uneven volume with little or no inflection</td>
</tr>
<tr>
<td></td>
<td>• Eye Contact (1 point)</td>
<td>• Speaks at appropriate volume and pace, with clarity</td>
<td>• Speaks appropriately usually, but occasionally too quiet, too loud, too slow, too fast, or without clarity</td>
<td>• Speaks too quietly, too loudly, too quickly, too slowly, or indistinctly</td>
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<td></td>
<td></td>
<td>• Holds attention of entire audience with the use of direct eye contact, seldom looking at notes</td>
<td>• Consistence use of direct eye contact with audience, but still returns to notes</td>
<td>• Displays minimal eye contact with audience, while reading mostly from notes/slides</td>
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<td></td>
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<td></td>
<td>• Displays minimal eye contact with audience, while reading mostly from notes/slides</td>
<td>• Holds no eye contact with audience, as entire report is read from notes.</td>
</tr>
</tbody>
</table>
## Use of white board

<table>
<thead>
<tr>
<th></th>
<th>• Amount/use of board</th>
<th>• Only writes most important words</th>
<th>• Usually writes most important words only, sometimes too little or too much written</th>
<th>• Writes more or less than needed for understanding by audience</th>
<th>• Writing on board distracts from presentation</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>• (1 point)</td>
<td>• Uses board to facilitate flow of presentation</td>
<td>• Use of board mostly facilitates flow of presentation</td>
<td>• Use of board does not facilitate flow of presentation</td>
<td>• Writing has no apparent purpose in presentation</td>
</tr>
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<td></td>
<td></td>
<td>• Draws illustrations to help with understanding</td>
<td>• Uses illustrations occasionally</td>
<td>• Rarely uses illustrations</td>
<td>• Does not use illustrations to help with explanations</td>
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<td></td>
<td>• Legibility</td>
<td>• Writing is legible</td>
<td>• Writing difficult to read</td>
<td>• Writing difficult to read</td>
<td>• Cannot read writing</td>
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<td>• (1 point)</td>
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<td>• Interaction with audience</td>
<td>• Maintains interaction with audience while using white board</td>
<td>• Sometimes loses interaction with audience when using board</td>
<td>• Rarely interacts with audience</td>
<td>• Does not interact with audience</td>
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<td>• (1 point)</td>
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Appendix 6: White Paper Guidelines and Grading Rubric

A white paper provides information that helps solve a problem that is meaningful to the reader. It should justify why the problem must be solved, objectively explore alternative ways to solve the problem, and logically lead the reader to the conclusion that your organization has the knowledge, expertise and tools required to solve the problem.

General Points/Guidelines

1. Length: 1-2 pages maximum [1 inch margins and 12-point font]

2. Use a logical, linear approach.
   - Attract the right audience
   - Engage your reader
   - Inform your reader
   - Convince your reader

3. Write a creative, meaningful title

4. The 3-30-3 rule
   - Catch someone’s interest within first 3 seconds of glancing at your piece
   - This gives you 30 seconds to deliver your introduction, which if on target will grant you-
     - 3 minutes to make your point
   - Emphasize compelling impact throughout, whether it is need (why we need your support), describing the request (what we are asking for), and in characterizing the person making the request (why we are the best person).

4. Write in the language of your reader
   - Target audience – who will read your paper? Are you targeting a company, a venture capitalist, a government agency? non-scientists?
   - Write as if you are trying to teach someone your subject.
   - Be crisp and to the point. Word economy is what we need.

5. Be knowledgeable
   - Your paper should be well researched and documented
   - References don’t count against your 2-page limit

6. Graphics are content too!
   - If you can illustrate your point with a smart schematic or flowchart, do it.
**White Paper Organizational Specifics**

**Identified Need**

This section should be 2-3 paragraphs. This section defines whatever problem you are trying to solve (e.g., Lyme vaccine), why this problem exists, and why no one has solved it to date (e.g., in a research area, why don’t we have the answers we need). To have maximum impact, some statistics (use citations) are always helpful - how many people get sick, how much a problem costs to solve, what is the cost to from not solving the problem.

This should be the section where you make the compelling case that the problem in question is significant enough it warrants an investment. In some instances, that means critiquing the weaknesses of current efforts underway and characterizing the gaps in what work is now being done. The reader should be left thinking that the situation is either a crisis, or if not addressed, could readily become a crisis.

**Specific Requested Action**

This section should again be about 2 paragraphs in length and should begin with something like: “Because of the compelling need in addressing problem X…”

Describe, in some thumb-nail fashion so the reader can understand, what kind of activities will be undertaken/questions addressed, how these efforts address the needs outlined in the previous section, and why this approach is superior.

As part of the requested action section, you should try to describe or quantify outcomes [e.g., we will cut the rate of Lyme disease cases by 50%]. What is the return on investment? Give a range of improvement or some other measure, even if it is just for a particular class of people.

**Conclusion**

The last section of the paper should be 2-3 sentences and should summarize the request, its importance, and why you are the place to get it done.

**Closing Points**

Try to straddle the line of providing enough information for a non-scientist to make a decision, without providing the kind of overly-technical detail that will lose the reader’s attention. It must educate and advocate at the same time, and do so in a direct, to-the-point, fashion. It must have enough depth that it compels the reader to say, despite the fiscal limitations we now face, this is a sound, defensible, even compelling use of federal expenditures.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>The audience is always clearly considered in the way the text is constructed.</th>
<th>The audience is frequently considered in the way the text is constructed.</th>
<th>The audience is somewhat considered in the way the text is constructed.</th>
<th>The audience is completely ignored in the way the text is constructed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audience</td>
<td>Purpose</td>
<td>Purpose is explained with examples.</td>
<td>Purpose is mentioned with some explanation.</td>
<td>Purpose is not described.</td>
</tr>
<tr>
<td>Purpose</td>
<td>The purpose of the White paper is clearly stated and explained with examples.</td>
<td>Purpose is explained with examples.</td>
<td>Purpose is mentioned with some explanation.</td>
<td>Purpose is not described.</td>
</tr>
<tr>
<td>Organization of writing</td>
<td>The introduction provides a well developed summary at the beginning. A background on issues with specific examples &amp; explanation is presented, followed by an appropriate conclusion/solution.</td>
<td>The introduction provides a summary at the beginning. A background on issues with specific examples &amp; explanation is presented, followed by a brief conclusion/solution.</td>
<td>The introduction provides an underdeveloped summary at the beginning. A background on issues with specific example &amp; explanation is presented, followed by an Inappropriate conclusion/solution.</td>
<td>The introduction provides no summary at the beginning. No background on issues with specific example &amp; explanation is presented and no appropriate conclusion/solution follows.</td>
</tr>
<tr>
<td>Reasons for Problem/Solution</td>
<td>Reasons are logical, pertinent, and well-explained.</td>
<td>Reasons are logical, pertinent, and explained.</td>
<td>Reasons are described and explained.</td>
<td>Reasons are not described or explained.</td>
</tr>
<tr>
<td>Support for Reasons</td>
<td>Sources are integrated to explain &amp; support reasons so they are clear to readers.</td>
<td>Sources are used to explain &amp; support reasons so they are clear to readers.</td>
<td>Sources are used to describe and explain reasons.</td>
<td>Sources are used to describe with little explanation.</td>
</tr>
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<tr>
<td>Sources: How they are selected</td>
<td>Have been thoroughly analyzed and evaluated for appropriateness for issue and audience.</td>
<td>Have been analyzed and evaluated for appropriateness for issue and audience.</td>
<td>Have been analyzed and evaluated for appropriateness for issue or audience.</td>
<td>Some analysis and evaluation has been done.</td>
</tr>
<tr>
<td>Conclusions /Solution</td>
<td>Recommendations are discussed and supported with evidence.</td>
<td>Recommendations are discussed and supported with evidence.</td>
<td>Recommendations are discussed.</td>
<td>Recommendations are mentioned.</td>
</tr>
<tr>
<td>Unity &amp; Coherence</td>
<td>All of the ideas developed in the paragraphs and White Paper present the problem, need for action and a solution. The paragraphs flow together smoothly with good use of transitions.</td>
<td>Most of the ideas developed in the paragraphs and White Paper present the problem, need for action and a solution. The paragraphs flow together smoothly with use of transitions.</td>
<td>Some of the ideas developed in the paragraphs and White Paper present the problem, need for action and a solution. The paragraphs flow together smoothly with some use of transitions.</td>
<td>Many ideas do not help develop the thesis. The White Paper and paragraphs usually do not flow smoothly because of lack of connecting words or order of ideas is confusing.</td>
</tr>
<tr>
<td>Grammar</td>
<td>1 or fewer errors</td>
<td>2 or fewer errors</td>
<td>3 or fewer errors</td>
<td>4 or fewer errors</td>
</tr>
</tbody>
</table>
Student Instructions:

Title of Presentation Assignment: **Persuasive Presentation of Biomedical Project**

Description of Assignment: Using your white paper for a basis you will create a 20-minute presentation (including time for questions) to convince a panel of potential investors to support your project. The investors are professionals but NOT necessarily scientists.
Investor Panelist Review

Please circle your decision on this pitch:

Full Support   Partial Support   Support with Reservations   Would not Support

Please list any comments or suggestions to explain your decision and improve the student’s abilities to communicate ideas in the future:

Grading guidelines for oral presentation:

- Logic/order of presentation: 10 points
- Viability of proposal: 15 points (# support/total x 15; -0.5 point for each scientific concern expressed, +0.5 point for scientific positive comment; Note that we did not ask students to address budget/manufacturing etc. in viability, just the science, so no deduction for unrealistic budget)
- Ability to answer questions: 15 points
- Presentation style: 10 points
Appendix 8: Module Evaluations

Part A

The two-semester Scientific Discovery course (BIMD501 and BIMD502) was designed to build skills in nine identified areas (competencies). It is anticipated that full mastery of each of these areas will not be achieved until the end of the second semester. However, each Module should build skills in most, if not all, of the nine competencies.

Please complete the survey to indicate whether you feel that you have acquired skill in the competency and whether the format used was effective.

---

**Competency #1**
Acquisition and application of advanced concepts in biochemistry, cell biology, molecular biology, and related basic biomedical sciences.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
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<tbody>
<tr>
<td>a. Module 4 effectively built skills related to this competency. Please answer NA if this competency was not addressed in this Module.</td>
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<tr>
<td>b. The learning modality used was effective for this competency. Please answer NA if this competency was not addressed in this Module.</td>
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**Competency #2**
Identification, reading, interpretation, and analysis of the current scientific literature.

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**Competency #3**
Evaluation and construction of testable hypotheses.

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<tr>
<td>Competency #4</td>
<td>Hypothesis testing and experimental design.</td>
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<td>Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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<tr>
<th>Competency #5</th>
<th>Development of written communication skills.</th>
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<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
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<thead>
<tr>
<th>Competency #6</th>
<th>Development of oral communication skills.</th>
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<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
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### Competency #7
Communication with the public.

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<th>Strongly Disagree</th>
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### Competency #8
Application of Scholarly Tools (statistical analysis, ethical considerations).

<table>
<thead>
<tr>
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### Competency #9
Application of basic biomedical science concepts to transdisciplinary and/or translational problems in related biomedical disciplines.

<table>
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<tr>
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Please answer the following general questions regarding Module 4.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
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<th>Agree</th>
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</tr>
</thead>
<tbody>
<tr>
<td>The Module was well organized.</td>
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<td>The Module expectations were</td>
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<td>clear.</td>
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</tr>
<tr>
<td>The readings and assignments contributed to my learning.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
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</tr>
<tr>
<td>Feedback on my performance was provided promptly.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
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</tr>
<tr>
<td>Grading of this Module was fair.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
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</tr>
<tr>
<td>The work required for the Module was appropriate for the credit given.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○</td>
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</tbody>
</table>

Please indicate the components of this Module that best promoted learning:

Please indicate the components of this Module that inhibited or were least effective for promoting learning:

Please add any additional comments regarding this Module: