Supplemental Materials

for

Correlating Student Knowledge and Confidence Using a Graded Knowledge Survey to Assess Student Learning in a General Microbiology Classroom

Lacey Favazzo\textsuperscript{1}, John D. Willford\textsuperscript{2}, and Rachel M. Watson\textsuperscript{2*}

\textsuperscript{1}Department of Microbiology and Immunology, University of Rochester School of Medicine and Dentistry, Rochester, NY 14642, \textsuperscript{2}Department of Molecular Biology, University of Wyoming, Laramie, WY 82071

Table of Contents

(Total pages 26)

Appendix 1: University of Wyoming Microbiology Program Curriculum Map
Appendix 2: Bloom’s levels used to classify pretest/posttest knowledge survey questions
Appendix 3: Pretest/posttest knowledge survey
Appendix 4: Pretest/posttest knowledge survey instructions for fall 2011

*Corresponding author. Mailing address: Department of Molecular Biology, 1000 E. University Ave., Laramie, WY 82071, Phone: 307-766-3524. Fax: 307-766-5098. E-mail: rwatson@uwyo.edu.

©2014 Author(s). Published by the American Society for Microbiology. This is an Open Access article distributed under the terms of the Creative Commons Attribution-Noncommercial-NoDerivatives 4.0 International license (https://creativecommons.org/licenses/by-nc-nd/4.0/ and https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode), which grants the public the nonexclusive right to copy, distribute, or display the published work.
Arrows indicate learning objectives addressed in – or type of assessment proposed to measure outcomes in – noted courses.
<table>
<thead>
<tr>
<th>Bloom's Level</th>
<th>Sample query sound or verb nature (suggested by Nuhfer and Knipp, 2003 and Overbaugh and Schultz, n.d)</th>
<th>Sample Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>define, list, state, answer who? or what?</td>
<td>List the four classes of macromolecules and state at least one cellular function of each.</td>
</tr>
<tr>
<td>Comprehension</td>
<td>recognize, classify, translate, interpret, paraphrase, explain, predict or give an example</td>
<td>Use your own words to explain the following passage: <em>(passages as taken from literature)</em>.</td>
</tr>
<tr>
<td>Application</td>
<td>solve, demonstrate, write, draw, calculate or interpret</td>
<td>If a yeast cell, in an aerobic culture completely catabolized 4.5 X 10^9 molecules of glucose, determine the maximum number ATP molecules that could be synthesized via both substrate-level and oxidative phosphorylation.</td>
</tr>
<tr>
<td>Analytical</td>
<td>compare, contrast, differentiate</td>
<td>Compare HIV and the poliovirus with respect to route of entry, capsid type, genome, route of transmission, and exit strategy.</td>
</tr>
<tr>
<td>Synthesis</td>
<td>design, construct, develop</td>
<td>Design and draw a plasmid that incorporates lac operon and would allow a researcher to visibly determine whether the genes under control of the operon are being expressed.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>justify, support, defend</td>
<td>If you were a physician hoping to treat a case of &quot;walking pneumonia&quot; caused by <em>Mycoplasma pneumoniae</em>, which antibiotic would you prescribe? Defend your choice based on bacterial cell wall structure and antibiotic target site.</td>
</tr>
</tbody>
</table>
Appendix 3: Pre-test / Post-test Knowledge Survey

Exam Manager - Preview Exam

Pre-test and Knowledge Survey

The following pre-test / post-test knowledge survey has been designed to enable our assessment of both knowledge and confidence. In administering this test/survey we have two primary goals. The first is to provide you, as students, with a list of many of the concepts that will be covered throughout the semester. We hope that this will enable you to monitor your progress through the course. We also hope that it will communicate some of our expectations / learning outcomes to you. Secondly and most importantly is that your instructor and teaching assistants will look to the survey to help us enhance our organization and coverage of course content and thus to better facilitate your learning. Towards these ends, a few of the questions that you encounter will represent concepts introduced in courses outside of General Microbiology.

Upon completing and submitting the survey, you will receive points for completion. These are extra points that can be used to replace your lowest homework score. However, your answers will not be scored for purposes of assigning a grade. Your overall course grade will not be impacted by your answers to the questions in any way. Your responses will be identifiable only to the instructor and teaching assistants of the course and will be used only in compilation with other student scores to determine overall usefulness of the knowledge survey tool.

For each item on the survey, please first, using your present knowledge, answer the question to the best of your ability and then secondly, rate (on a three-point scale) your confidence in your answer. To assess your confidence, please fill in an A, B or C in accord with the following instructions:

Mark an “A” as response if you feel confident that you answered the question sufficiently for graded test purposes.

Mark a “B” response to the question if you feel that you answered at least 50% of it or if you know precisely where you could quickly get the information needed and could return here in 20 minutes or less to provide a complete answer for graded test purposes.

Mark a “C” as response to the question if you are not confident that you adequately answered the question for graded test purposes at this time.

1. List four classes of macromolecules and state at least one cellular function of each. Also, what type of bonds/ linkages form between each precursor to form the macromolecule for each type? (Points : 1)

2. Rate your confidence in your answer to question #1. (Points : 1)

A
3. What are the components of the following bacterial cell wall? Is this a Gram-positive or Gram-negative bacterium?

![Bacterial Cell Wall Diagram]

3. (Points : 1)

4. Rate your confidence in your answer to question #3 (Points : 1)

☐ A
☐ B
☐ C

5. What two HIV proteins mediate viral attachment to a CD4 cell, and what host cell receptors do they use? (Points : 1)

[Spellchecker]

4. (Points : 1)
6. Rate your confidence in your answer to question #5 (Points : 1)
   - [ ] A
   - [ ] B
   - [ ] C

7. List two structures found in most eukaryotic cells but that are absent in most bacterial cells. (Points : 1)
   
   Spellchecker

8. Rate your confidence in your answer to question #7. (Points : 1)
   
   - [ ] A
   - [ ] B
   - [ ] C

9. In general, the cytosol of a Gram positive cell has a ________ charge as compared to the ________ charge of extracellular fluid. (Points : 1)
   
   Spellchecker

10. Rate your confidence in your answer to #9. (Points : 1)
    
    - [ ] A
    - [ ] B
    - [ ] C

11. Match each description with the correct element of the cytoskeleton.
Microtubules
Microfilaments
Intermediate Filaments

A. 8-10 nm  
B. composed of tubulin  
C. responsible for maintaining shape  
D. composed of actin  
E. involved in motion and shape change  
F. Bear tension and strengthen  
G. the most stable structural element  
H. form mitotic spindles

12. Rate your confidence in your answer to #11. (Points : 1)

☐ A  
☐ B  
☐ C

13. Name Mendel's two laws. (Points : 1)

Spellchecker

14. Rate your confidence in your answer to #13. (Points : 1)

☐ A  
☐ B  
☐ C
15. True or false: natural selection occurs when a single organism changes genetically in response to a change in environment. (Points : 1)

- True
- False

16. Rate your confidence in your answer to #15. (Points : 1)

- A
- B
- C

17. Give an organism in which you might expect to see polyploidy without catastrophic phenotypic results. (Points : 1)

- Spellchecker

18. Rate your confidence in your answer to #17. (Points : 1)

- A
- B
- C

19. Define proteome. (Points : 1)

- Spellchecker

20. Rate your confidence in your answer to #19. (Points : 1)

- A
- B
- C

21. What is the name given to an organism that uses light as an energy source but uses an organic carbon source? (Points : 1)

22. Rate your confidence in your answer to #21. (Points : 1)

- A
- B
23. What is the purpose of fermentation in a yeast cell growing anaerobically? (Points: 1)

24. Rate your confidence in your answer to #23. (Points: 1)
   - A
   - B
   - C

25. Name three amino acids that would likely be present in an integral membrane protein and exposed to the hydrocarbon tails of the phospholipid bilayer. In contrast, name three amino acids you would never expect to find in the hydrocarbon portion of a phospholipid bilayer. (Points: 1)

26. Rate your confidence in your answer to #25. (Points: 1)
   - A
   - B
   - C

27. Explain the significance of meiosis. (Points: 1)
28. Rate your confidence in your answer to #27. (Points : 1)

☐ A
☐ B
☐ C

29. Describe a type of chromosomal translocation in which the phenotype is likely to remain normal and suffer no ill effects. Explain your reasoning. (Points : 1)

30. Rate you confidence in your answer to #29. (Points : 1)

☐ A
☐ B
☐ C

31. Describe the function of a leader exon. (Points : 1)
32. Rate your confidence in your answer to #31. (Points : 1)
   - A
   - B
   - C

33. How does a promoter regulate gene expression? (Points : 1)
   Spellchecker

34. Rate your confidence in your answer to #33. (Points : 1)
   - A
   - B
   - C

35. Explain the life cycle of a lytic bacteriophage. (Points : 1)
   Spellchecker
36. Rate your confidence in your answer to #35. (Points : 1)
   □ A
   □ B
   □ C

37. List at least three functions of a lipid bilayer and explain their importance to a cell. (Answers need not necessarily be confined to the cytoplasmic membrane.) (Points : 1)

   Spellchecker

38. Rate your confidence in your answer to #37. (Points : 1)
   □ A
   □ B
   □ C

39. An important aspect of innate immunity is the ability of tracheal cells to sweep mucus and trapped microbes up and out of the trachea. What organelle is most important in this process? (Points : 1)

   Spellchecker
40. Rate your confidence in your answer to #39. (Points : 1)

☐ A
☐ B
☐ C

41. The following passage has two obvious mistakes. Please note and correct these.
In 1972, S. Jonathan Singer and Garth L. Nicolson developed the Fluid Mosaic model. This model describes the membrane as an impermeable phospholipid bilayer in which proteins and phospholipids are rigid and tightly tethered. (Points : 1)

Spellchecker

42. Rate your confidence in your answer to #41. (Points : 1)

☐ A
☐ B
☐ C

43. Salmonella typhimurium commonly causes water-borne disease. This pathogen is capable of surviving and replicating in host phagocytic cells by a mechanism that was largely unknown for many years. In a 1989 a study was published in Science (Vol. 243) showing that a gene called phoP plays a large role in virulence. In fact, strains with phoP mutations are largely avirulent (do not survive phagocytosis).

The following is a partial sequence for this gene (as accessed on GenBank):
1  5’gtgactctgg tcgacgaact taaataatgc ctgcttcacc ctcttttctt cagaaagagg
61 gtgactattt gtctggttta ttaactgttt atccccaaag caccataatc aacgctagac
121 tgttcttatt gttaacacaa ggagaagag atgatgcgcg tactggttgt agaggataat
181 gcattattac gccacacct gaaggttcag cttccagtct aggctacca ggtcgatgcc
241 gcagaagatg ccagggaagc tgattactac cttgtaatgc accttccgga tattctatt
301 gtgatttag agtcgccgga taaagcaggg ccctcctatt aacgcgccttg ggcaacagt
361 gatgttttac tgcgggttct tgtgttaacc gcgcgcaagac ggtgccagga taaagctgag
421 gtcttgactct ccggggccaag tgactactgtg acaagagcat tccacatcgag agggtaattg
481 gcggagtgtgc aggcgttaat gccgcgcaat gccgcggttgag cttccaggtgatcagactc...
The region that will be transcribed to form the Shine-Dalgarno sequence has been underlined.
What are the first five amino acids of the PhoP gene product? (Please do not forget to specify whether the amino or carboxyl terminus is first. Please see the codon usage table for assistance.)?
44. Rate your confidence in your answer to #43. (Points : 1)

☐ A  
☐ B  
☐ C

45. What technique is described by the following passage from *Applied and Environmental Microbiology* (2004 February; 70(2): 781–789)?

“...initial denaturation of the template DNA at 95°C for 5 min, a pause at 82°C to add *Taq* DNA polymerase (5 U; Promega), and then 35 cycles of denaturation, annealing, and extension using a touchdown program as described previously (Ferrari, V. C., and J. T. Hollibaugh. 1999. *Hydrobiology* 401:55-68).”

(Points : 1)

46. Rate your confidence in your answer to #45. (Points : 1)

☐ A
47. Give a Product and a Mechanism for the following reaction. State the type of reaction that is occurring.

\[
\begin{array}{c}
\text{Br} \\
\text{Me} \\
\text{OH}
\end{array}
\]

(Points : 1)

48. Rate your confidence in your answer to #47. (Points : 1)

☐ A  ☐ B  ☐ C

49. Prior to making wine, a starter culture of yeast is made and allowed to grow in an aerobic environment. If a yeast cell in this culture completely catabolizes \(4.5 \times 10^9\) molecules of glucose, determine how many ATP could be generated via substrate-level and oxidative phosphorylation. Assume that the electrons carried by the NADH molecules produced in glycolysis generate \(~2\) ATP/NADH if delivered to the ETC. Please clearly explain every step of your calculation.

(Points : 1)
50. Rate your confidence in your answer to #49. (Points : 1)
- [ ] A
- [ ] B
- [ ] C

51. Mitochondrial diseases display non-Mendelian inheritance. Explain why this is so. If a child's father has a mitochondrial disease but the mother doesn't, could the child also have the disease? Why or why not? (Points : 1)

52. Rate your confidence in your answer to #51. (Points : 1)
- [ ] A
- [ ] B
- [ ] C

53. The eukaryotic organelles, mitochondria and chloroplasts, are thought to have originated from bacterial ancestors. List two features of these organelles and explain why these features give credence to this endosymbiotic theory. (Points : 1)
54. Rate your confidence in your answer to #53. (Points : 1)

□ A
□ B
□ C

55. A cell needs to allow the movement of a molecule down its concentration gradient, but the molecule is too large/polar for simple, passive diffusion. How else could the cell move this molecule? (Points : 1)

56. Rate your confidence in your answer to #55. (Points : 1)

□ A
□ B
□ C

57. The cyanobacteria, such as Nostoc, utilize both photosystem I and II in their light reactions. Ammonia is toxic to cyanobacteria as it enacts damage on photosystem II. If this photosystem were damaged to the point of being basically ineffective, explain how each of the following would be affected: The ability to oxidize water, Production of NADPH, The Calvin Cycle (Points : 1)
58. Rate your confidence in your answer to #57. (Points : 1)

☐ A
☐ B
☐ C

59. Compare and contrast an enveloped and a non-enveloped virus with respect to morphology and possible entry and exit strategies. (Points : 1)

60. Rate your confidence in your answer to #59. (Points : 1)

☐ A
☐ B
☐ C

61. Choose two of the stages of mitosis to compare and contrast, making sure to include form and location of genetic material and microtubules as well as any other relevant information. (Points : 1)

Spellchecker
62. Rate your confidence in your answer to #61. (Points : 1)

☐ A  
☐ B  
☐ C

63. Compare and contrast aneuploidy and polyploidy. (Points : 1)

[Spellchecker]

64. Rate your confidence in your answer to #63. (Points : 1)

☐ A  
☐ B  
☐ C

65. Compare and contrast natural selection with artificial selection, including the causal agent of each. (Points : 1)

[Spellchecker]
66. Rate your confidence in your answer to #65. (Points : 1)

☐ A
☐ B
☐ C

67. Fermented beverages have a long and diverse history. One famous fermented product is Kombucha, originally a Chinese beverage that has gained popularity in the United States. Traditionally Kombucha is made with both bacteria and yeast. One Lactic Acid Bacterium sometimes used is *Lactobacillus*. This bacterium is strictly fermentative. One type of yeast used is *Candida stellata*. Like most yeast, *C. stellata* can grow using either aerobic respiration or alcoholic fermentation. The home-brewer interested in making Kombucha would generally begin a culture with an inoculum from a previous culture. This would be placed into a jar with sugared tea and fully mixed. The jar is covered with a paper towel or coffee filter. Bearing in mind that the paper towel or coffee filter does not preclude the entrance of atmospheric gases and that the culture was just mixed, please describe and differentiate between the fate of the pyruvate in the metabolism of *Lactobacillus* versus that of *C. stellata*? (Points : 1)

68. Rate your confidence in your answer to #67. (Points : 1)

☐ A
69. Use your own words to explain the difference between oxidative and substrate-level phosphorylation. (Points: 1)

---

70. Rate your confidence in your answer to #69. (Points: 1)

---

71. Design and describe a plasmid that incorporates the lac operon and would allow a student researcher to visibly determine whether the genes under control of the operon are being expressed. Please clearly indicate the environmental conditions under which the visible gene product would be produced. (Points: 1)

---

72. Rate your confidence in your answer to #71. (Points: 1)

---

73. Viruses are usually very host specific. Viral infection is based on traits of the virus, the host cell, and the interactions between the two. You have just discovered a new virus that needs a large water filled vacuole to effectively infect its host. Based on this background knowledge, describe the structure and type of cell that is most likely host to this virus.

(Points: 1)
74. Rate your confidence in your answer to #73? (Points : 1)

☐ A
☐ B
☐ C

75. Amy is working in the lab over the summer with two enteric bacteria: *Shigella flexneri* and *Salmonella enteritis*. She has stably transformed *Shigella flexneri* with a plasmid encoding for resistance to ampicillin. She then notes that if she incubates this strain with the *Salmonella enteritis* overnight, then *Salmonella* also gains resistance to ampicillin. Amy correctly concludes that this is due to a lateral gene transfer event. She further hypothesizes that it is conjugation occurring between the two genera. Describe an experiment that Amy could perform to support her hypothesis. (Points : 1)

76. Rate your confidence in your answer to #75. (Points : 1)

☐ A
☐ B
☐ C
77. If you were a physician hoping to treat a case of "walking pneumonia" caused by *Mycoplasma pneumoniae*, which antibiotic would you prescribe. Defend your choice based on bacterial cell wall structure and antibiotic target site.) (Points : 1)

78. Rate your confidence in your answer to #77. (Points : 1)

☐ A
☐ B
☐ C

79. The following is the abstract from an article in the *Journal of Medical Ethics*. Take the position you believe and defend your choice.

"The purpose of this article is to ascertain and appraise the ethical issues inherent to the utilisation of preimplantation genetic diagnosis for gender selection in infertile patients anticipating undergoing a medically indicated assisted reproductive technique procedure. Performance of preimplantation genetic diagnosis per request specifically for gender selection by an infertile couple undergoing medically indicated assisted reproductive technique may not breach the principles of ethics, and is unlikely to alter the population balance of sexes."

(Points : 1)
80. Rate your confidence in your answer to #79. (Points : 1)

☐ A
☐ B
☐ C

81. Please discuss your overall confidence as you begin this course. Feel free to tell us about particular areas or ways in which you feel more or less confident. (Points : 1)

82. I am: female or male? (Points : 1)

83. Do you consider yourself to be part of a minority group? (Points : 1)

84. In the list of courses below please check those that you have taken or are currently taking: (Points : 1)

☐ Genetics
☐ Animal Biology
☐ Plant Biology
☐ Introduction to Organic Chemistry or Organic Chemistry I and II
☐ Introduction to Molecular Biology
☐ Principles of Biochemistry or Biochemistry I and II
☐ General Microbiology
☐ Pathogenic Microbiology
☐ Microbial Genetics
☐ Immunology
Appendix 4: Pre-test / Post-test Knowledge Survey Instructions for Fall 2011

General Microbiology: Pre-test / Post-test Knowledge Survey

The following pre-test / post-test knowledge survey has been designed to enable our assessment of both knowledge and confidence. In administering this test/survey we have two primary goals. The first is to provide you, as students, with a list of many of the concepts that will be covered throughout the semester. We hope that this will enable you to monitor your progress through the course. We also hope that it will communicate some of our expectations / learning outcomes to you. Secondly and most importantly is that your instructor and teaching assistants will look to the survey to help us enhance our organization and coverage of course content and thus to better facilitate your learning. Towards these ends, a few of the questions that you encounter will represent concepts introduced in courses outside of General Microbiology.

Upon completing and submitting the survey, you will receive points for completion. These are extra points that can be used to replace your lowest homework score. However, your answers will not be scored for purposes of assigning a grade. Your overall course grade will not be impacted by your answers to the questions in any way. Your responses will be identifiable only to the instructor and teaching assistants of the course and will be used only in compilation with other student scores to determine overall usefulness of the knowledge survey tool.

For each item on the survey, please first, using your present knowledge, answer the question to the best of your ability and then secondly, rate (on a five point scale) your confidence in your answer. To assess your confidence, please mark your confidence from 1 to 5 in accord with the following instructions:

5  Mark a "5" if you feel confident that you answered the question completely and had no need for outside information.
4  Mark a "4" if you feel confident that you answered at least 50% of the question or know precisely where you could quickly (20 minutes or less) get the information needed to provide a complete answer.
3  Mark a "3" if you feel confident that you answered at least 50% of the question or know precisely where you could quickly (20 minutes or less) get the information needed to provide a complete answer.
2  Mark a "2" if you are not confident that you knew the answer or do not know where you could quickly get the information needed to answer the question completely.
1  Mark a "1" if you are not confident that you knew the answer or do not know where you could quickly get the information needed to answer the question completely.