1. The following table contains some of the main steps in beer production, but the order is scrambled. Arrange the steps in order, from 1 to 6. Also, fill in the functions of any four of the steps. *If you fill in more than four, I will count only the first four in the list* (14 points total).

<table>
<thead>
<tr>
<th>Step number</th>
<th>Name of step</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boiling with hops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling of wort</td>
<td></td>
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<tr>
<td></td>
<td>Conditioning</td>
<td></td>
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<tr>
<td></td>
<td>Fermenting</td>
<td></td>
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<tr>
<td></td>
<td>Malting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pitching</td>
<td></td>
</tr>
</tbody>
</table>

2. On the graph below, draw lines showing how sugar content (solid line) and ethanol content (dashed line) should change as fermentation proceeds. In the space to the right of the graph, explain the logic behind your answer (4 points).
3. Michelle’s paper compared three yeast strains that varied in their tolerance for oxidative stress.

   a. What did the researchers predict would be the relationship between oxidative stress tolerance and the oxidative stability of the beer? (2 points)

   b. How did the results compare to this prediction? (2 points)

   c. Given that they used three strains, how confident are you in the relationship between oxidative stress tolerance and oxidative stability? Briefly explain. (2 points)

4. Jeremiah’s paper was about the effect of pitching rate on fermentation performance and beer quality.

   a. In theory, why does it save money for a brewery to increase the pitching rate? (2 pts)

   b. In this study, how did pitching rate affect fermentation rate? (2 points)

   c. In this study, how did pitching rate affect beer quality? (2 points)

5. a. According to your background reading on natural products chemistry, what is the difference between primary metabolites and secondary metabolites? (2 points)

   b. List three examples of secondary metabolites produced by fungi (3 points).

   Total (this page) ________/17 points
6. Erin’s paper described the discovery of a compound called pseudallin.
   a. What evidence led the authors to conclude that pseudallin is an antibiotic? (2 pts)

   b. List two examples of additional evidence that you might require before deciding whether pseudallin is worth pursuing as a potential drug for use in humans (4 pts).

7. Hoang’s paper was about a “cuckoo fungus” with a unique form of mimicry.
   a. What does the fungus seem to be mimicking? (2 points)

   b. How did the researchers use glass balls to test their hypotheses about the chemicals responsible for the mimicry? (3 points)

8. How has epigenetics changed the way Dr. Cichewicz’s team induces fungi to produce useful secondary metabolites? (3 points)

9. a. Nate’s paper was about the formation of appressoria by a plant pathogenic fungus, whereas Robert’s was about the development of a plant disease called corn smut. In general, how were the methods described in the papers similar? (4 points)

   b. What is the structure and function of an appressorium? (3 points)

Total (this page) ________/21 points
c. *Ustilago maydis* is the fungus that causes corn smut. Is it a zygomycete, ascomycete, or basidiomycete? (2 points)

d. A partial life cycle of *Ustilago maydis* appears below. Indicate the locations of plasmogamy, karyogamy, and meiosis (3 points).

![Life cycle of Ustilago maydis](image)

e. What fungal structure develops inside the tumors that form on a plant infected with corn smut? (2 points)

10. a. According to Tracey Payton Miller, what is the function of a county extension service? (2 points)

   b. Draw and label the disease triangle (3 points).

Total (this page) ________/12 points
c. What is integrated pest management (IPM)? (2 points)

d. How is the disease triangle useful as a framework for using IPM? (4 points)

11. Matt’s paper was about cobweb disease of white button mushrooms.
   a. What was the overall objective of the study? (2 points)
   
   b. What was the most useful finding of the study? (2 points)

12. Ning’s paper was about biological control of a particular pest of commercially grown white button mushrooms.
   a. What was the pest, and what were the two biocontrol agents they compared? (You don’t need to give the scientific names, just the types of organisms.) (3 points)

      The pest: ______________________________

      The two biocontrol agents: __________________________ and __________________________

   b. Describe one weakness of the experimental methods these researchers used (3 pts).

Total (this page) ________/16 points
13. Sandra Williams (Lost Creek Mushroom Farms) described commercial mushroom operations ranging from the very high-tech (China) to the “medium tech” (India) to the very low tech (Ghana). Give two specific examples that illustrate how the Chinese, Indian, and Ghanaian operations differed (6 points).

14. Apply what you learned about IPM to the cultivation of white button mushrooms in the United States.

   a. What are two abiotic and two biotic conditions might cause diseases in a mushroom growing facility? You can choose anything you want except the specific pathogens covered by Matt’s and Ning’s papers. (2 points)

      a. abiotic:

      b. biotic:

   b. As a grower, what are examples of IPM-friendly ways you might combat the specific conditions you selected? (4 points)

   c. Describe two benefits and two drawbacks of IPM (4 points).

Total (this page) ________/16 points