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Name: \_\_\_\_\_

Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ Class Hour: \_\_\_\_

## Dairy Waste To Power

### Student Response Guide

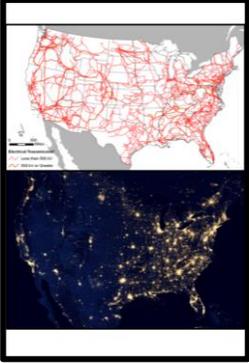
**This is not a Student Response Guide yet!** First it is your job to:

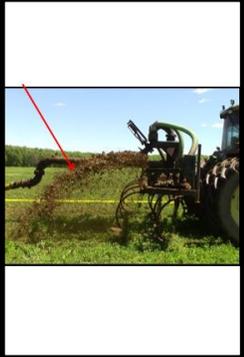
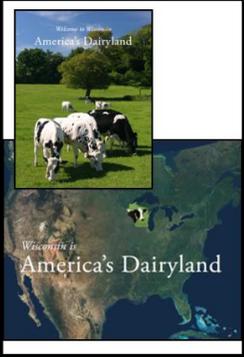
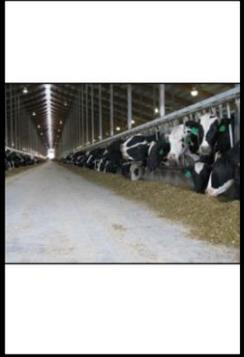
- select the assessment questions you would like to use from the menu of questions that follows
- change the wording as necessary to suit your teaching level or situation
- delete questions you do not want to use
- add questions of your liking to these
- change the order and numbering if you like
- delete the copyright page, delete these instructions, and reorganize the document to your liking.

Pictures from the lesson have been placed by each question. Research shows that placing a visual related to an assessment question improves student answers.

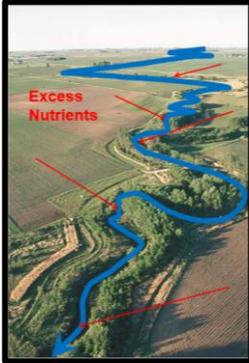
Question and Answer	Photograph
<p>1. What is this?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p>* Answer</p>	

Question and Answer	Photograph
<p>2. What is this (the bubbles)?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>3. Each of these is a(n)?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>4. Each of these is a(n)?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>5. Each of these is a(n)?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>6. What is this?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>7. What is this?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>8. What is this?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>9. Each of these depicts?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>10. What is this?</p> <p>Choices:</p> <p>anaerobic digester, biogas, biosolids, cow feed, cow waste, digested liquid fertilizer, electrical generator, electrical grid, lagoon storage, solids separator</p> <p><b>* Answer</b></p>	
<p>11. Name one popular industry from another state that Wisconsin's dairy industry easily surpasses economically:</p> <p><b>* Answer</b></p>	
<p>12. Which product segment in Wisconsin's dairy industry is growing the fastest (it's almost doubled in the last 20 years)?</p> <p><b>* Answer</b></p>	
<p>13. Wisconsin has roughly <b>* Answer</b> dairy cows on about <b>* Answer</b> dairy farms.</p>	

Question and Answer	Photograph
<p>14. Each cow in Wisconsin generates more than * <b>Answer</b> of economic activity every year.</p>	
<p>15. Describe at least three ways dairy cows are well cared for. * <b>Answer</b></p>	
<p>16. Explain: Besides keeping milk production up, why is it in a dairy farmer's best interest to keep cows healthy? * <b>Answer</b></p>	
<p>17. Cows typically consume over * <b>Answer</b> pounds of food each day.</p>	

Question and Answer	Photograph
<p>18. Cows are mammals called “ruminants” that * <b>Answer</b>. This is when the food a cow consumes is later returned to its mouth where it is chewed a second time.</p>	
<p>19. The three most important nutrients needed for plant growth are * <b>Answer</b></p>	
<p>20. A * <b>Answer</b> will track which nutrients are already in the soil, which nutrients are applied to the soil, when, where, and how they are applied, and in what form they are applied.</p>	
<p>21. Streams that are close to fertilized fields can be seriously affected by excess nutrient * <b>Answer</b> when the snow melts or when it rains.</p>	

Question and Answer	Photograph
<p>22. * <b>Answer</b> is the environmental response of a waterway to the addition of excess nutrients from fertilizer.</p>	
<p>23. Explain: What is eutrophication? What are the steps that lead to eutrophication?</p> <p>* <b>Answer</b></p>	
<p>24. Explain: How can urban, city dwellers cause the same kind of eutrophication that happens from agricultural runoff?</p> <p>* <b>Answer</b></p>	
<p>25. Explain: What general information is contained in a dairy farm's nutrient management plan?</p> <p>* <b>Answer</b></p>	

Question and Answer	Photograph
<p>26. Explain: Why is it important for a dairy farm to have a nutrient management plan?</p> <p>* <b>Answer</b></p>	
<p>27. Describe at least three qualities that good cow bedding material must possess.</p> <p>* <b>Answer</b></p>	
<p>28. The average cow in Wisconsin, when milking, produces about * <b>Answer</b> pounds of milk each day, which is about * <b>Answer</b> gallons.</p>	
<p>29. A typical milk cow will eliminate over * <b>Answer</b> pounds of waste in a day.</p>	

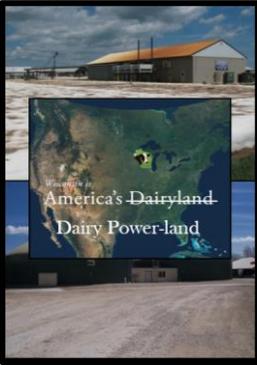
Question and Answer	Photograph
<p>30. * <b>Answer</b> can be defined as the breakdown of organic material by microorganisms in the absence of oxygen.</p>	
<p>31. You may think of an anaerobic digester as a really big * * <b>Answer</b>.</p>	
<p>32. The price for building a “small” anaerobic digester will start somewhere near * <b>Answer</b>.</p>	
<p>33. While it passes through the digester cow waste is kept at a temperature of about * <b>Answer</b>.</p>	

Question and Answer	Photograph
<p>34. Explain: Where does the heat required for the anaerobic digester come from?</p> <p><b>* Answer</b></p>	
<p>35. A liquid storage lagoon will always be lined. A liner is used to protect <b>* Answer</b> supplies beneath the lagoon from any kind of contamination from above.</p>	
<p>36. For lagoon liquid storage, a liner of <b>* Answer</b> will always be used. If conditions require it, a second lining of thick <b>* Answer</b> may be applied over the top of the first liner.</p>	
<p>37. Explain: What are the differences between what is stored in a lagoon on a dairy farm with a digester compared with what is stored in a lagoon on a dairy farm without an anaerobic digester.</p> <p><b>* Answer</b></p>	

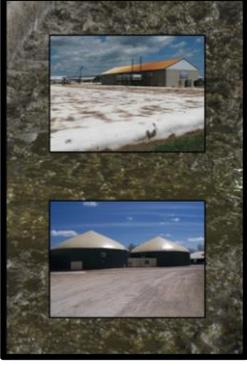
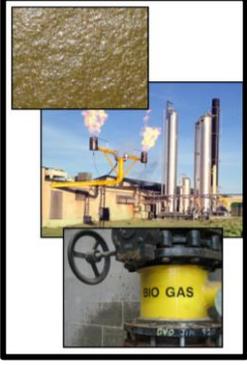
Question and Answer	Photograph
<p>38. Explain: Why is digested liquid fertilizer easier for plants to use and safer for the environment than fertilizing with raw cow waste?</p> <p><b>* Answer</b></p>	
<p>39. Crops can take up and use nutrients from a synthetic fertilizer about as easily as they can take up and use nutrients from digested liquid fertilizer. Why is digested liquid fertilizer looked at as a better, more sustainable, “green” fertilizer?</p> <p><b>* Answer</b></p>	
<p>40. As you know, anaerobically digested liquid cow waste is used as a liquid crop fertilizer. Raw cow waste is also applied to crops as a fertilizer. Explain: What are the three important differences between digested liquid fertilizer and raw cow waste that is used as a fertilizer?</p> <p><b>* Answer</b></p>	
<p>41. Explain: What characteristics do biosolids possess that make them an excellent soil amendment? What characteristics do biosolids possess that make them an excellent cow bedding material?</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>42. Anaerobic bacteria perform natural decomposition within the digester. In the end the gaseous product, called biogas, is a mixture of mostly * <b>Answer</b> and some carbon dioxide (CO<sub>2</sub>).</p>	 <p>The photograph is split into two parts. The top part shows a close-up of numerous small, light-colored bubbles rising through a dark liquid. A small red box with the text 'Bubbles of biogas' is overlaid on this section. The bottom part shows a yellow cylindrical container labeled 'BIO GAS' with a black valve handle on top, mounted on a metal base.</p>
<p>43. As you know, biogas is also produced from raw, undigested cow waste. However, this biogas is produced as the raw cow waste breaks down in the storage lagoon or as it breaks down after it is applied on a field. The biogas produced in this way is released to the * <b>Answer</b>.</p>	 <p>The photograph is split into two parts. The top part shows a large, calm body of water, likely a storage lagoon, surrounded by green trees. The bottom part shows a rural landscape with a field of golden-brown crops in the foreground and a few houses in the distance under a clear sky.</p>
<p>44. Explain: On a farm without an anaerobic digester, where does the methane that's produced go? On a farm with an anaerobic digester, where does the methane that's produced go?</p> <p>* <b>Answer</b></p>	 <p>The photograph is a collage of four images. The top-left image shows a storage lagoon. The top-right image shows a farm with a large white structure, likely an anaerobic digester. The bottom-left image shows a field of crops. The bottom-right image shows a farm building.</p>
<p>45. As you know, methane biogas is produced in the anaerobic digester. Explain how the production of methane biogas can be looked at as a positive result. Also explain how the production of methane biogas can be looked at as a avoiding a negative result.</p> <p>* <b>Answer</b></p>	 <p>The photograph is split into two parts. The top part shows a close-up of numerous small, light-colored bubbles rising through a dark liquid. The bottom part shows a yellow cylindrical container labeled 'BIO GAS' with a black valve handle on top, mounted on a metal base.</p>

Question and Answer	Photograph
<p>46. Biogas that has been produced in an anaerobic digester is pumped here and burned to produce * <b>Answer</b>.</p>	
<p>47. Unlike renewables like wind and solar, electricity production from renewable biogas can be depended on * <b>Answer</b> hours a day, * <b>Answer</b> days a week.</p>	
<p>48. The waste from a dairy farm of 2750 cows can be used to make enough electricity to power * <b>Answer</b> average homes.</p>	
<p>49. Name three common <u>nonrenewable</u> natural resources used to produce electricity in Wisconsin:  * <b>Answer</b></p>	

Question and Answer	Photograph
<p>50. Name three common <u>renewable</u> natural resources used to produce electricity in Wisconsin:</p> <p><b>* Answer</b></p>	
<p>51. Explain: Why is it a disadvantage for Wisconsin to use energy resources that are brought in from out of state? Why is it an advantage for Wisconsin to use energy resources that are found within our state borders?</p> <p><b>* Answer</b></p>	
<p>52. Describe at least two important advantages of using renewable energy resources over using <u>nonrenewable</u> energy resources.</p> <p><b>* Answer</b></p>	
<p>53. Describe the most important advantage of using digester-produced biogas over most other <u>renewable</u> energy resources.</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>54. In the end, the anaerobic digester produces a solid, a liquid, and a gaseous product. Describe these three end products in detail. Explain what each product is used for.</p> <p><b>* Answer</b></p>	
<p>55. A dairy farmer who puts in an anaerobic digester expects to make money from the investment. Spend some time talking to such a farmer though, and you will hear plenty of other reasons for putting in a digester. Explain why such a farmer would give each of these as a reason for putting in a digester:</p>	
<p>55a. "I want to be thought of as a good neighbor by those who live close by me."</p> <p><b>* Answer</b></p>	
<p>55b. "I want to do a good job when it comes to keeping our local water supplies healthy."</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>55c. "I want my children and their children to breathe healthier air."</p> <p><b>* Answer</b></p>	
<p>55d. "I want Wisconsin to be more self-sufficient."</p> <p><b>* Answer</b></p>	
<p>56. Name two other substrates (what you would probably think of as wastes) that when digested, produce more energy for their weight than cow waste.</p> <p><b>* Answer</b></p>	
<p>57. Describe one other way the methane biogas produced from anaerobic digestion can be put to good use.</p> <p><b>* Answer</b></p>	

Question and Answer	Photograph
<p>58. Biosolids are currently used as a soil amendment or recycled as cow bedding. Name one other purpose to which they can be put—one other thing they can be used for.</p> <p><b>* Answer</b></p>	
<p>59. List at least ten professions / trades / jobs that are likely to be needed on a farm with an anaerobic digester.</p> <p><b>* Answer</b></p>	
<p>60. Energy from the sun comes to us from every energy resource we use. Describe how the electricity we get through the process of anaerobic digestion originates from the sun.</p> <p><b>* Answer</b></p>	