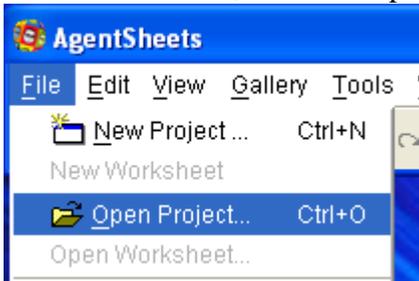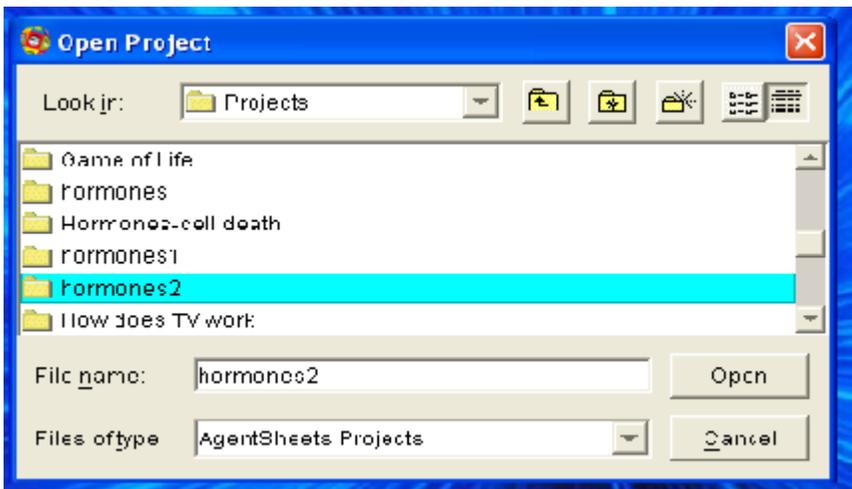Name _____   Date _____

Insulin's Role in a Negative Feedback System

1. Open Agent Sheets (it's in the applications folder)
2. Click on file, click on "open project."

3. A window will appear called "Open Project". Scroll through the list to find "hormones2".

4. Double click on hormones2 and a narrow window called "gallery" should open on the left side of your screen.
5. Go back to file, and click on "open worksheet."
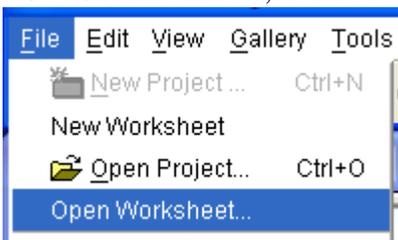
6. A window will appear called "Open Worksheet". Scroll through the list to find "bloodstream2".
7. Double click on "bloodstream2" and a large window called "Worksheet: bloodstream2" will appear.

8. Stop for a moment and examine the picture.
   Label each organ

#	Organ
1	
2	
3	
4	
5	
6	
7	

9. Select the "hammer" from the toolbar on the left side of the worksheet window.

10. Now click on "run" at the bottom of the worksheet.

11. Click several times on the pink area in the middle of organ 4-the stomach.
12. You should see the stomach release "molecules" into the bloodstream, and they should begin to circulate. In this model, these molecules represent glucose.
   What would happen if you keep adding glucose and it never goes away?

   _____

   Keep clicking and see what happens!!
13. The glucose is traveling through the bloodstream but is that where it is needed?

   _____
14. For what essential life process is glucose needed? _____
15. This process happens in every cell in your body not in the tubes of your bloodstream. Since this process occurs in cells the glucose must move from the bloodstream into the cells.
   a. By what process that you have already studied are molecules moved through a membrane? _____
   b. Though a certain amount is brought into cells in this manner. Extra stores of glucose must be on reserve both in all cells and particularly the liver

where large stashes can be found. Therefore insulin is sent through the bloodstream to signal specific cells to take in even more glucose.

16. Insulin is what kind of molecule that gives signals to cells and organs? _____

17. Insulin is made in the pancreas and released into the bloodstream when the pancreas detects sufficient amounts of glucose in the bloodstream.

18. To simulate this process, we're going to change the model. **Stop the model**.

19. Click on the title bar of the gallery window to bring it onto the front of the screen. Each folder in this file is called an "agent". It represents one of the symbols found on the worksheet and is always a noun.

20. Scroll through and find the "pancreas" agent.
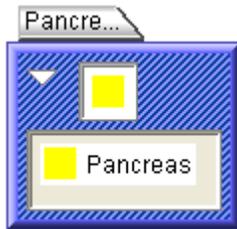
21. Double click in the blue area of the folder and a window should open called "Behavior: Pancreas". The "behavior" is where we program the agent to do something specific. In this case we want to release insulin from the pancreas in proportion to the amount of glucose in the bloodstream.

22. Read the explanation at the top of the window. You'll notice that the % chance of the pancreas releasing glucose is currently set to zero (0).
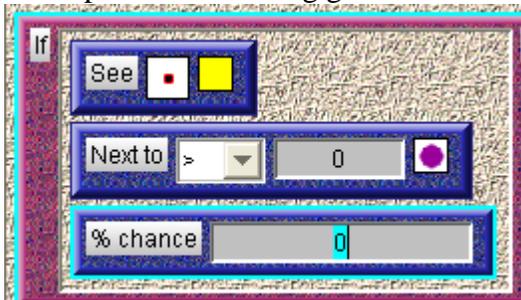
Highlight the "0" and change it to 100. Click on "OK" and the window should close.

23. Go back to the worksheet window by clicking on it. Click "reset." Make sure the hammer is chosen, then press run and add glucose again by clicking on the stomach.

24. The messenger in the form of insulin is being sent out by the pancreas. Why doesn't the glucose amount change?

25. You may remember that hormones need to bind to receptor cells to pass on their message. The main receptor cells for insulin are in liver cells although there are a few receptors in other cells.

26. Click on the title bar of the Gallery. Scroll down to the folder marked "receptor." You can look/change the graphic by double clicking inside the rectangle where it shows both the graphic and the word receptor.

27. A new window called depiction:receptor will appear which contains a picture of the receptor which can be edited. DO NOT EDIT THE PICTURE AT THIS TIME.
28. Go back to the gallery and scroll down to the hormone and double click on that depiction as well. Compare the two pictures. Describe their shapes. Close both of the depiction windows.
29. In order for the hormone to deliver its message, it must first find the correct cells to give the message to. You will simulate this idea by placing receptor proteins on the cells of the liver. Go to the Gallery and scroll back to the folder marked "Receptor". Highlight the folder by clicking on the blue part of the folder. This will choose this "Agent" to add to the "Worksheet". Click on the title bar of the Worksheet. Then click on the "pencil tool" on the toolbar on the left side of the worksheet. This is the tool used for adding "Agents" to the worksheet.
30. Since the "liver" contains the most receptors we will place receptor agents inside the liver on the worksheet. Click on six spaces around the liver but not directly on the bloodstream that flows through the liver. If you accidentally put an agent in the wrong spot you may use the eraser tool on the worksheet to erase the agent.
31. Now we have our glucose, hormones, and receptors. Run the simulation again. What happens? What are we missing?
32. What is the message we are supposed to be sending to the liver?
33. To actually deliver the message the formation of a hormone-receptor complex must signal the delivery of the message: Store glucose in the liver. To do this go to the Gallery and find the folder marked "Complex". Double click on the blue area to open the window called "Behavior:Complex". The area under each yellow and black striped area is called a "Method". Right now the % chance of this happening is 0 which means nothing happens. Change the % to 100. This means that this will always happen. If there is 1 or more complexes formed then it sends a message to glucose that it should be stored in the liver.
34. Run the program again and describe what happens to the amount of glucose and hormone as the number of complexes increase.
35. Should the glucose level in the blood fall to 0? Why or why not?