wrong	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
right	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	
score	100	99.1	98.2	97.2	96.3	95.4	94.5	93.6	92.7	91.7	90.8	89.9	89.0	88.1	87.2	86.2	85.3	84.4	83.5	82.6	81.7	

Bee HyperAttractive

Name_____

You should have read the information about honeybee biology from the website before coming to class. This is a computer exercise in ***pollination biology***. Why computers in biology? Bees are very dangerous to handle...it could be fatal for some of you! Computer bees are harmless "bugs." Moreover, we can vary the computer flowers without having a huge collection of expensive real flowers on hand...all at the perfect stage of readiness for pollination! Also, we can do the project in a time interval less than a whole research career. The results given by the computer are consistent with those that have been obtained tediously in the field over a very long period of time.

You will design the specifications for flowers and present them to a bee. The bee will visit each flower a certain number of times based upon how attractive you have made the flower and upon the temperature you have set. You will record the temperature, the characteristics of each flower and the number of visits to each flower. **It is OK to use ditto marks or draw arrows** for repetitive entries. Your goal is to be able to answer the questions using the data you have collected.

The Effect of Color

Set the temperature to 20°C. Be sure all the other variables are "none." Try all the colors for the flowers:

20°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1		none	none	none	
Flower 2		none	none	none	
Flower 3		none	none	none	
Flower 4		none	none	none	
Flower 5		none	none	none	

What is the most attractive color of flower? red yellow white blue purple

What is the least attractive color of flower? red yellow white blue purple

Repeat the trials at the other two possible temperatures.

30°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1		none	none	none	
Flower 2		none	none	none	
Flower 3		none	none	none	
Flower 4		none	none	none	
Flower 5		none	none	none	

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Koning, Ross. E. 1994. Bee HyperAttractive. *Plant Physiology Information Website*.
http://plantphys.info/plants_human/labpdf/beehyperattractive.pdf

10°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1		none	none	none	
Flower 2		none	none	none	
Flower 3		none	none	none	
Flower 4		none	none	none	
Flower 5		none	none	none	

Notice which colors are now the favorites and which are now the least preferred.

Do bees change their color preferences as temperature is increased? yes no

Why are bees attracted to certain colors?

Honeybee vision allows a bee to see colors from _____ to _____ in the human visible spectrum.

Why are bees not attracted to certain other colors?

Honeybees cannot see our color _____ because it is outside of the bee's visible spectrum.

The Effect of Fragrance

Set all the flowers to the best color.

Then, holding all other variables the same, change the fragrance:

20°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1			none	none	
Flower 2	"		none	none	
Flower 3	"		none	none	
Flower 4	"		none	none	
Flower 5	"		none	none	

What is the most attractive fragrance? sweet spicy acrid fetid

What is the least attractive fragrance? sweet spicy acrid fetid

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Repeat the trials at the other two possible temperatures:

30°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1			none	none	
Flower 2	"		none	none	
Flower 3	"		none	none	
Flower 4	"		none	none	
Flower 5	"		none	none	

10°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1			none	none	
Flower 2	"		none	none	
Flower 3	"		none	none	
Flower 4	"		none	none	
Flower 5	"		none	none	

Notice which fragrances are now the favorites and which are now the least preferred.

Do bees change their fragrance preferences as temperature is increased? yes no

Check over your past experiments to answer these three questions:

Does a bee visit a flower that is the wrong color and produces no fragrance? yes no

Does a bee visit a flower that produces neither a nectar nor pollen reward? yes no

Will the bee make a return visit to such a flower? yes no

The Effect of Nectar

Set all the flowers to the best fragrance as well as the best color.

Then, holding all other variables the same, vary the nectar:

20°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1				none	
Flower 2	"	"		none	
Flower 3	"	"		none	
Flower 4	"	"		none	
Flower 5	"	"		none	

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30°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1				none	
Flower 2	“	“		none	
Flower 3	“	“		none	
Flower 4	“	“		none	
Flower 5	“	“		none	

10°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1				none	
Flower 2	“	“		none	
Flower 3	“	“		none	
Flower 4	“	“		none	
Flower 5	“	“		none	

What is the most preferred nectar at 30 degrees? watery sweet sugary bitter

What is the most preferred nectar at 20 degrees? watery sweet sugary bitter

What is the most preferred nectar at 10 degrees? watery sweet sugary bitter

What nectar is least preferred? watery sweet sugary bitter

Why do bees prefer the quality of nectar observed to be best at 10 degrees?

At 10° C a honeybee needs more _____ to replace what is used when the honeybee _____ her _____ without moving her _____ which generates body heat.

Why do bees prefer the quality of nectar observed to be best at 30 degrees?

At 30° C a honeybee needs more _____ to replace what is used when the honeybee _____ her _____ for evaporative cooling.

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The Effect of Pollen

Leave the flowers at the best color and fragrance. Set the temperature to 20 degrees. **Set the nectar to its best state for 20 degrees**. Then, change the pollen type:

20°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1					
Flower 2	"	"	"		
Flower 3	"	"	"		
Flower 4	"	"	"		
Flower 5	"	"	"		

Set the temperature to 30 degrees. **Set the nectar to its best state for 30 degrees**. Repeat…

30°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1					
Flower 2	"	"	"		
Flower 3	"	"	"		
Flower 4	"	"	"		
Flower 5	"	"	"		

Set the temperature to 10 degrees. **Set the nectar to its best state for 10 degrees**. Repeat…

10°C	Color	Odor	Nectar	Pollen	#Visits
Flower 1					
Flower 2	"	"	"		
Flower 3	"	"	"		
Flower 4	"	"	"		
Flower 5	"	"	"		

What is the preferred pollen at all these temperatures? dry clumped sticky wet

The least preferred pollen at 10°C is _____, and it is more acceptable at _____°C because the honeybee needs more _____ to replace what is used when she _____ her _____ for evaporative cooling.

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What are the Optimum Flower Characteristics?

Check through your projects so far to answer these three questions:

What is the optimal combination of flower characteristics at 10 degrees?

10°C	Color	Odor	Nectar	Pollen	#Visits
Optimal Flower					

What is the optimal combination of flower characteristics at 20 degrees?

20°C	Color	Odor	Nectar	Pollen	#Visits
Optimal Flower					

What is the optimal combination of flower characteristics at 30 degrees?

30°C	Color	Odor	Nectar	Pollen	#Visits
Optimal Flower					

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