SBA conference 2019

An investigation into transpiration and leaf temperature

Question - Why is leaf surface of plants always a few degrees lower than the air temperature?

Hypothesis - Transpiration at leaves can produce a cooling effect. Explain why.

Prediction - What will happen to the temperature of a leaf when its lower surface is smeared by Vaseline? Explain why.

Experimental procedure provided

1. Measure the **temperature of the upper surface** of a leaf with an infrared thermometer. Keep the thermometer **1 cm** away from and **vertical** to the leaf surface.
2. Swear **Vaseline on the lower surface** of the leaf and wait for **15 minutes**.
3. Measure the temperature of the upper surface of the leaf again. Compare the leaf temperature with that of the first measurement.
4. Repeat the above measurements on **30 leaves** from the **same plant** and in **similar size** and at **similar locations**

Questions about experimental procedure

1. Why measure upper surface T and vaseline lower surface ?
2. Why keep infrared thermometer 1cm from leaf?
3. Why leaves from same plant and of similar size and locations?
4. Any assumptions about environmental conditions?

Independent variable	Dependent variable	Control variables
Transpiration rate of leaves (manipulated by smearing Vaseline on lower leaf surface)	T of upper leaf surface	○ Size, structures and locations of leaves ○ Environmental conditions e.g. temperature, light intensity, wind speed ○ Time of treatment between the two measurements ○ Operation of the thermometer e.g. position, distance and angle of measurement

Results

Show the data of your experiment in a table, which should include the leaf number and leaf temperatures before and after smearing of Vaseline. Add more information and calculations in the table if you find it necessary.

Leaf number	Leaf T before smearing of Vaseline (°C)	Leaf T 15 mins after smearing of Vaseline (°C)	Difference in temperature (°C)
1			
2			
Total			
Mean T (°C)			
SD			

Discussions

1. With reference to the data, how did the leaf temperature change after its lower surface was smeared with Vaseline? Explain why there is such a change.
2. The changes of leaf temperature are not exactly the same for different leaves. Explain TWO likely causes of it.
3. Explain how different water content of the soil may affect the results.

Conclusions

1. Do the results of the experiment support the hypothesis? Explain it.
2. Someone queries the conclusion. He says the increase of leaf temperature could be a result of the changes in environmental conditions. How would you improve the experiment in response to this query?

Fat in milk?

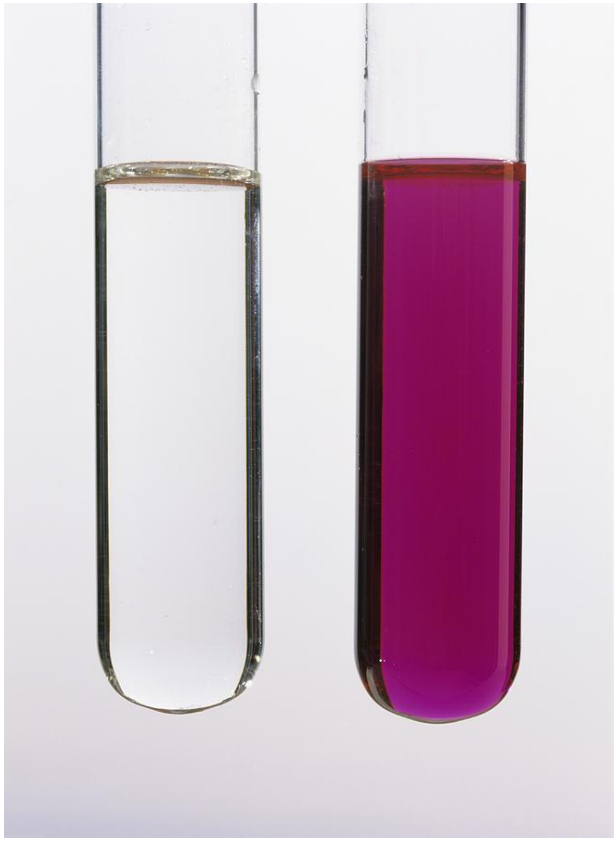
In this investigation, you will compare the fat content of **full-fat milk and skim milk**.

$$\text{Fat (in milk)} \xrightarrow{\text{lipase}} \text{Fatty acids} + \text{glycerol}$$

1. How will the **pH value** of milk change along with the digestion of fat? Explain why.
2. Explain how the pH change can be used to estimate the **rate of the reaction**.
3. How can the rate of reaction be used to estimate the **fat content** of milk?

Phenolphthalein

- pink at pH 10 or above
- colourless at pH 8.3 or below.



- Explain how phenolphthalein can be used to estimate the fat content of milk.
- Predict the results for full-fat and skim milk.

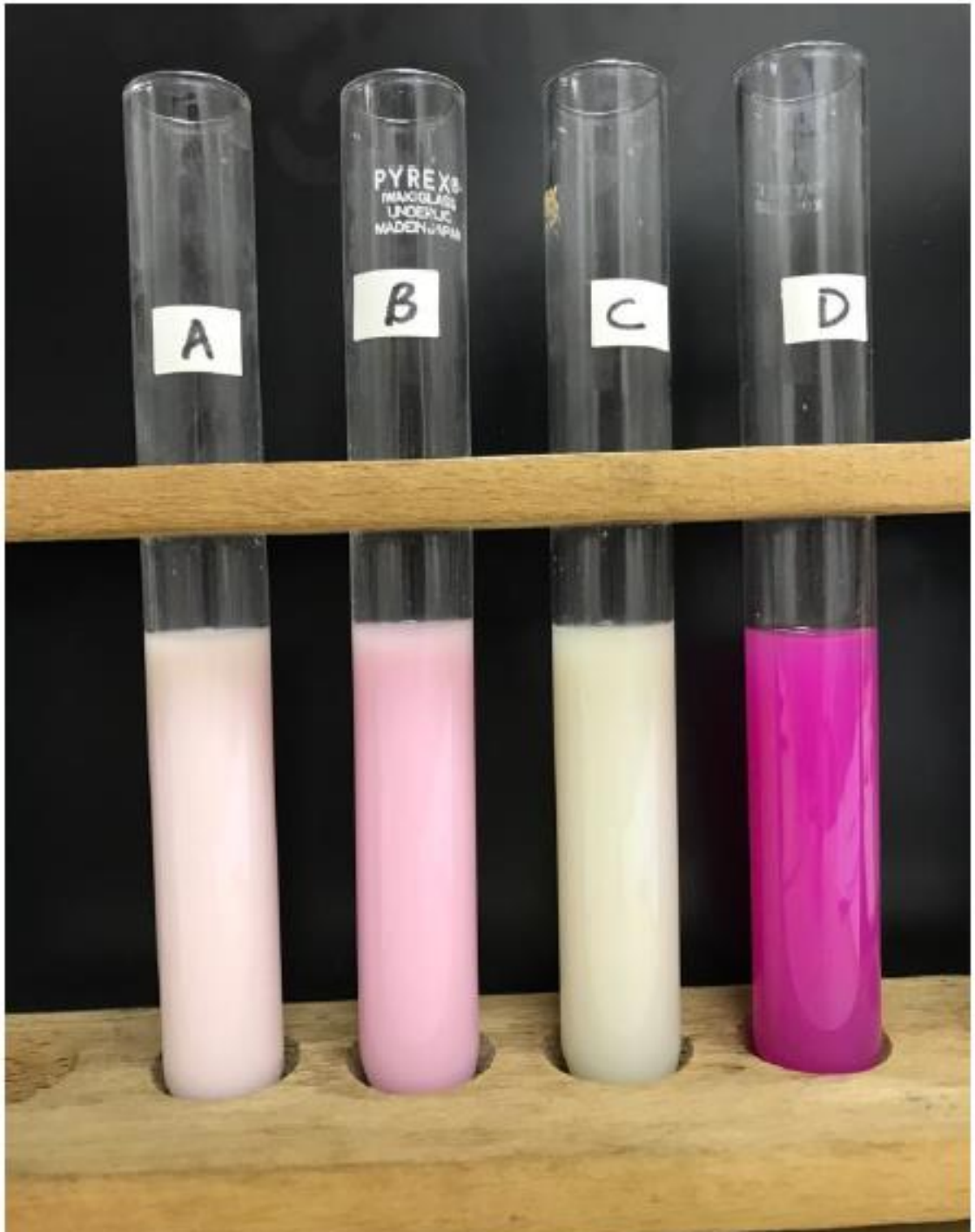
Independent variable	Dependent variable	Control variables
Types of milk : Full-fat milk or skim milk	Amount of fat, (measured by the time phenolphthalein changes from pink to colourless)	○ Volume of milk, ○ original pH of milk, lipase (conc and volume) ○ amount of phenolphthalein ○ temperature

Procedure (partly provided)

1. Add **in turn** the following contents into **four test tubes** and mix it well. A1 and A2 are replications, so are B1 and B2. Fill in the missing volumes in the table.

	Tube A1	Tube A2	Tube B1	Tube B2
Milk	Full-fat milk ( )	Full-fat milk 5 cm^3	Skim milk ( )	( ) milk ( )
sodium carbonate solution	7 cm^3	( )	( )	( )
phenolphthalein	( )	( )	( )	5 drops

2. Add 1 cm^3 of 5% lipase into each of the four test tubes and start the stopwatch.
3. Stir the contents of the test tube regularly until the solution loses its pink colour completely. Note the time needed for the colour change.


A
B
C
D

Results

1. Use a table to present the data obtained.
2. How can the above data be converted into two values that show the relative reaction rate of the two types of milk? Show your calculations.

- *Average the times for A1 and A2, and B1 and B2.*
- *Relative reaction rate is 1/average time.*

Discussions

1. Describe the results.
2. Explain the results.
3. Fat is not soluble in water so it exists as small fat droplets in milk. Would the size of the fat droplets affect the results? Explain why.
4. With reference to the size of fat droplets, what assumption does this investigation need to make? Do you think this assumption is likely correct?
5. Are there any variables that were not properly controlled in the experiment? How can they be controlled if you do the experiment again?

Alternative design

- A student suggests another method to compare the fat content of milk. He measures the change of pH value from the start to the end of the reaction (the pH value becomes stable). Explain how this new method is better than the present one.

Answer:

- This new method is better because it compares the total amount of fat in the milk instead of the rates of fat digestion.

Conclusions

- With reference to the results of this experiment, which milk, full fat or skim, has higher fat content?
- How much confidence do you have in this conclusion after taking into account all the assumptions, uncontrolled variables and measurement errors of the experiment? Explain why.

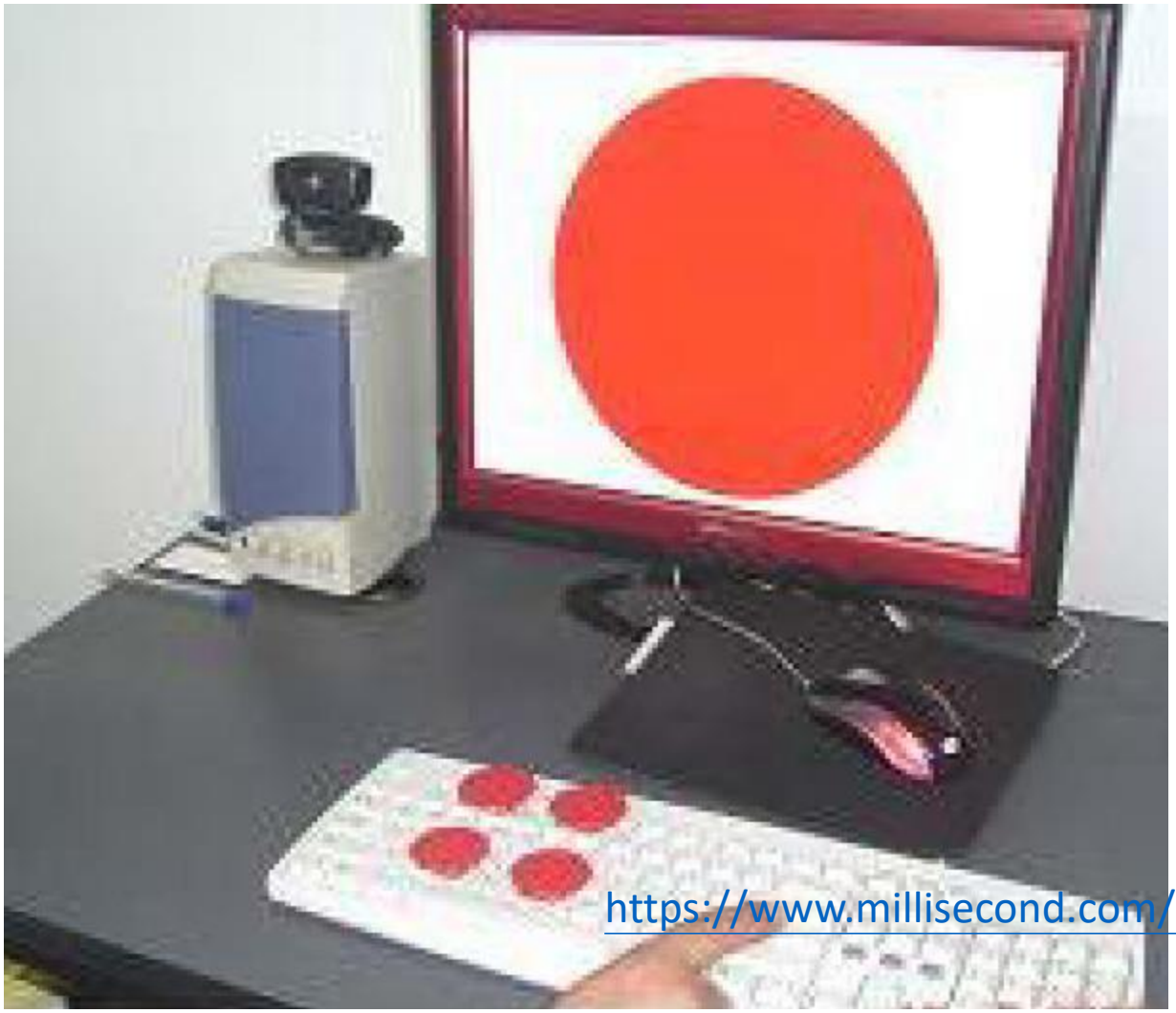
A valid conclusion:

- Large difference in average end point times – 500s compared to 1200s
- Small differences between replications → negligible measurement errors

How fast to react?

In this investigation, you will be finding out our reaction time to visual and auditory stimuli, and how the reaction time is affected by gender and exercise level.

Inquisit 5 - Simple auditory and visual reaction time test,



https://www.millisecond.com/download/

Design of the investigation

1. A person will react faster after some practice. How would this affect the result of testing for ART and VRT? How can this problem be avoided or reduced?
2. If different computers are used for the test, will it affect the results? If yes, how to reduce the problem?
3. How to reduce the effects of environment on the performance?

Independent variable	Dependent variable (measured by)	Control variables
• visual and auditory stimuli • gender • exercise levels	reaction time (measure by computer test)	• Practice of the tests • Computers used • Environmental conditions

Procedure (provided)

1. Each student does the reaction time test in the assigned computer.
2. Practice the visual and auditory test for one time.
3. Do the two tests in an assigned order (visual or auditory first).
4. Record your results in the table below.
5. Enter your personal data into the class table to pool up the class data.

Complex data analysis

n=	Average time	Male	Female	Regular exercise	Sedentary
VRT					
ART					

SD

Significance test (paired and unpaired t test)

Further experiments

- How caffeine affects the reaction time of males and females?

http://www.iosrjournals.org/iosr-jdms/papers/Vol13-issue7/Version-1/D013711416.pdf

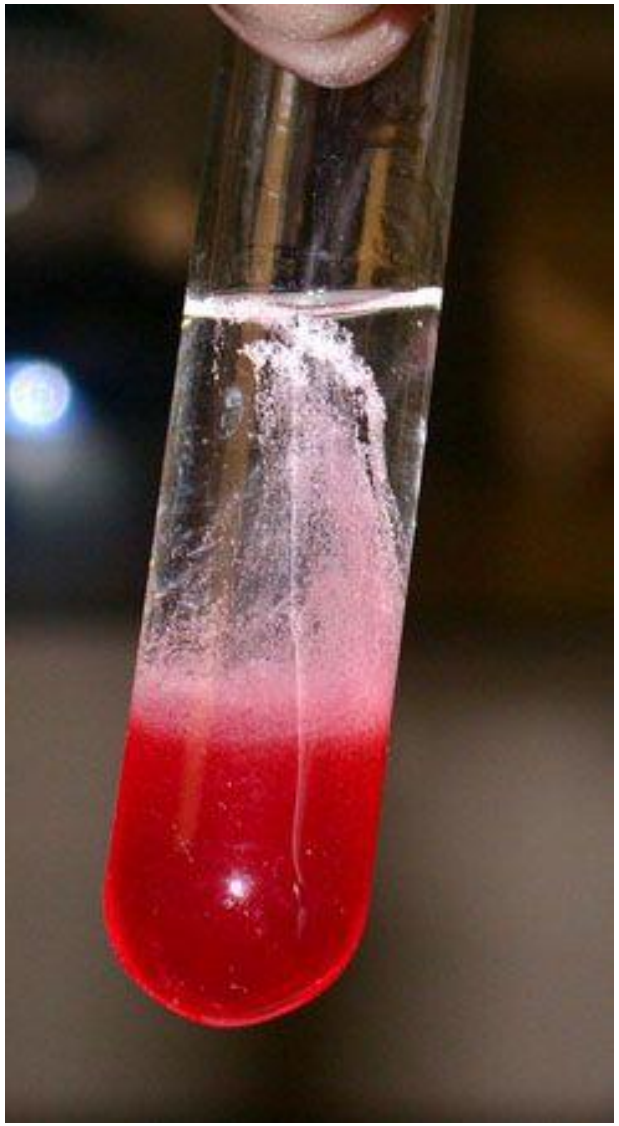
Results

n=	Average time ± SD (ms)
Visual reaction time	
Auditory reaction time	

	Male (n=) Average±SD (ms)	Female (n=) Average±SD (ms)
VRT		
ART		

	Regularly exercising Average±SD (ms)	Sedentary (n=) Average±SD (ms)
VRT		
ART		

Biotech experiment



Extraction of ‘DNA’ of strawberry

- Any design of experiment?
- Any interpretation of data?
- Any conclusion made?

Biotech experiment – construction of recombinant plasmid

	Tube 1	Tube 2	Tube 3 (control for 1)	Tube 4 (control for 2)
Plasmid	4 µL Plasmid A	4 µL plasmid K		
Restriction enzyme	2 µL	2 µL		
Buffer	4 µL			
Water	0µL			
Total volume	10 µL			

Explain the importance of control tubes 3 and 4.

Comparions

	Leaf T	Milk fat	Reaction time	Biotech
Complexity	low	middle	high	highest
Assessment	B1, B2	B1, B2	B1, B2	B2