Thermal Influences of Metabolic Rates

Chemists find that chemical reactions, such as enzyme activity. One concept based upon this is the Q^{10}. Q 10 is the ratio of a reaction, obtained by dividing the rate of the reaction at one temperature by the rate of the reaction at another temperature at 10 C less.

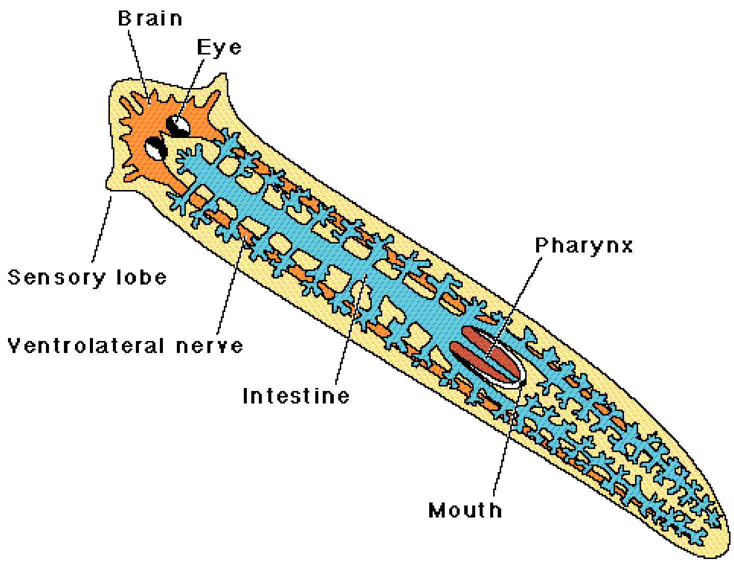
For example if the reaction rate is 20 grams of product at 40 C and 10 grams of product at 30 C then:

Q10 = rateT + 10 [rate at 40 C] / rateT [rate at 30 C] = 20 gm/10 gm = 2.0

For many reactions a Q10 of 2.0 is thought to be the typical difference in reaction rates, but this is an oversimplification. Regardless, the chemical reaction rates are affected by changes in temperature and so are metabolic rates, which are based upon chemical (enzymatic) reactions.

In this lab you will be measuring the metabolic activity and the Q10 for an organism. We will consider the metabolic rate in the carnivorous flatworm *Dugesia* [don't worry, it doesn't eat students]. This aquatic animal is an ectotherm and tends to move by means of a carpet of cilia on its ventral surface. The rate of movement for a specific animal should relate to its metabolic activity. As the metabolism increases, so should the rate of movement.

The variable will be the specific temperatures under which the observations [for movement] take place.



http://www.biologycorner.com/bio1/notes_flatworms.html

Hypothesis to Test:

The Q10 rate for flatworm metabolism is close to 2.0. This will be tested against three Q10 ratios.

Methods:

Select one tray and graph paper (which will be placed under the tray). Place a small amount of water ~.5 cm in the tray at from a specific temperature. Measure the temperature of the water in the tray.

Select and delicately place 3 *Dugesia* in the center of the tray. Use a plastic pipette, with the lower part snipped off, to collect and move the *Dugesia*.

Let the *Dugesia* sit in the tray for 2 minutes, to equilibrate to this temperature. They are small ectotherms, so their body adjusts to the temperature of the water quickly.

One student will be monitoring the temperature of the water to keep it as constant as possible.

Now measure the movement of *Dugesia* for a 5 minute period. Attempt to follow **one** of the three *Dugesia* continuously during this time. Each time the animal moves across a line and into a new square on the graph grid should be counted as one unit of movement. Keep count of every unit of movement during this 5 minute period using the hand counters. One student should accurately count the starting and ending time, while another watches the Dugesia for unit of movements.

As individual *Dugesia* move to the edge of the plate they have a tendency to remain there. If this occurs then the student observer who is counting their movement should shift attention to another *Dugesia* and add on movements in the same fashion.

As *Dugesia* move to the edge of the plate, another student [not the time keeper or unit of movement counter] should gently move them back towards the center of the tray.

Perform each measurement of *Dugesia* movement for five minutes at four different temperatures. The temperatures should be kept as constant as possible and as close to the starting temperatures as you can. One student should be monitoring and adjusting temperatures during the each experimental trial.

The three temperatures we will attempt to conduct this at are:

25 C

15 C

5 C

After 5 minutes change water to another temperature. Let the *Dugesia* in this container sit for 2 minutes (to equilibrate to the water temperature) and then begin counting again for 5 minutes of movement.

If needed, use warmer water for the 25 C condition. You will need to start with warmer water – in a heated beaker. This will need to be mixed with room temperature water or a small amount of ice to adjust it to 25 C **before placing the Dugesia in the container.**

As you continue, you should have a small beaker of warmer water to add, with a pipette to this container, if the temperature drops. The 25 C water should be close to room temperature. Obtain fresh water for this.

The 15 C and 5 C water conditions will need to be cooled down with some ice, or ice water, before starting the 2 minute equilibrium time for the *Dugesia*. Continue to monitor and adjust as needed.

Results:

List the following:

Temp C	# units moved in 5 min	Ave units moved/minute
25		
15		
5		

Q 10 ratios (use average units moved)

1) # squares moved at 25 C/ # squares moved at 15 C

2) # squares moved at 15 C/ # squares moved at 5 C

Graph the # squares moved [y axis] against each temperature [x axis].

Graph the 2 Q10 ratios [y axis] against the specific temperature ratios 25/15, 15,/5

Questions:

What was the Q10 for each of the 2 ratios? Did it remain constant or not? Why do you think the activity was this way? Was the hypothesis supported for any or all of the Q10's measured?

What other metabolic processes might be measured for Q10? How might you do so?

What were the controls and the variables for this lab? What were the potential problems and limits of this lab?