Bio390 **Problem: Metabolism and Q_{10} SOLUTIONS**

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These problems are due on Wednesday Feb 9

1. The rate of metabolism of a certain poikilothermic animal at 10º C 27 is $\mu lO_2\ g^{-1}h^{-1}$. What are its rates of metabolism at 20, 30, and 40ºC if the Q_{10} is 2? If it is 2.5?

$$R_2 = R_1 * Q_{10}^{(\frac{T_2 - T_1}{10})}$$

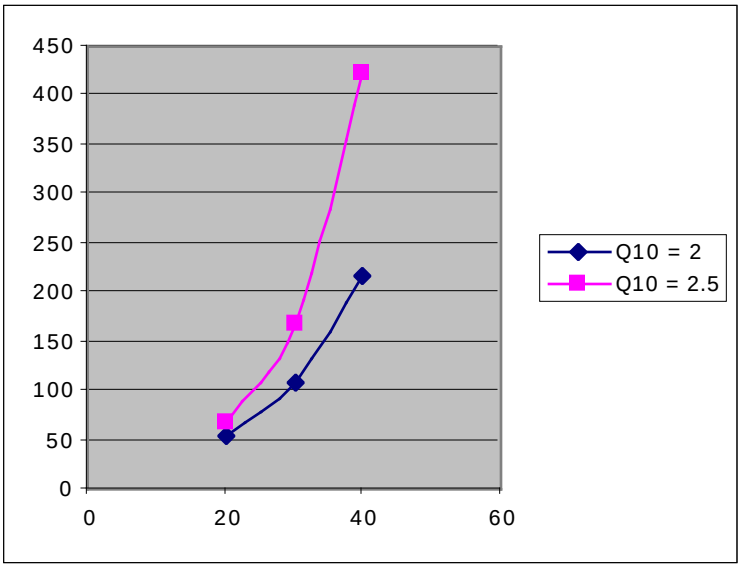
One example, then the answers. If Q_{10} = 2.0 and we want the rate (R_2) at 20 ° C (T_2) given the rate (R_1) at 10° C (T_1) of 27 $\mu lO_2\ g^{-1}h^{-1}$:

R_2 = 27 * 2 ^((20 - 10)/10) = 27 * 2 ^1 = 54 $\mu lO_2\ g^{-1}h^{-1}$

Here are the others, all given in $\mu lO_2\ g^{-1}h^{-1}$

Ta	Q10 = 2	Q10 = 2.5
20	54	67.5
30	108	168.75
40	216	421.875

and a graph showing the effect of Temp on Rx rate



2. The following table reports the rates of metabolism of a poikilotherm at a series of ambient temperatures:

Temperature (ºC)	Rate of Metabolism ($\mu lO_2\ g^{-1}h^{-1}$)
15	10.00
20	13.42
30	21.22

(a) Calculate the Q_{10} values for each temperature interval.

We need to rearrange the formula used in the previous example:

$$Q_{10} = \{\frac{R_2}{R_1}\}^{(\frac{10}{T_2 - T_1})}$$

Be sure you know how to make this manipulation -- ask someone if you don't

Ta	Rate		
	15	10	
	20	13.42	1.80
	30	21.22	1.58
overall (15 to 30)			1.65

FOR THE FIRST TWO VALUES (1.8 AND 1.58) THE PREVIOUS TEMPERATURE SERVED AS T_1 AND GAVE R_1. THE OVERALL CAN BE OBTAINED EITHER BY AVERAGING BOTH OR BY USING 15C AS T_1 AND 30 AS T_2

(b) Within which temperature interval (15-20 or 20-30) is the rate of metabolism most sensitive to temperature change?

SLIGHTLY MORE SO BETWEEN 15 AND 20 SINCE THE Q10 IS LARGER

(c) For this species, would a Q_{10} calculated for 15 to 30º C be as useful as several for smaller temperature ranges? Calculate that Q_{10} as part of your answer.

YES, IT AGREES REASONABLY CLOSELY WITH VALUES (I.E. THE VALUES DO NOT DIFFER MUCH FROM EACH OTHER

3. The reaction rate for a certain process at **14º C is 15 units / time.**

(a) What would be the reaction rate at 20º C if the Q_{10} = 1?

14 UNITS/TIME -- A FLAT Q10 BY DEFINITION IS TEMPERATURE INDEPENDENCE

(b) What would be the reaction rate at 10º C if the Q_{10} = 2?
CALCUATION USING FORMULA AS IN #1
ANS:

$$R_2 = R_1 * Q_{10}^{(\frac{T_2 - T_1}{10})}$$

= 15 * 2^ ((10 - 14)/10)

= 15 * 2^(-0.4) = **11.4 UNITS/TIME**

(c) What would be the reaction rate at 25º C if the Q_{10} = 0.75?

SAME METHOD:

= 15 * 0.75^(25-14)/10))

= 10.9 UNITS / TIME

NOTICE THAT THE RATE DECREASED WITH AN INCREASE IN TEMPERATURE