Q10 – The Temperature Coefficient

The Q_{10} temperature coefficient is a measure of the rate of change of a biological or chemical system as a consequence of increasing the temperature by 10°C. It is useful in studying cold blooded organisms because it expresses the temperature dependence of a biological process. There are many examples where the Q_{10} value is used, from the calculation of the nerve conduction velocity to the calculation of muscle fiber contraction velocity. In fact, the Q_{10} value can be applied to chemical reactions and physiological processes in most cold blood animal systems.

The Q10 is calculated using the formula listed below, which is found on the AP Formula Sheet.

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

> R is the Rate
> T is the Temperature (Celsius degrees or Kelvins)

Q_{10} is a unitless quantity, as it is simply the factor by which a rate changes for every 10°C increase in body temperature.
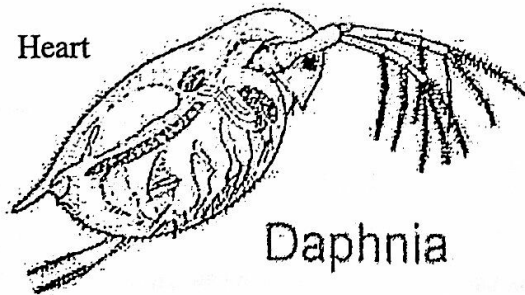
To check your calculations, the R and T values may be inserted into the online Q_{10} calculator at the web address shown below.

http://www.physiologyweb.com/calculators/q10_calculator.html

Practice Problems

1. Determine the Q_{10} value for the heart rate in *Daphnia*, the water flea.

Temperature (C°)	Average Heart Rate (beats per minute)
14	127
20	162
26	197

Heart

Daphnia

① FIRST TWO PTS:

$$Q_{10} = \left(\frac{162}{127}\right)^{10/(20-14)}$$

$$= \left(\frac{162}{127}\right)^{10/6}$$

$$= \left(\frac{162}{127}\right)^{1.67}$$

$$Q_{10} = 1.50$$

② NEXT TWO

$$Q_{10} = \left(\frac{197}{162}\right)^{10/(26-20)}$$
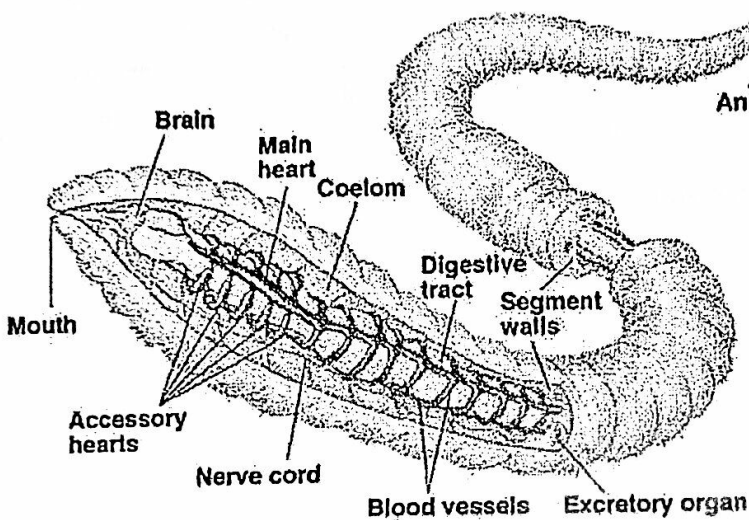
$$Q_{10} = 1.39$$

③ FIRST AND LAST

$$Q_{10} = \left(\frac{197}{127}\right)^{10/(26-14)}$$

$$Q_{10} = 1.73$$

④ Q_{10} (ave) $= \dfrac{1.50 + 1.39 + 1.73}{3} = 1.54.$

2. Determine the Q_{10} value for the blood vessel contraction in *Lumbricus terrestris*, the earthworm.

Temperature (C°)	Average Blood Vessel Contraction (contractions per minute)
17	16
21	19
25	22

① $Q_{10} = \left(\dfrac{19}{16}\right)^{10/3}$

$Q_{10} = 1.77$

② $Q_{10} = \left(\dfrac{22}{19}\right)^{10/4}$

$Q_{10} = 1.44$

③ $Q_{10} = \left(\dfrac{22}{16}\right)^{10/9}$

$Q_{10} = 1.42$

④ $Q_{10}(ave) = (1.77 + 1.44 + 1.42) \div 3$

$Q_{10} = 1.54$

3. Determine the Q_{10} value for the breathing rate of *Sphaerodactylus macrolepis*, the dwarf gecko lizard.

Temperature (C°)	Average Breathing Rate (breaths per minute)
21	24
27	39

$Q_{10} = \left(\dfrac{39}{24}\right)^{10/(27-21)}$

$Q_{10} = 2.25$