RESPIRATORY QUOTIENT

During the process of aerobic respiration, oxygen (O_2) is consumed, and carbon dioxide (CO_2) is released. The respiratory quotient (RQ) or respiratory ratio is defined as the ratio of the volume of CO_2 evolved to the volume of O_2 consumed in respiration. This parameter provides insights into the type of respiratory substrate being utilized. The respiratory quotient is calculated using the formula:

$$\text{RQ} = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

The specific value of the respiratory quotient is dependent on the type of respiratory substrate involved in the respiration process. Here are some key scenarios:

- **Carbohydrates as Substrate:** When carbohydrates are utilized as a substrate and undergo complete oxidation, the RQ is 1.0. This is due to the equal amounts of CO_2 and O_2 evolved and consumed, respectively, as illustrated in the equation:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

$$\text{RQ} = \frac{6CO_2}{6O_2} = 1.0$$

- **Fats as Substrate:** When fats are the respiratory substrate, the RQ is less than 1.0. For example, for the fatty acid tripalmitin, the calculation is as follows:

$$\underset{\text{Tripalmitin}}{2(C_{51}H_{98}O_6)} + 145O_2 \longrightarrow 102CO_2 + 98H_2O + \text{Energy}$$

$$\text{RQ} = \frac{102CO_2}{145O_2} = 0.7$$

- **Proteins as Substrate:** For proteins used as respiratory substrates, the ratio is approximately 0.9.
- **Organic Acids:** The RQ value for oxalic acid is 4, while for malic acid, it is 1.33. Organic acids tend to have RQ values greater than unity because they contain a higher proportion of oxygen compared to carbon and hydrogen. As a result, less oxygen is absorbed than CO_2 liberated.
- **Anaerobic Conditions:** In the case of anaerobic conditions, such as the fermentation of glucose to produce alcohol, the RQ is infinite (∞) since oxygen is not consumed in this process:

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} \xrightarrow{\text{Zymase}} \underset{\text{(Alcohol)}}{2C_2H_5OH} + 2CO_2$$

$$\text{RQ} = \frac{2CO_2}{0O_2} = \infty \text{ (infinite)}$$