RESPIRATORY BALANCE SHEET

The concept of a respiratory balance sheet involves theoretical calculations to determine the net gain of ATP for each oxidized glucose molecule. However, it is crucial to recognize that these calculations are essentially hypothetical and remain confined to theoretical considerations. Such calculations rely on certain assumptions:

- The existence of a sequential and orderly pathway is assumed, where one substrate leads to the formation of the next, and where glycolysis, the tricarboxylic acid (TCA) cycle, and the electron transport system (ETS) pathway follow each other in a sequential manner.
- It is presumed that the NADH synthesized during glycolysis is effectively transported into the mitochondria and subsequently undergoes oxidative phosphorylation.
- The assumption is made that none of the intermediates within the pathway are diverted to synthesize any other compounds. The pathway is envisioned to operate linearly, without side reactions or branch points leading to the production of alternative substances.
- The calculations are based on the exclusive respiration of glucose, without the participation of any alternative substrates entering the pathway at any intermediary stages. The analysis is confined to the metabolism of glucose without considering the utilization of other potential energy sources.

ATP molecules produced during respiration

Stage of Respiration	Source	Number of ATP Molecules Produced
Glycolysis	Direct 2-molecules of $NADH_2$ (one molecules of $NADH_2$ yields 3 molecules of ATP)	2 6
Pyruvic acid to acetyl-CoA	2 molecules of $NADH_2$	6
Citric acid cycle	6 $NADH_2$ 2 $FADH_2$ ($FADH_2$ produces only 2 molecules of ATP) Direct	18 4 2

The total net gain of ATP from the process of aerobic respiration is typically reported to be either 36 or 38 ATP molecules, depending on the type of shuttle system utilized. In the majority of eukaryotic cells, the net ATP yield is considered to be 36 molecules.

However, it's important to recognize that such assumptions do not fully reflect the dynamic nature of a living system. In reality, metabolic pathways operate concurrently rather than sequentially, with substrates entering and exiting pathways as needed. ATP is utilized on demand, and enzymatic activity is regulated through multiple mechanisms.

Despite these complexities, engaging in this theoretical exercise can still be valuable in gaining insight into the remarkable efficiency of living organisms in extracting and storing energy. Therefore, it can be understood that during aerobic respiration of one glucose molecule, there is a potential net gain of 36 ATP molecules, highlighting the intricate and efficient processes involved in cellular metabolism.

The efficiency of aerobic respiration can be evaluated based on the following considerations:

- The energy yield of approximately 34 kJ/mol is associated with the production of one adenosine triphosphate (ATP).
- When considering a total of 38 ATP molecules generated through aerobic respiration, the cumulative energy obtained is calculated as 1292 kJ. In comparison, a glucose molecule is known to store approximately 2870 kJ of energy.

(iii) To determine the efficiency of aerobic respiration, the ratio of the energy obtained (1292 kJ) to the total energy stored in glucose (2870 kJ) is calculated and expressed as a percentage. Therefore, the efficiency can be computed as follows:

$$\text{Efficiency } = \frac{1292}{2870} \times 100 = 45\%$$

Let's now contrast fermentation with aerobic respiration

Fermentation	Aerobic respiration
In fermentation partial degradation (breakdown) of glucose occurs.	In this respiration complete of glucose occurs.
There is a net gain of 2 ATP molecules for each molecule of glucose degraded.	36-38 ATP molecules are released.
Oxygen is not required.	Oxygen is required.
End products are lactic acid or alcohol.	End products are CO_2 and H_2O
NADH is oxidised to NAD^+ slowly in fermentation.	Here the conversion is very vigrous