

# Total versus Free ATP

## Definitions

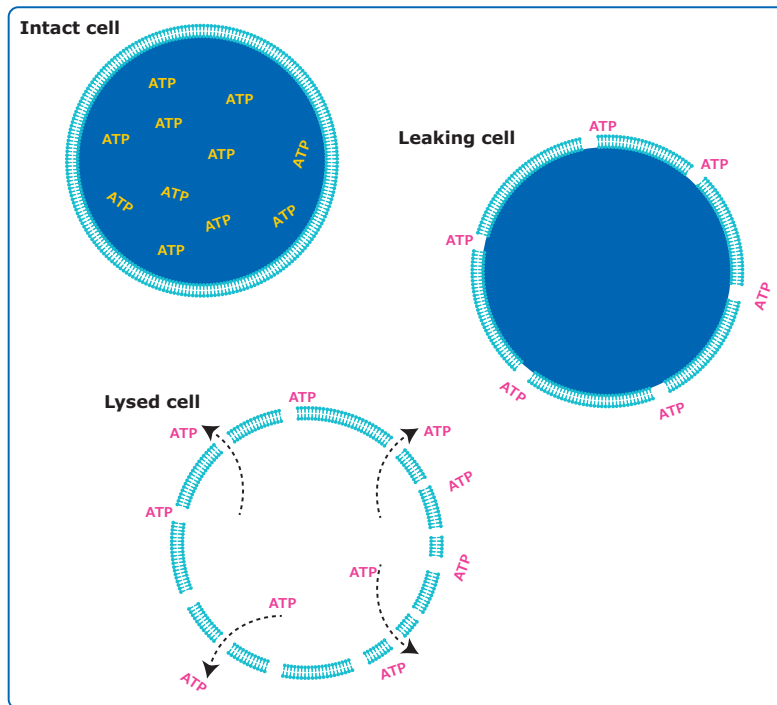
**Total ATP:** all ATP whether inside or outside of cells

**Free ATP:** another word for “extra-cellular ATP” = ATP which is outside cells

**Cellular ATP:** another word for “intracellular ATP” = ATP inside cells

ATP is normally generated inside cells where it is used to transport energy from one place to another, to supply energy where this is needed in the cell.

However, cells may “leak” a certain amount of ATP to the surroundings. Usually this will be very limited, and mainly associated with cell injury, but under certain conditions, high proportions of ATP can leak out. Notably one class of biocide will cause death of the cells by lysing (perforation of the cell membrane causing leaking from the cell). Other conditions, which can cause high levels of extra-cellular (Free) ATP, are physical stress such as centrifugation, vacuum or high pressure. Physical disruption of the cell membrane e.g. by ultrasonication will also cause leaking of ATP into the environment. Immediately after such treatments, the proportion of free ATP will typically be near 100% of Total ATP

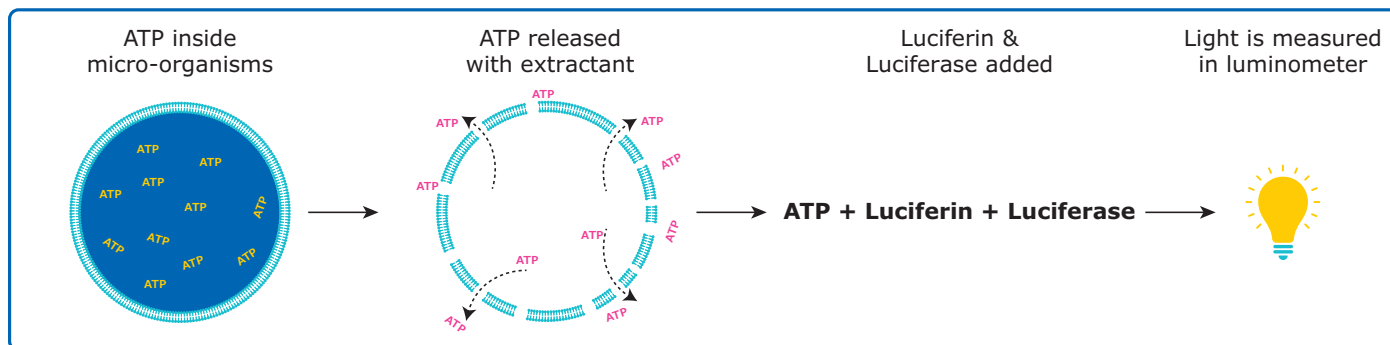


Usually, when cells are disrupted, enzymes which break down ATP will be released together with the ATP. Extracellular ATP therefore typically does not remain in the system indefinitely, but gradually breaks down within hours or up to a day or two.

However, certain conditions (acidic pH, high phosphate ion concentration, absence of oxidizing compounds and oxygen, low temperature) all increase the stability of ATP.

Under normal circumstances, the proportion of extra-cellular or “free” ATP in a fresh culture of micro-organisms is probably no more than 1-2% or the Total ATP. Under slightly more stress, such as occurs in “normal”, environmental conditions, the figure may get up to 5-10%.

For condition monitoring in systems, where biofilm growth may occur or where the stress conditions may be variable, it may be useful to monitor both total and free ATP. When this is the case, we recommend calculating the relative proportion of Free to Total ATP (or simply tracking both ATP levels on the same trend monitoring graph).



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