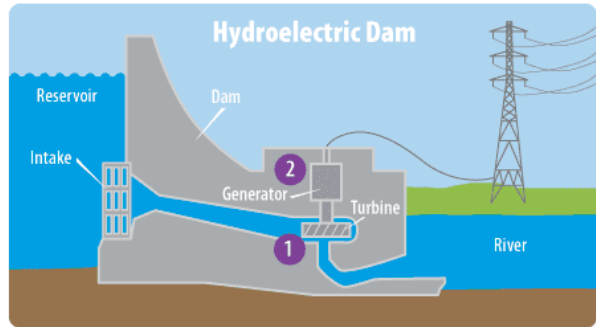


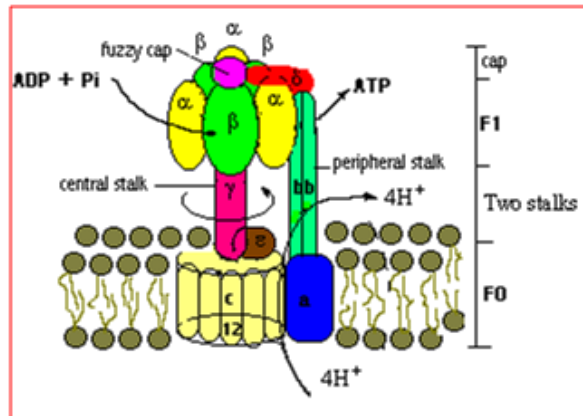
THE TURBINE GENERATOR INSIDE YOU

A typical hydroelectric power plant is always situated near water reservoirs (eg. dams). It comprises of a water turbine (essentially a rotating fan) connected to the power generator. When the reservoirs are full with water, it is allowed to flow away which in turn, causes rotation of the turbine.



The rotating turbine rotates converts this mechanical energy into electrical energy using the generator. As a result, the potential energy stored into the reservoir water is initially converted into mechanical energy (via turbine) which is ultimately converted into electrical energy that we are so fond of. What if I told you that something similar takes place inside all living things!

Cellular organelles mitochondria and chloroplasts have outer and inner membrane and a vacant space between these membranes called inter membranal space. The inner membrane bears many proteins and enzymes, one of which is ATP synthase. As its name suggests, it synthesizes ATP molecule, the energy currency of the cell. Structurally it is quite distinct, having a body (F₀), a stalk and a head (F₁). The F₀ domain is embedded within the inner membrane. The F₁ domain is in the matrix, connected to the F₀ via a short stalk made of γ and δ subunit. F₁ in turn is hexameric complex made of alternating α and β subunits.



Various metabolic processes in the mitochondrion (and chloroplasts) pump protons in the inter membranal space, resulting in it becoming more acidic than the rest of the inner matrix. This difference in proton concentration outside and inside inner membrane forms a proton gradient. Once sufficient gradient is generated, the protons flow from the inter membranal space to the matrix, via a small tunnel protein (A subunit) associated with F₀. As the proton crosses the tunnel, it rotates the F₀, which in turn rotates the γ stalk attached to it. F₁ on the other hand, does not rotate, but the β units undergo some conformation change every time γ rotates. As β changes shape, it binds ADP and converts it to ATP, following

which it is liberated. For a complete 360° turn by F_0 , 9 protons flow away into matrix, and 3 ATP molecules are formed. Thus, the potential energy stored in form of proton concentration in membranal space is converted to mechanical energy (via rotation of γ stalk), which is ultimately converted to chemical energy (ATP). Does that sound familiar to you?

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1) <https://archive.epa.gov/climatechange/bids/solutions/technologies/water.html>

2) <https://www.biotecharticles.com/Agriculture-Article/ATP-Synthase-Structure-and-Function-3375.html>