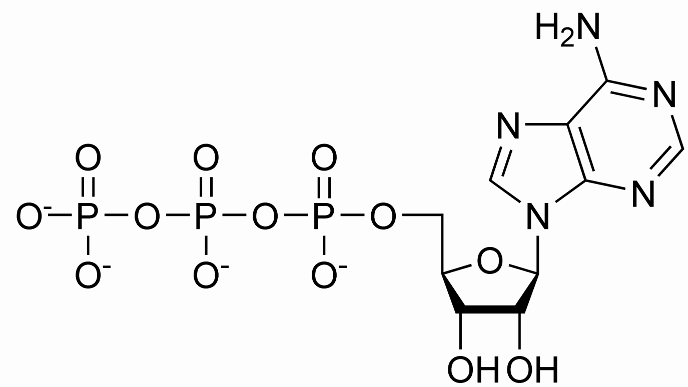
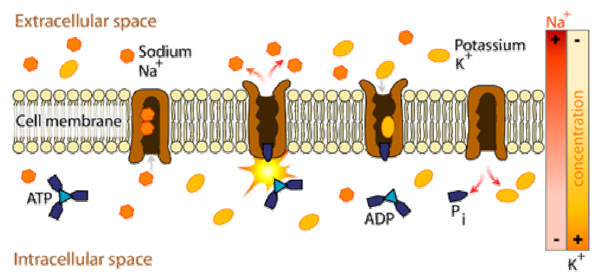
The Roles of ATP

ATP, or Adenosine triphosphate, is an organic chemical compound that has a strong chemical bond which acts as an energy fuel, it isn't a long term energy store as the bond is quite unstable so when ATP is made it is used almost immediately, when this bond is broken it releases chemical energy which can be used straight away for many functions, it is considered in biology to be the currency of life. This energy gets released when a phosphate is broken off, you can get a small energy release from one phosphate leaving the ATP; when one leaves you get ADP. The ADP can then be recharged back to being ATP in the mitochondria of our cells, using respiration; this is how we get energy from food. ATP can also give up bigger amounts of energy if it is needed, when it gives up two phosphates, leaving AMP. ATP has many roles because it is the primary source of energy in living things , we use it in our body to contract muscles for movement, for active transport, it even lights up fireflies, it powers almost every activity that goes on in our cells. As far as it is known every living thing uses ATP as its primary source of energy, from bacteria to plants. At any instant in time a cell in the human body can contain about one billion ATP molecules, but this amount is used up quite quickly and is normally recycled straight away in the mitochondria where chemiosmotic phosphorylation occurs.



One way that ATP is used is for muscle contractions, when you are running, walking, even me typing this essay, your body is using ATP to move muscles for movement, but not only movement, but it isn't only used for skeletal muscle contractions, but also cardiac muscles, responsible for blood transport and the smooth muscle, used to contract blood vessels as well as the gastrointestinal tract, which moves our food along our intestines. ATP is also used on a cellular level, in bacteria it is used for the movement of flagella so the cells can move about. ATP is the immediate source of energy for muscle contractions, but a muscle fibre only contains enough ATP for a few twitches, so the ATP needs to be replenished almost constantly, a muscle fibre different for ATP. In the muscle fibre there is about 10 times more phosphate creatine then ATP so this is a good reservoir, the phosphate creatine donates its phosphate and energy to ADP leaving ATP and creatine. Glycolysis also provides ATP if there is no oxygen, this is anaerobic respiration, this doesn't have a high yield so a fibre can't last long on just this, it also causes a build up of lactic acid which can't be removed fast enough by the body, which must then turn to Aerobic Respiration. Aerobic respiration is used to create a constant yield of ATP when you undergo exercise; this is why you need to breathe more deeply during exercise as anaerobic respiration requires a steady source of oxygen, which we can't store in our bodies. It is also needed to get rid of the lactic acid that may build up, this is known as oxygen debt. The ATP provides energy for the muscle during ATP hydrolysis.

ATP is also used in active transport. Active transport is the movement of particles across a membrane against the concentration gradient and is vital in regulating the concentrations of molecules in a cell, this requires energy, unlike passive transport which doesn't. ATP-ase is an enzyme required in active transport. An example of active transport is sodium potassium pumps, sodium ions get pumped out of a cell against the gradient, whilst potassium ions get pumped in. All ATP-powered pumps have one or more binding sites for ATP, and these are always on the cytosilic (inside) face of the membrane. Although these proteins are often called ATP-ases, they normally do not hydrolyze ATP into ADP unless ions or other molecules are simultaneously transported. Because of the tight coupling between ATP hydrolysis and transport, the energy stored in the bond is not lost. So ATP-powered transport proteins are able to collect the free energy released during ATP hydrolysis and use it to move ions or other molecules uphill against a potential or concentration gradient. The ATP allows the pump to open and close, and ATP can be used in two ways, indirectly or directly. Direct ATP is when ATP is directly bonded to the pump or transporter, and the energy of its hydrolysis is used to drive the active transport. Indirect active transport uses the energy already stored in the gradient; this potential energy gets released when it is released with facilitated diffusion. The concentration gradient in indirect active transport gets built up by the use of ATP in direct active transport.



Bioluminescence in fireflies is another way that ATP is used, it involves a luminescent reaction, where light is produced by the oxidation of a luciferin.

Fireflies need to light up to attract a mate, some deep sea creatures also use bioluminescence. The cells in the firefly's abdomen contain luciferin, a light emitting pigment, and luciferase, an enzyme that speeds up the reaction. The luciferin firstly combines with the ATP and then substrates to the active site of luciferase. This makes luciferyl adenylate which then combines with oxygen to make oxyluciferin, AMP and light, this is an example of when a larger "energy packet" is needed. This is a really interesting way of energy usage to create light, almost 100% of the ATP used in the reaction creates light, unlike lights we use which waste energy on heat, with less than 20% of energy actually giving off light.

ATP is also used to keep us warm, it is what helps us remain in homeostasis. When ATP is made during respiration only about 40% of the energy from glucose goes into the ATP, the rest is released as heat, this is known as an endothermic reaction. That's why when your cold you shiver, by moving your muscles you're using up ATP and by doing that the mitochondria will produce more, and with it heat.

ATP has many more uses including repair and maintenance of cells, DNA replication, Cell division and synthesis of other products. The roles and uses of ATP are endless and it plays a part in every second of our life, but not only our life but every living thing, from the smallest bacterium, simple plants to complex animals. Simplified it is a rechargeable battery but it is used to carry out many complex functions and mechanisms in our body, as well as being quite complex to create. It's a quick to use energy source found in every cell in our body, being a much more manageable form of getting little packets of energy, which it can give up in one reaction.

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