**ATP vs GTP- *Read this!***

**Why ATP?**

ATP is an efficient and relatively simple biosynthesized molecule that can fulfil multiple biochemical roles. Cells do have alternative energy carriers, some with more specialized roles, however ATP is **ubiquitous** (\**KNOW THIS WORD*!) throughout our cells and intercellular spaces. There isn't a wealth of resources explaining why ATP is any better than other compounds, however there are plenty of reasons why the phosphates are required.

**Why not the alternatives?**

* Not enough energy provided.
* Toxic.
* Others are used for inefficient high energy bursts.
* Ancestral dominance of shape.

Citric acids and their derivatives are a good candidate, with deductible groups and high bioavailability but they simply don't give enough energy to stabilize genetic material. Another tribasic candidate is arsenic acid. This is a fundamentally toxic compound though, which isn't particularly great for living things... it makes them dead. There are other phosphates too, and they are used in many organisms. But they have specific functions, and not used as the general energy carrier. Creatine triphosphate provides a high energy phosphoanhydride bond that is often used to quickly and anaerobically regenerate ATP, useful during high rate muscle activity for contraction. **GTP is structurally very similar to ATP. GTPases are used more to initiate cellular signaling pathways. It is sometimes used as an energy source*. ATP has a regulatory role in apoptosis: when there is too much ATP in a cell, it destroys itself. Excessive GTP does not cause cell death*. This is a good example of an alternative energy carrier. Over the years, many proteins have evolved and specialized with a specific shape, and this chance is the primary reason behind ATP over GTP. In other words, the choice of ATP over GTP is primarily down to cellular preference of molecular shape. One of them had to 'win'.**

**Efficiency and simplicity.**

* Pi is a good leaving group.
* ATP synthase can efficiently reattach the Pi to ADP.
* Lots available to organisms.

There are a couple of reasons that make ATP such a chemically efficient way of storing and transporting energy (hydrolysis reaction of ATP->ADP + Pi). **The phosphate groups in ATP are full of negative charges and these are repelling one another.** **This means that the third phosphate is a great leaving group, as breaking the phosphoanhydride bond is a favorable exergonic reaction.**

**When it comes to 'rebinding' the Pi to ADP, it is fairly easy since ADP never chemically binds to anything, which would require a lot of energy to recover the ADP**. **This also helps the bioavailability of free ADP to**[**ATP synthase**](http://www.youtube.com/watch?v=3y1dO4nNaKY)**, an incredibly efficient enzyme that uses membrane proton gradient to drive the production of ATP**. Talking actual numbers is difficult here as there is only data available from Rat hepatocytes, and who is to say mammals are representative of all organisms? The estimates of energy of hydrolysis range from [ΔG˚ = -48 kJ mol-1](http://sandwalk.blogspot.co.uk/2011/11/better-biochemistry-free-energy-of-atp.html) to [-30.5 kJ mol-1](http://biology.stackexchange.com/questions/576/how-on-a-physical-level-does-atp-confer-energy?rq=1). Note that these are considerable, but not exceptional values, so it's easy for many different proteins that need not be very specialized, to break the bond all over the body. I couldn't even find the numbers for the synthase reaction per ATP, but astonishingly a single ATP synthase can produce up to 600 ATP per minute!

**The final point of this efficiency is that the elements in ATP are very abundant in the biosphere making it easily available.**

**Multifunctionality:**

* Can provide more energy if needed.
* Easily useable by a variety of proteins.

**ATP is ubiquitous in the body, but in some cases more energy is needed than there are ATP available. In these times of need, ATP can be used to produce more energy, breaking another phosphoanhydride bond to become AMP+2Pi. With the low activation energy required to break the phosphoanhydride bond, a multitude of enzymes (waaay too many to list here) can make use of ATP in order to gain energy towards the activation energy for many other functions.**