

D. Energy currency

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1. What strategy can a cell use to drive slightly thermodynamically unfavorable catalyzed reactions? How can this be achieved in a cell?

Sometimes the reaction is just too thermodynamically unfavorable to be driven by such tricks.

2. What is the strategy used by the cell to drive such reactions?

We say that ATP is the energy currency of the cell.

3. Why does it make sense to have energy currency?

4. Where in ATP is the energy available to do work stored?

5. What makes ATP a good candidate for the position of energy currency in the cell?

ATP is also a building block of RNA.

6. Given what you know about the early history of life on Earth, why does this make sense?

D. Energy currency Solutions

Enzymes can not make thermodynamically unfavorable reactions proceed. But they do lower the activation energy of a reaction in both directions.

1. What strategy can a cell use to drive slightly thermodynamically unfavorable catalyzed reactions? How can this be achieved in a cell?

As discussed above, skewing the concentrations in favor of reactants can drive such a reaction forward. This can be achieved by immediately siphoning off any newly formed products, thus maintaining the concentration gradient.

Sometimes the reaction is just too thermodynamically unfavorable to be driven by such tricks.

2. What is the strategy used by the cell to drive such reactions?

In the cell, energetically unfavorable reactions are often coupled with favorable ones, such that the new overall reaction is favorable.

We say that ATP is the energy currency of the cell.

3. Why does it make sense to have energy currency?

By producing ATP whenever possible, the cell can store the excess energy to fuel endergonic reactions whenever needed.

4. Where in ATP is the energy available to do work stored?

In ATP energy is stored in the bonds. The most unfavorable of these bonds is the bond between the second and third phosphates.

5. What makes ATP a good candidate for the position of energy currency in the cell?

The third phosphate can be removed, releasing a lot of energy. This phosphate can actually be transferred to one of the reactants, taking that molecule to a higher energy state, and allowing a previously non-spontaneous reaction to proceed.

ATP is also a building block of RNA.

6. Given what you know about the early history of life on Earth, why does this make sense?

It is believed that early in evolution there were very few molecules around. The triphosphate feature of ATP made it a good candidate for energy storage, and once the pathway was developed, it became a selective liability to change it too much. As we discussed on the first day of class, many key pathways, such as glycolysis, are ancient, and trace their origin to the early stages of evolution of life on Earth.