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A.T.P. and Calories: The Chemistry of the Body

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The Chemistry of the Body

INTRODUCTION

Adenosine Triphosphate, also referred to as ATP, is the pure energy of life. This molecule is the essential source for all of the activities our body must do. We ultimately receive this energy from what our body takes in. More than 200 septillion (2.0×10^{26}) ATP molecules are produced every day totaling over 352 pounds! Of course we use nearly of this energy throughout the day by simply being alive. Within the body, the amount of energy released is referenced in Calories. These are the Calories that people "watch" while on a diet and that are on boxes and bags of food. This poster aims at presenting the chemistry of the formation of ATP and the use of ATP in the form of Calories.

BODY

The body produces ATP through a process called cellular respiration. This consists of glycolysis, the krebs (or citrus) cycle, and the electron transport chain (ETC). Through these processes large molecules, primarily glucose, is broken down and a total of 36 net ATP are produced.

1. GLYCOLYSIS

Once the body has reduced food down to a molecule of glucose, the molecule undergoes glycolysis. Glycolysis takes place in the intracellular fluid. For every one molecule of Glucose ($C_6H_{12}O_6$) the process requires two ATP, two NAD^+ ions, two ADP (Adenosine Diphosphate), two inorganic phosphates (P_i), and two coenzyme A. All of the body chemistry discussed will assume the presence of "unlimited" oxygen.

$$1\,C_6H_{12}O_6 + 2\,ATP + 4\,NAD^+ + 2\,ADP + 2\,P_i + Coenzyme\ A$$

$$\downarrow$$

$$2\,Acetyl\ CoA + 4\,ATP + 4\,NADH + CO_2$$

Since two ATP are used and four ATP are produced, the net product for glycolysis is two ATP. The process also yields two NADH which will be used in the ETC, and two Acetyl Coenzyme-A, which will be individually used in the Krebs cycle.

2. KREBS CYCLE

Once the two molecules of Acetyl CoA are produced, they each undergo a process called the Krebs Cycle. This process involves the removal of the coenzyme and the production of ATP through phosphorylation.

$$2\,Acetyl\ CoA + 2\,ADP + 6\,NAD^+ + 2\,FAD$$

$$\downarrow$$

$$4\,CO_2 + 2\,ATP + 6\,NADH + 2\,FADH_2$$

The net reaction of the Krebs Cycle results in four carbon dioxides and two ATP. The reaction also produces six NADH and two $FADH_2$ which will be used in the ETC. After the Krebs cycle the body has produced four net ATP.

3. ELECTRON TRANSPORT CHAIN (ETC)

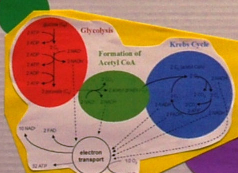
The final stage of the production of ATP takes place in the cristae of the mitochondrion. The NADH and $FADH_2$ molecules bring their electrons to the ETC. The energy released from the reduction of carriers is used to pump hydrogen across the membrane. The hydrogen ions are used by ATP synthase to combine with ADP and inorganic phosphate (P_i) to form ATP. Each NADH can produce two ATP and each $FADH_2$ can produce two ATP. Once this has happened the left over electrons and protons are combined with excess oxygen to form excess water.

$$10\,NADH + 2\,FADH_2 + 34\,ADP + 34\,P_i + \text{Excess } O_2$$

$$\downarrow$$

$$32 - 34\,ATP + \text{Excess } H_2O$$

The net ratio for cellular respiration is therefore 36-38 ATP to each molecule of glucose. The variance is due to imperfections in the ETC.

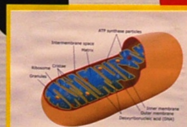


Every mole of ATP produces approximately 7000 calories (7 Cal). Every gram of sugar contains approximately 5.6×10^{-3} moles of glucose.

$$\frac{1\ g\ sugar}{1} \cdot \frac{1\ mol\ glucose}{180.16\ g\ sugar} \cdot \frac{36\ mol\ ATP}{1\ mol\ glucose} \cdot \frac{7000\ cal}{1\ mol\ ATP} \cdot \frac{1\ Cal}{1000\ cal} = 1.4\ Cal$$

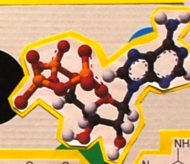
Using 1.4 Cal per gram of sugar as well as 7 Cal per mole of ATP can determine the amount of energy available from foods, as well as the amount of energy needed for certain exercises.

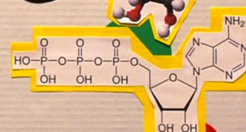
Activity	Cal/Hr	ATP mol req.	g sugar
Med. Bicycling	700	100.	500g
Light Dancing	400	57.1	285g
Golf (walking)	400	57.1	285g
Light Jogging	400	57.1	285g
Med. Running	800	114.	570g
Med. Swimming	450	64.3	321g
Light. Walking	300	42.9	214g



CONCLUSION

We use ATP in the form of energy Calories every second of every day. Whether we are sleeping, eating, or exercising, we rely on a smooth transition from ingestion to cellular respiration. Our body stores all this energy either for immediate use as ATP, or for later use as lipids from which they can be returned to ATP. Our body is a network of chemical reactions, and without all of these reactions working in sync, ATP would not be created. ATP is the foundation of life. Without it, life would literally cease to exist.





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