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2 1/2 years of undergraduate/graduate chemistry · 7y

On average, how many chemical reactions happen in the body in one second?

Originally Answered: On average, how many chemical reactions happen in the body in one second ?

Let's start with the number of reactions in one human eukaryotic cell per second. I've heard estimates ranging from hundreds of million to several billion. Let's take a rough average and say 1 billion.

It's tough to say exactly how many cells are in the human body, but the most current estimate is 37.2 trillion. This number likely fluctuates over time and varies from person to person, but it should be pretty close, so let's use it!

$(1 \times 10^9 \text{ RXNs per second per cell}) \times (37 \times 10^{12}) = 37 \times 10^{21}$, i.e. 37 with 21 zeros after it, or 37 thousand billion billion chemical reactions per second in the human body.

You might be wondering at this point how so many reactions can be taking place every second in our cells. And the answer lies in their size. Whether or not a reaction will take place, and how long it takes to complete are largely determined by two things: a) how frequently atoms and molecules in a given space crash into each other, which is a function of the size of the container relative to the number of atoms and molecules, and b) how fast they're moving when they collide, which is a function of temperature. It just so happens that the average Eukaryotic cell, of which all multicellular organisms are comprised, has a volume of about 1×10^{-11} liters, which nature selected over time because it is the perfect size for the most efficient biochemistry, i.e. the perfect number of collisions per unit time at body temperature, which is 37 degrees Celsius for humans.

These chemical reactions are the basis of what we would consider to be life. Copying our DNA and manufacturing new organelles and cell walls so the cells can multiply, transcribing DNA into RNA which is then translated into proteins, which are the building blocks of organic life's structures, and also comprise a vast array of enzymes, which help reactions occur under the right set of circumstances, good things like sugar and fat are broken down into usable energy (ATP) and harmful things like bacterial toxins are destroyed and expelled, hormones are synthesized to communicate with other cells, and the list goes on and on. One of my favorite realizations as a freshman biology student was that each new biological process I learned about in class had occurred trillions and trillions of times in the bodies of everyone in the room during the time it took the professor to explain it.

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