

# Thermodynamics of Muffins

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**Question:** Does evolution contradict the 2<sup>nd</sup> law of thermodynamics?

**Answer:** No

## **Explanation:**

Creationists get a lot of mileage out of this chestnut because it uses scientific terms like thermodynamics and entropy to bolster their contention that evolution is unscientific. In fact, local increases in complexity/order are not only completely consistent with thermodynamics, but expected by the theory. Nevertheless, creationists contend: “Evolutionary theory stands in obvious defiance of the Second Law” and “Evolution teaches that life increases in complexity, and therefore defies the second law. ...The second law says that everything in our world and in the universe is like a wound-up clock that is running down.” ([www.pathlights.com/ce\\_encyclopedia/18law03.htm](http://www.pathlights.com/ce_encyclopedia/18law03.htm) ; <http://evolution-facts.org/Ev-Crunch/c18.htm> see also [www.cryingvoice.com/Evolution/Physics.html](http://www.cryingvoice.com/Evolution/Physics.html)). This ruse works best with an audience that is already inclined to hope that evolution isn't true, and requires that the audience does not already understand thermodynamics. This burdens the defender of evolution with having to explain not only all of evolutionary theory but thermodynamics on top. I've found that the following explanation often works pretty well to help folks understand basic implications of the 2<sup>nd</sup> law as it relates to life on earth and evolution.

The 2<sup>nd</sup> law of thermodynamics has to do with entropy –the entropy of the universe increases during any spontaneous process. A traditional way to understand this is that disorder increases in a closed system. This is where some muffins come in handy.

1) Imagine you have 6 muffins hot from the oven & 6 frozen in the freezer. You place the dozen muffins in a special box alternating hot with cold muffins. You place a lid on the box & when you do it will not allow any heat inside the box to escape nor any outside temperature to affect the muffins. All heat in the muffins will remain in the box (a closed system).

2) Inside the box, your system is highly ordered: hot, cold, hot, cold. The average temperature in the box is obtained by averaging the temperature of all the muffins together. As time goes by, the heat from the hot muffins mixes with the cold from the frozen muffins to produce a situation where all muffins are the same temperature. Notice that the average temperature is still the same as it was when the muffins first went into the box; only the arrangement of the heat has changed. Entropy has increased; your system is no longer ordered.

3) To keep your system ordered, you would have to have some sort of electrodes (or some other intervention system) that would continually heat the hot muffins & cool the frozen ones. This energy would have to come from outside the system (as it does in the case of a refrigerator, which must be plugged into an external energy source). So, you

could keep the system ordered, but to do it, you would have to have an open system (where energy can flow in).

4) Life is similar. You might have two human beings who seek to increase order by making the two human bodies into three. In a closed system, this increase in order would be impossible. But humans exist in an open system where they take matter and energy in and can spin out additional humans at the rate of one every 9-12 months.

5) This is because the earth is not a closed system. Energy from the sun is like a giant electrode powering life on earth. Plants increase the order/complexity in their own bodies as they grow from seed to flower (using the sun's light directly plus the minerals & water in the earth). Herbivores use the energy in plants, carnivores use herbivores, etc. So a huge cascade of complexity is built on the very simple source of energy from the sun.

6) If the earth were a closed system, then every living organism on earth would be defying entropy on a daily basis.

7) The earth is not a closed system, thus, respiration, growth, reproduction, and evolution happen on earth on a daily basis without violating the 2nd law of thermodynamics.

8) Many physicists think the universe as a whole is a closed system. That is, not only will the sun burn out some day and life on earth will no longer have the external energy source it needs (actually worse things will probably destroy life on earth before that as the sun will probably expand and cook everything well before it burns out). Eventually all the energy in the universe –currently arranged like the muffins in the closed box– will even out to the point where no order will exist at all. When the muffins are all the same temperature, the game is over...

9) However, many physicists think that long before the universe falls into total entropy, other things will happen to the overall structure of the universe, so it hardly makes sense to talk about the entire universe as a closed system anyway.

*One caveat: Do not look for the muffin example to comprehensively cover all of physical theory. It discusses entropy in terms of the classical theory of thermodynamics. Quantum mechanics & relativity theory put a different spin on it. Since we don't really have conservation of energy in general relativity, it's hard to say what a really comprehensive thermodynamics will look like once the physicists work it out. However, the more Einsteinian versions of thermodynamics thus far all look far worse for the creationist objection than does the classical theory. For a more advanced understanding of classical thermodynamics, see: [www.entropylaw.com/](http://www.entropylaw.com/)*

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