# Survivalist fatty acids to prepare for life on Mars (or just plain old aging)

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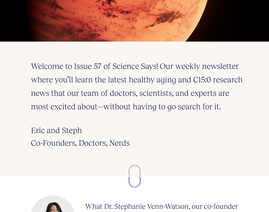

Welcome to Issue 57 of Science Says! Our weekly newsletter where you'll learn the latest healthy aging and C15:0 research news that our team of doctors, scientists, and experts are most excited about—without having to go search for it.

Eric and Steph
Co-Founders, Doctors, Nerds

What Dr. Stephanie Venn-Watson, our co-founder and author of over 80 peer-reviewed scientific publications, is reading.

HEALTHY AGING

## How cells use fatty acids to survive extreme conditions

In this series, we are covering the science behind our cell membranes - because they (literally) cover our cells, our health, and even our longevity.

Last week, we discussed how quickly the fatty acid makeup of our cell membranes change based on what we eat. This week, let's talk about how extremophiles use different fatty acids in their cell membranes to be, well, extremophiles.

**Sounds interesting. What is an extremophile?**

Bacteria that thrive in super hot or ultra cold environments are called extremophiles. Their survival, be it high-pressure seawater hydrothermal vents at 220°F or frozen Arctic glaciers, is thanks to the type of fatty acids they have in their cell membranes. It's pretty *simple*, really. As described by Driessen et al., the more stable the fatty acids, the better these bacteria can survive in extreme environments.

**Three survivalist fatty acids**

Over 50 years ago, Chan et. al showed that there are three main groups of cell membrane fatty acids that help make cells the ultimate survivors:

- **Monounsaturated fatty acids are flexible for freezing.** Unsaturated fatty acids have double bonds which make them flexible, but also susceptible to breakdown. *Mono*-unsaturated fatty acids, however, only have one double bond, which provides flexibility with limited instability. This is likely why psychrophilic (cold-loving) bacteria use monounsaturated fatty acids over polyunsaturated fatty acids to survive those freezing temps.
- **Branched odd-chain saturated fatty acids can handle the heat.** In contrast, thermophiles (heat-loving bacteria) have very high amounts of branched odd-chain saturated fatty acids. These molecules consist of an odd-chain fatty acid with a remora-like methyl attached. By far, the most common branched odd-chain saturated fats used by thermophiles contain C15:0.
- **Straight-chain saturated fatty acids are the ultimate equalizers.** Whether cold or hot, extremophiles love to use saturated fatty acids in their cell membranes to survive. The lack of double bonds make saturated fats the go-to molecule for stabilizing cells.

Okay, this makes sense over millions of evolutionary years. But can fatty acids in cell membranes be rapidly changed to adapt to challenging environments?

**Preparing for life on Mars**

The answer is, yes! Garci-Descalzo et al. recently published a study in *Frontiers in Astronomy and Space Sciences*, where the team challenged bacteria with Mars-like conditions to see how life on earth could adapt to living on Mars. Here, they exposed a bacterium called *Rhodococcus* to poly-extreme environments: warm, cold, and subzero temps, as well as added magnesium perchlorate to mimic Mars. At the maximum stress level, *Rhodococcus* responded by turning on its survivor mode: namely, increasing the amount of saturated fatty acids in its cell membrane, and decreasing the unsaturated and branched fatty acids.

**Good for bacteria, but how relevant is this story for humans?**

Great question. We aren't quite basking in 220°F heat or freezing in glaciers, nor are most of us heading to Mars anytime soon. But understanding how bacteria alter their cell membrane fatty acid makeup provides relevant insights into how we can protect our own cells against stressors, such as age, cancer treatments, and alcohol.

Here are a few cases in point:

- **Monounsaturated fatty acids are associated with longer life.** Ali et al. showed that long-lived individuals (folks who are between 90 to 111 years old) in Sicily had substantially higher monounsaturated fatty acid levels compared to younger people. The authors concluded that these fatty acids, given their chemical structures, may help limit oxidation while also maintaining membrane fluidity.
- **Branched and odd-chain saturated fatty acids increase in cancer survivors.** Pakiet et al. demonstrated that breast cancer survivors had favorable changes in their serum fatty acids, both 12 and 24 months after treatment, including increased branched chain fatty acids, odd-chain fatty acids (aka C15:0 and C17:0) and improved omega-6 to omega-3 ratios. The authors concluded that these may be adaptive and protective changes in survivors.
- **Saturated fatty acids protect against ethanol damage to livers.** You know that craving for super fatty foods after drinking too much alcohol? In their review, Kirpich et al. cover a slew of studies showing how saturated fats can protect livers against the direct damage of alcohol. But before you use these studies as an excuse to grab that messy burger, understand that higher levels of even-chain saturated fatty acids (e.g. C16:0) continue to be associated with increased risks of developing type 2 diabetes and heart disease.

In summary (despite not having brains) bacteria have been pretty darn smart about how to survive extreme conditions. This ability to turn up survivor-supporting monounsaturated, branched, and odd-chain saturated fats in cell membranes has direct relevance to our survival, too.

Who's ready for a trip to Mars?

**Next week,** we'll talk about an emerging new player to the cellular membrane aging vs. survival story which you may find a bit *iron*-ic.

In the meantime, have a great week!

## Dive deeper into the science

READ THESE STUDIES


- Najiari A (ed). Life in extreme environments - diversity, adaptability and valuable resources of bioactive molecules
- Driessen & Albers. Membrane adaptations of (hyper)thermophiles to high temperatures
- Chan et al. Fatty acid composition of thermophilic, mesophilic and psychrophilic bacteria
- Garcia-Descalzo et al. Changes in membrane fatty acids: Implications for Mars habitability
- Ali et al. Age-associated changes in circulatory fatty acids: new insights on adults and long-lived individuals
- Pakiet et al. Serum fatty acid profiles in breast cancer survivors
- Kirpich et al. Alcoholic liver disease: updated on the role of dietary fat
- Forouhi et al. Differences between individual saturated fatty acids and incident type 2 diabetes
- Djousse et al. Serum fatty acids and risk of heart failure in older adults


- Check out all the C15:0 science at www.discoverC15.com