DesignerMicroStar: Aceba (*Acinetobacter baylyi*)

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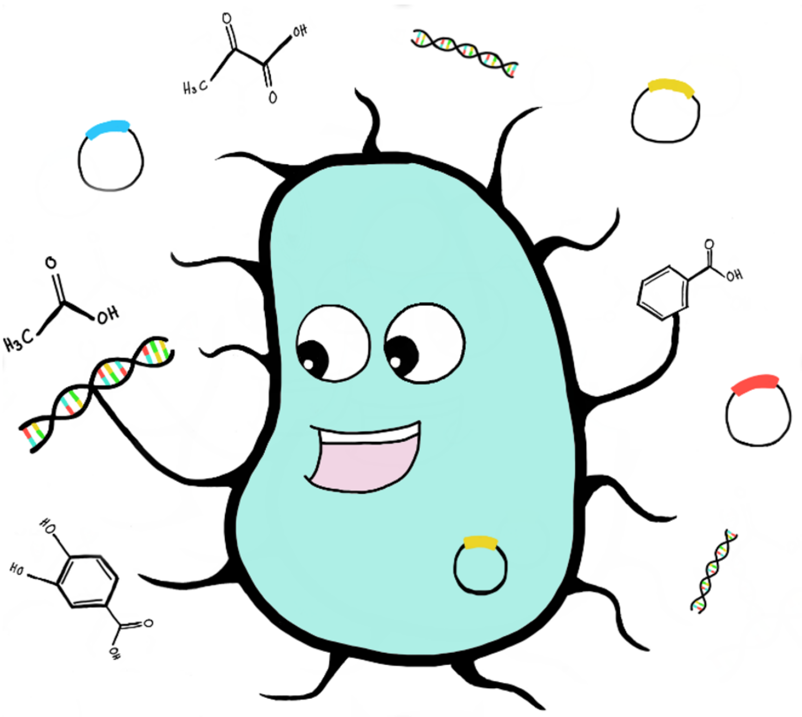


Acinetobacter baylyi's superpowers are DNA uptake from its environment and a very broad metabolism.

Claim to fame: An unparalleled ability to capture DNA and acquire new superpowers

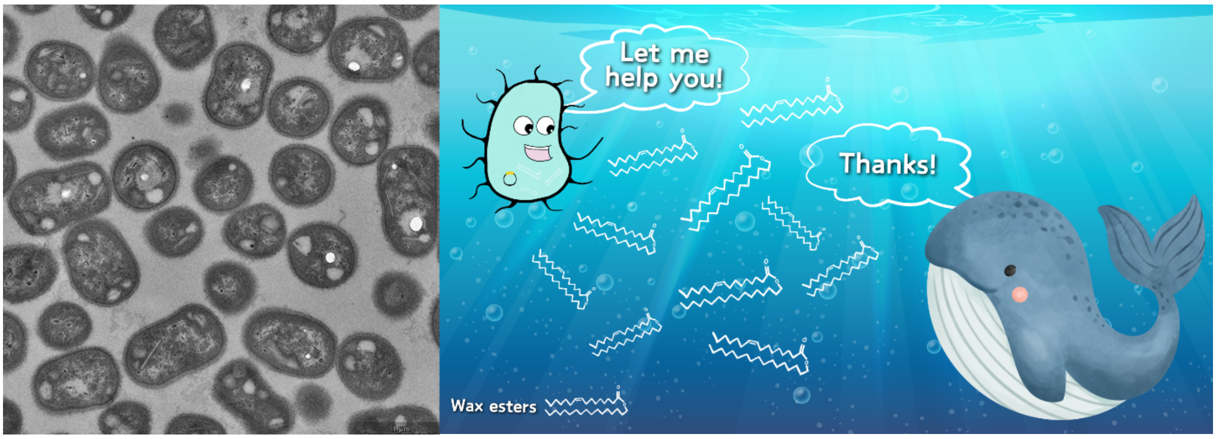
As we gain more knowledge on the reactions that cells can carry out, and we develop more powerful tools for genetic engineering, we are finding new ways to produce useful chemicals and materials in a more sustainable manner. In particular, we can manipulate microbes so that they can convert cheap renewable feedstocks (for example, residues from agriculture or municipal waste) into interesting molecules, making them a "greener" alternative to traditional industrial processes that may require extreme temperatures and pressures or depend on finite resources.

Usually, these microbial cell factories are built from well-studied hosts such as *Escherichia coli* and baker's yeast, for which an enormous number of genetic tools have been developed over the years. In the laboratory, these microorganisms need to be "tricked" into taking up foreign DNA so that they can produce the compounds we want – and this requires specialized equipment and a lot of time and effort!

Luckily, more and more diverse bacteria with interesting properties are gaining popularity as cell factories. Among them, *Acinetobacter baylyi* ADP1 (Aceba) stands out for its natural ability to incorporate DNA fragments directly from the environment, which allows it to better adapt to its surroundings and survive in fascinating ways. For us, this means that we can very easily manipulate its genetic information in the laboratory, generating many different mutants that we can rapidly test! In addition, Aceba has a very broad metabolism, so it can use many different compounds for growth and energy. For example, it can eat sugars, aromatic compounds derived from lignin (a very tough natural polymer that gives plants their rigidity), and alkanes found in petroleum. These characteristics make Aceba an attractive study organism, sparking growing interest in both environmental and biotechnological applications.

Aceba's natural habitat and friends. Aceba was first isolated from soil in 1960. In a time when molecular biology tools were not as widely available as they are today, its ability to take up DNA directly from the culture medium and incorporate it into its own genetic material made it an extremely valuable laboratory model to study bacterial metabolism and physiology. In fact, it is one of the first bacteria in which the metabolism of aromatic compounds was studied! Furthermore, unlike other *Acinetobacter* species that are known to cause infections in hospitals, Aceba does not harm humans. Therefore, it is a safe model to study how its pathogenic relatives can adapt and, for example, become resistant to antibiotics.

How Aceba can save whales. Thanks to Aceba's metabolic versatility and its natural ability to incorporate new genes, scientists can engineer it to efficiently degrade tough substrates that bacteria typically don't like to eat – and produce valuable compounds at the same time. Aceba naturally accumulates a special mixture of oils: wax esters and triglycerides. These compounds are very similar in their chemical composition to the spermaceti oil that was traditionally obtained from the sperm whale, which was used to make candles, soap, cosmetics, pharmaceuticals, and many other products. Spermaceti was in such high demand that it almost led to the extinction of the sperm whale! So, imagine having Aceba produce these oils from waste that we usually burn or throw away, such as leftovers from agriculture or plastic residues. This is possible thanks to genetic engineering! In recent years, scientists have successfully engineered Aceba to convert different compounds derived from plant biomass or the plastic used in PET bottles into wax esters, triglycerides, and other valuable chemicals, opening the door to more sustainable production processes from affordable resources.



Transmission electron micrographs of Aceba cells showing accumulation of wax esters and triglycerides (white spots inside the cells). *A. baylyi* is an alternative for the production of wax esters that can contribute to saving whales.

Why Aceba is important for us

Aceba is emerging as a new microbial cell factory with great potential for use in environmental and biotechnological applications. We can take advantage of its metabolism to remove toxic pollutants from the environment, contributing to keep waters and soils clean and safe (SDGs 3, 6, 14 and 15). We can also engineer it to sustainably produce valuable chemicals and materials, like bio-based alternatives to conventional plastics (SDGs 11, 12 and 13). Lastly, its simple genetic manipulation with minimal instrumental requirements can make quality education on microbial biotechnology and synthetic biology more accessible (SDG 4).

Aceba is a great small ally for a more sustainable future!