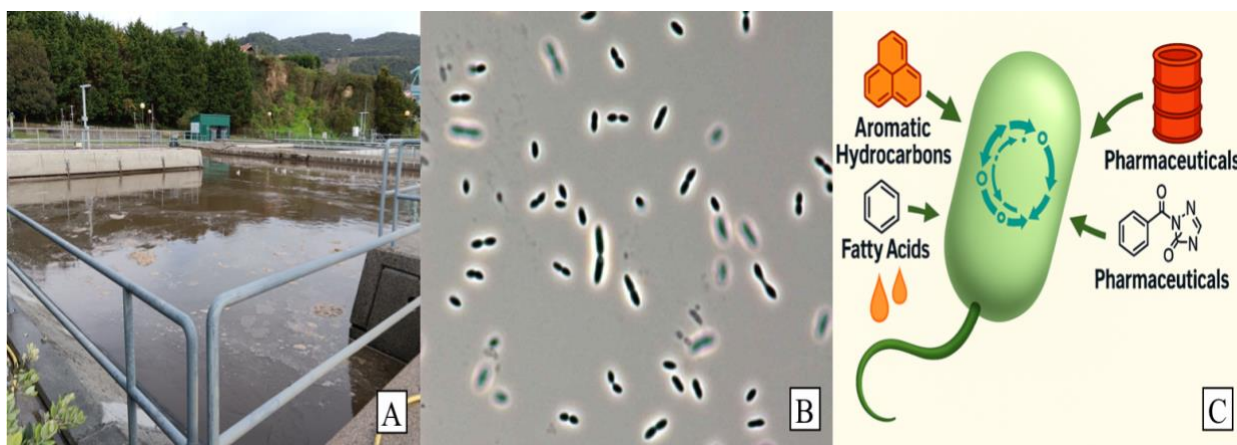


Micro-Hero: Pseudo (*Pseudomonas putida*) (VÍCTOR HERNANDO-MORALES)



Wastewater treatment plant in northwest Spain (A) at the aerobic microbiological treatment (photo by V. Hernando Morales); microscopic view of *Pseudomonas putida* cells (B), and illustration of the versatile degrader of organic compounds, *Pseudomonas putida*, breaking down different complex compounds (C).

Claim to fame: turning toxic and complex chemicals into harmless building blocks

Every day, wastewater treatment plants (WWTPs) receive enormous volumes of dirty water from our homes, schools, hospitals, and industries. This water contains food leftovers, soaps, oils, medicines, fuels, and many other chemical substances that should never reach rivers, lakes, or the sea untreated.

Luckily, WWTPs are not working alone. Hidden inside the bubbling tanks lives a powerful workforce of microorganisms that clean the water for us. Among the most versatile and hardworking of these is Pseudo, whose real scientific name is *Pseudomonas putida*.

Meet Pseudo: who is it? Where did scientists find it? *Pseudomonas* is a rod-shaped bacterium commonly found in soil, water, and wastewater treatment plants all over the world. Under the microscope, it looks simple, but its metabolism is extraordinarily sophisticated.

Pseudo belongs to the wide group of fluorescent *Pseudomonas*. This group was first described at the end of the 19th century by the German microbiologist Walther Migula. His original description was very brief and even included some mistakes (for example, he suggested that some *Pseudomonas* species could form spores, which we now know is not true). Later microbiologists debated the meaning of the name. One interpretation suggested it meant “false unit” (from Greek *pseudes* = false and *monas* = unit). However, another explanation passed down by microbiologists who worked close to Migula’s time, suggests that he named the bacteria *Pseudomonas* because they looked and moved like tiny flagellated organisms called *Monas*. Perhaps, Migula's primary intention may was to call the bacteria ‘false Monas’ instead of ‘false units’. Who knows! However, this story reminds us that scientific names often reflect early observations, and that science improves as our tools and knowledge grow.

Bacteria of the genus *Pseudomonas* belongs to a bigger group called heterotrophic bacteria, meaning they feed on organic matter. But unlike many microbes that can only eat “easy” food, Pseudo is famous for its ability to break down complex and toxic compounds that most organisms cannot use.

One of the best characterized Pseudo is *Pseudomonas putida*, currently use as a toolbox in environmental and synthetic biology.

Pseudo’s superpowers

A learner-centric microbiology education framework

Pollution eater. Pseudo can degrade a wide range of pollutants, including:

- Hydrocarbons (such as oil and fuel residues)
- Solvents and industrial chemicals
- Pharmaceuticals and personal care products
- Aromatic compounds that are toxic to many organisms

It does this by producing special enzymes that cut large, harmful molecules into smaller, harmless ones. A bit like molecular scissors that only microbes know how to use.

Nature's recycler

As Pseudo breaks down pollutants, it turns them into:

- Carbon dioxide
- Water
- Biomass (new microbial cells)

This process removes pollution while recycling nutrients back into natural cycles.

Team player

Pseudo does not work alone. In activated sludge, it cooperates with many other bacteria, sharing by-products and stabilizing microbial communities. Pseudo often works alongside *Bacillus* species (enzyme producers), nitrifying bacteria (nitrogen transformers) and protozoa (which keep bacterial populations balanced). Together, they form microbial "cities" called flocs, which settle out of the water so clean water can flow onward. This teamwork helps prevent the domination of harmful or nuisance organisms and keeps the treatment system balanced.

Where does Pseudo work in a WWTP?

Pseudo is most active in the secondary (biological) treatment stage, especially in:

- Activated sludge systems
- Biofilms attached to carriers or reactor walls

Here, wastewater is mixed with air and microbes, creating ideal conditions for Pseudo to perform its cleaning job.

Why is Pseudo important for us?

Without microbes like Pseudo:

- Organic pollutants would accumulate in water
- Toxic compounds would enter rivers and oceans
- Aquatic life and human health would be at risk

By quietly doing its job every day, *Pseudomonas putida* helps:

- Protect drinking water sources
- Reduce environmental pollution
- Support public health
- Enable water reuse and circular water management

A learner-centric microbiology education framework

In short: Pseudo helps turn wastewater back into a resource.

Did you know ?

Scientists use *Pseudomonas putida* as a model organism in environmental biotechnology because it is:

- Easy to grow in the laboratory
- Genetically flexible
- Extremely resilient

Some strains are even engineered to clean up oil spills and industrial contamination sites!

Pseudo does not wear a cape.

It does not make noise.

But every second of every day, it protects ecosystems and human societies by cleaning what we discard.

When wastewater is clean, Pseudo has done its job

Scientific references

Palleroni, N. J. (2010). *The Pseudomonas story*. Environmental Microbiology, 12(6), 1377–1383.

Nelson, K. E., et al. (2002). *Complete genome sequence of Pseudomonas putida KT2440*. Environmental Microbiology, 4(12), 799–808.

Y. Chen, C.J. Lin, G. Jones, S. Fu, H. Zhan. Enhancing biodegradation of wastewater by microbial consortia with fractional factorial design. J. Hazard. Mater., 171 (2009), pp. 948-953

M. Bramucci, H. Kane, M. Chen, V. Nagarajan. Bacterial diversity in an industrial wastewater bioreactor. Appl. Environ. Microbiol., 62 (2003), pp. 594-600

Kirilova, M., Yotinov, I., Todorova, Y., Dinova, N., Lincheva, S., Schneider, I., & Topalova, Y. (2024). Microbiome Structure of Activated Sludge after Adaptation to Landfill Leachate Treatment in a Lab-Scale Sequencing Batch Reactor. Processes, 12(1), 159.

Udaondo, Z., Ramos, J. L., & Abram, K. (2024). Unraveling the genomic diversity of the *Pseudomonas putida* group: exploring taxonomy, core pangenome, and antibiotic resistance mechanisms. FEMS Microbiology Reviews, 48(6), fuae025.

Doi: 10.5281/zenodo.18365857