Pseudomonas putida

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Pseudomonas putida is a ubiquitous rhizosphere saprophytic bacterium and soil colonizer that belongs to the wide group of fluorescent *Pseudomonas* species. *P. putida* strain KT2440, the best-characterized member of the group, became a model laboratory species that attracted considerable attention as a cell host for synthetic biology and metabolic engineering due to its remarkable and versatile metabolism, which has evolved to withstand harsh environmental conditions and physicochemical stress. This species has also retained the ability to survive and thrive in natural soil environments. *P. putida* mt-2 and other isolates have been recognized and used as agents for bioremediation due to their ability to grow on complex substrates, including aromatic compounds (e.g., toluene and xylenes). The absence of pathogenic determinants is another key feature of strain KT2440 that facilitated its adoption for both fundamental and applied research in microbiology.

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Resources

Bergey's Manual of Systematics of Archaea and Bacteria; <https://doi.org/10.1002/9781118960608>

KEGG: www.genome.jp/kegg-bin/show_organism?org=ppu

NCBI: www.ncbi.nlm.nih.gov/genome/174?genome_assembly_id=271486

Literature

1. Belda, E. *et al.* (2016) The revisited genome of *Pseudomonas putida* KT2440 enlightens its value as a robust metabolic chassis. *Environ. Microbiol.* 18, 3403–3424
2. Nikel, P.I. and de Lorenzo, V. (2018) *Pseudomonas putida* as a functional chassis for industrial biocatalysis: from native biochemistry to trans-metabolism. *Metab. Eng.* 50, 142–155
3. Nikel, P.I. *et al.* (2014) Biotechnological domestication of pseudomonads using synthetic biology. *Nat. Rev. Microbiol.* 12, 368–379
4. Nogales, J. *et al.* (2020) High-quality genome-scale metabolic modelling of *Pseudomonas putida* highlights its broad metabolic capabilities. *Environ. Microbiol.* 22, 255–269
5. Palleroni, N.J. (2010) The *Pseudomonas* story. *Environ. Microbiol.* 12, 1377–1383
6. Timmis, K.N. (2002) *Pseudomonas putida*: a cosmopolitan opportunist par excellence. *Environ. Microbiol.* 4, 779–781
7. Poblete-Castro, I. *et al.* (2017) Host organism: *Pseudomonas putida*. In *Industrial Biotechnology: Microorganisms* (Wittmann, C. and Liao, J.C., eds), pp. 299–326, Wiley-VCH
8. Worsey, M.J. and Williams, P.A. (1975) Metabolism of toluene and xylenes by *Pseudomonas putida* (arvilla) mt-2: evidence for a new function of the TOL plasmid. *J. Bacteriol.* 124, 7–13
9. Jiménez, J.I. *et al.* (2002) Genomic analysis of the aromatic catabolic pathways from *Pseudomonas putida* KT2440. *Environ. Microbiol.* 4, 824–841
10. Nikel, P.I. *et al.* (2016) From dirt to industrial applications: *Pseudomonas putida* as a synthetic biology chassis for hosting harsh biochemical reactions. *Curr. Opin. Chem. Biol.* 34, 20–29

KEY FACTS:

Genome size: 6 181 873 bp.

G+C content of the genome: 61.5%

Number of protein-encoding genes: 5592.

Number of genes encoding hypothetical proteins or proteins of unknown function: 1151.

Five genome-wide metabolic models are currently available for strain KT2440 (the latest includes 2929 reactions).

Stanier, Palleroni, and Doudoroff provided the first accurate description of the *Pseudomonas* genus; it was further refined by Palleroni based on the sequence of the 16S rDNA.

Obligate aerobe.

TAXONOMY AND CLASSIFICATION:

KINGDOM: Bacteria

PHYLUM: Proteobacteria

CLASS: Gammaproteobacteria

ORDER: Pseudomonadales

FAMILY: Pseudomonadaceae

GENUS: *Pseudomonas*

SPECIES: *Pseudomonas putida*

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Figure 1. *Pseudomonas putida* Has Gained Interest among Both the Academic and Industrial Communities since Its Isolation in 1960. Physiological robustness, metabolic versatility, and high tolerance to stress are key features of this species. In nature, this rhizobacterium colonizes soil and roots (often forming biofilms); under laboratory conditions, both planktonic and attached lifestyles can be exploited. The value of this species as a cell factory (e.g., for biopolymer production or in biodegradation) prompted the development of several tools for all kinds of genetic manipulations.

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Figure 2. (A) Timeline of Significant Scientific and Industrial Achievements in the Research and Application of *Pseudomonas putida*. (B) *P. putida* KT2440 growing on a minimal medium containing glucose: wild-type strain (left panel), and engineered variants, constitutively expressing the genes encoding the green and the red fluorescent protein (middle and right panels, respectively). P14g and BCD2 are a constitutive promoter and a translational coupler, respectively. (C) The cyclic glycolysis of *P. putida* encompasses activities of the Entner–Doudoroff (ED), the (incomplete) Embden–Meyerhof–Parnas (EMP), and pentose phosphate (PP) pathways. This metabolic architecture enables the cells to adjust the catabolic formation of NAD(P)H by regulating the rate of cycling.