Postdoctoral Position in Molecular Microbiology

Molecular mechanisms of iron acquisition in biofilms of heterotrophic bacteria degrading particulate substrate in marine environments

Scientific Context

In oceans, remineralization of the organic carbon into CO_2 occurs mostly through the respiration of heterotrophic bacteria that degrade the organic matter released by lysed or decaying phytoplankton cells (1). The greatest part of the heterotrophic activity resides in the particulate fraction of the organic matter (POM) consisting of aggregated compounds (mostly proteins, polysaccharides and lipids) that is colonized by biofilm-forming bacteria (2). Metal availability, particularly iron, is expected to have a strong impact on organic carbon remineralization since heterotrophic bacteria have higher iron content than eukaryotic phototroph and respiration is a highly iron demanding process, the respiratory chain alone containing approximately 94% of the cellular iron (3) (4).
In response to the challenge of metal acquisition, marine bacteria have evolved very efficient pathways designed to extract trace amount of iron and most likely other metals from their surrounding environment. The best-documented acquisition pathway is the siderophore-mediated iron uptake. Siderophores bind iron with a very high affinity and hence are able to scavenge iron at low concentration or to displace iron from other ligands having a lower affinity. Siderophore-Fe(III) complexes are then recognized and transported across the cell membranes through an energy dependent process involving outer membrane receptors, periplasmic binding proteins and inner membrane transporters. Relatively few siderophore structures from marine bacteria have been elucidated in comparison with those of terrestrial or pathogenic bacteria (5). The majority of marine siderophores identified to date are amphiphilic or/and photoreactive (6). Some bacterial species produce several siderophores or suite of siderophores with various hydrophobic tails(7) (8). The eco-physiological role of the different siderophores produced by one strain as well as the function of the amphipathy and photoreactivity are not understood.

References

1. Buchan A, LeCleir GR, Gulvik CA, Gonzalez JM. 2014. Master recyclers: features and functions of bacteria associated with phytoplankton blooms. Nat Rev Microbiol 12:686–698.
2. Benner R, Amon RMW. 2015. The Size-Reactivity Continuum of Major Bioelements in the Ocean, p. 185–205. In Carlson, CA, Giovannoni, SJ (eds.), Annual Review of Marine Science, Vol 7. Annual Reviews, Palo Alto.
3. Tortell PD, Maldonado MT, Price NM. 1996. The role of heterotrophic bacteria in iron-limited ocean ecosystems. Nature 383:330.
4. Marine bacteria and biogeochemical cycling of iron in the oceans - Tortell - 1999 - FEMS Microbiology Ecology - Wiley Online Library.
5. Sandy M, Butler A. 2009. Microbial Iron Acquisition: Marine and Terrestrial Siderophores. Chem Rev 109:4580–4595.
6. Butler A, Theisen RM. 2010. Iron(III)-siderophore coordination chemistry: Reactivity of marine siderophores. Coord Chem Rev 254:288–296.
7. Kem MP, Zane HK, Springer SD, Gauglitz JM, Butler A. 2014. Amphiphilic siderophore production by oil-associating microbes. Metallomics 6:1150–1155.
8. Gauglitz JM, Iinishi A, Ito Y, Butler A. 2014. Microbial Tailoring of Acyl Peptidic Siderophores. Biochemistry 53:2624–2631.

Objectives

We will focus on the acquisition of iron *by Marinobacter hydrocarbonoclasticus* SP17 that degrades, through biofilm formation, particulate substrates like lipids and alkanes. This strain produces the photoreactive siderophores petrobactin as well as sulfonated derivatives of petrobactin. The main objective of this project is to gain insight into the significance of the suite of siderophores (petrobactin, its sulfonated forms and its photoproducts) in biofilm development on particulate substrates.

The general intended strategy is:
i) Identification and quantification of the different forms of petrobactin produced in biofilm and determine if they are specifically produced in this mode of growth. The siderophores and their iron-complexes will be determined by HPLC- high-resolution high mass accuracy MS in collaboration with chemists of the institute. The siderophores profiles will be established in different growth conditions, biofilms on alkanes or lipids vs planktonic cells growing on acetate.
ii) Identification of the genes involved in iron acquisition by Tn-seq and / or miniTn*5* mutagenesis and investigation of the mutants phenotype and of the regulation of expression of the corresponding genes in relation to biofilms formation.

Keywords

Microbiology, biofilms, marine bacteria, particulate substrates, iron acquisition, siderophores, molecular genetics, biochemistry, Tn-seq.

Working context

Hosting laboratory: IPREM

The proposed post-doctoral position is part of the project 'MesMic' (Metals in Environmental Systems Microbiology) funded by E2S UPPA from 2018 to 2022 (http://e2s-uppa.eu/en/index.html). MesMic is a collaborative and transdisciplinary project involving microbiology and analytical chemistry. The objective of the project is to unravel metal ion interactions with microbial ecosystems at the molecular, cellular and community levels. 6 PhD and 6 Post-Doctorates are funded by MesMic project.

Scientific team

Post-doc Supervisor: Régis Grimaud
S. Nolivos (molecular biology), P. Sivadon (molecular biology), F. Hakil (molecular biology), L. Urios (microbiology), L. Ouerdane (analytical chemistry), R. Lobinski (analytical chemistry), O. Donard (analytical chemistry), M. Sebilo (biogeochemistry), D. Amouroux (biogeochemistry).
1 PhD students and 3 post-doc.
Location: IPREM, Université de Pau et des Pays de l'Adour, Pau, Nouvelle-Aquitaine, France
Starting period: spring 2020 to summer 2020
Duration: 3 years (full-time)
Teaching duty (in English or French): 64 hours / years
Gross salary: 2920 euros/month
Funding: This postdoc position is funded by the project E2S UPPA (Energy Environment Solutions)

Some research group references

Sivadon P, Barnier C, Urios L, Grimaud R. 2019. Biofilm formation as a microbial strategy to assimilate particulate substrates. Environmental Microbiology Reports, 11(6), 749–764.

Mounier J, Hakil F, Branchu P, Naïtali M, Goulas P, Sivadon P, Grimaud R. 2018. AupA and AupB Are Outer and Inner Membrane Proteins Involved in Alkane Uptake in Marinobacter hydrocarbonoclasticus SP17. mBio 9:e00520-18.

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Sivadon P, Grimaud R. 2017. Assimilation of Hydrocarbons and Lipids by Means of Biofilm Formation, p. 1–12. In Krell, T (ed.), Cellular Ecophysiology of Microbe. Springer International Publishing, Cham.

G. Ghssein, C. Brutesco, L. Ouerdane, C. Fojcik, A. Izaute, Shuanglong Wang, C. Hajjar, D. Lemaire, R. Lobinski, P. Richaud, R. Voulhoux, A. Espaillat, F. Cava, D. Pignol, E. Borezée-Durant, P. Arnoux (2016). Biosynthesis of a broad-spectrum nicotianamine-like metallophore in Staphylococcus aureus. Science, 352 (6289), pp.1105--1109.

Mounicou, S., Szpunar, J., & Lobinski, R. (2009). Metallomics: The concept and methodology. Chemical Society Reviews, 38(4), 1119-1138.

Flis, P., Ouerdane, L., Grillet, L., Curie, C., Mari, S., & Lobinski, R. (2016). Inventory of metal complexes circulating in plant fluids: a reliable method based on HPLC coupled with dual elemental and high-resolution molecular mass spectrometric detection. New Phytologist, 211(3), 1129-1141

Required competences

- ✓ Good knowledge in physiology, molecular genetic (Tn-seq Transposon mutagenesis) and biochemistry of bacteria are required. Skills in bioinformatics (genome analysis, Tn-seq data analysis) would be an advantage.
- ✓ Taste and aptitude for multidisciplinary work, the candidate will have to be interested in microbiology and analytical chemistry.
- ✓ Scientific rigor
- ✓ Good ability to communicate and write in French and English.

Application procedure

Applications must be sent as a single pdf file and must include:

- ✓ a cover letter describing the candidate's motivations, previous research experiences and how it is related to the present position (one or maximum two pages)
- ✓ a CV (max 2 pages)
- ✓ a copy of the candidate's PhD thesis diploma
- ✓ candidate's PhD abstract and publications
- ✓ two reference letters
- ✓ contact details (2 referees, including the PhD supervisor and post-doc supervisor (if applicable)

Contacts

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