MAXIMILIAN JOSEF LUDWIG JOHANNES FÜRST, PhD

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ACADEMIC EMPLOYMENT, RESEARCH, EDUCATION

06/2022 – present
University of Groningen (RUG): Tenure-Track Assistant Professor / Group Leader.
My lab is using computational protein design to engineer proteins and enzymes relevant for synthetic biology and biocatalysis. A particular research focus lies on the application of DNA-modifying enzymes for the development of new high-throughput screening techniques, with the aim of creating massive sequence-function data sets that serve as the basis for machine learning for protein design.

09/2019 – 05/2022
MRC Laboratory of Molecular Biology: Postdoctoral Scientist with Dr. P. Holliger
Ultra-high-throughput DNA polymerase engineering to i) make expanded genetic alphabets for synthetic biology and semi-synthetic *E. coli* and ii) investigate disease-related RNA modifications by defined reverse transcription error profiles. Screened large libraries of DNA Pol mutants via bead emulsions and flow cytometry. Contributions to ribosome display on NGS sequencer for massive sequence-function maps.

03/2019 – 09/2019
University of Groningen: Postdoctoral Scientist with Prof. M. W. Fraaije
Initiated the first experiments of a new EU-funded group project ("Smartbox") that aims to engineer oxidative enzymes for industrial biocatalysis by computational design.

03/2015 – 03/2019
RUG: PhD Thesis with Prof. M. W. Fraaije
Explored biocatalytic potential of heme and flavoproteins in an EU project with academic and industrial partners ("ROBOX") via enzyme discovery, characterization, computational redesign, and engineering. I engineered solvent and thermostable monooxygenases via energy calculations, MD simulations, and wet lab screening. By structure-guided mutagenesis, I elucidated substrate promiscuity mechanisms and rationalised altered specificities via *in silico* methods. My PhD thesis received a rare **cum laude distinction**.

05/2016
Visiting scholar at the **University of Pavia with Prof. A. Mattevi**
Gained experience in protein crystallography, incl. data collection at the synchrotron.

10/2011 – 11/2013
University of Munich (LMU): MSc Biology. Genetics, microbiology, and biochemistry.

04/2013 – 09/2013
Master Thesis with Prof. J. Lassak and Prof. K. Jung, Microbiology Department
Discovered and characterised a glycosyl transferase that rhamnosylates an elongation factor post-translationally. Performed *in vivo* reporter assays, created knock out strains, cloned genetic constructs, and performed basic protein engineering. This work resulted in the first report of arginine glycosylation in bacteria.

09/2012 – 03/2013
Semester abroad via Erasmus Mobility Program at the **University of Málaga**
Expanded theoretical repertoire on cell biology and biotechnology. Spanish to level B1.

06/2012 – 08/2012
Research Internship (Prof. T. Lahaye, Genetics Dep.), in which I cloned a Split-GFP system to monitor plant pathogen TALEs. Cloning and *Agrobacterium* transfections.

12/2011 – 02/2012
Research Internship (Prof. H. Jung, Microbiology Dep.), where I characterized *H. pylori* virulence KO mutants. Genetic complementation and phenotyping at biosafety ML-2.

10/2008 – 11/2011
University of Munich (LMU): BSc Biology. Molecular biology subjects. In my **bachelor thesis** with Prof. D. Leister, I genetically mapped signalling rescue mutations in *A. thaliana* via a PCR assay. Wrote an image analysis script for phenotyping plants.

TEACHING EXPERIENCE

03/2022 - present
RUG: Lecturer
I hold various lectures in the "Biochemistry" and "Biotechnology" (BSc LST and Biology, respectively) and "Advanced Genetic Engineering" (MSc Biomolecular Sciences) courses and of the "Biochemistry and Biotechnology" (BSc) course and practical for Chemistry

students. I am further involved in the RUG's teaching activities by acting as examiner for exams, essays, and colloquia in Biology, Chemistry, and Pharmacy.

06/2021 – 08/2021   **MRC LMB: daily supervisor for undergraduate summer student**
I supervised a master student in a project aimed at isolating a single specific DNA fragment from a large pool of identical DNA via a unique molecular identifier ("barcode").

2015 – 2018   **RUG: daily supervisor theses**
I supervised a master student involved in thermostability engineering and structural analysis followed by semi-high-throughput protein production, purification, and screening. Also supervised two bachelor projects on protein engineering. One included command line tools and the student later pursued a MSc and PhD in bioinformatics.

2015 – 2017   **RUG: mentor for visiting scientists**
I guided a PhD student to screen monooxygenases via biochemical conversions and chemical analysis. I guided a postdoc from Delft (now a PI at the UMCG) in computational enzyme design, giving *i.a.* an introduction to scripting, docking, and MD simulations. Trained two visiting PhD students in enzyme production and kinetic analysis.

2012 – 2013   **LMU: practical course tutor.** Microbiology for BSc biology year 1 and 2**,** botany for year 1

GRANTS, PRIZES, AND AWARDS

03/2023	**EU Horizon Europe Research and innovation action** partner (€405k)
12/2021	**NWO-Talent programme Veni** for "Designer Proteins on Display" (€280k)
12/2020	**EMBO Postdoctoral Fellowship**, 2 years funding (€120k) for the project "Engineered Reverse Transcriptases for High-Throughput Epitranscriptome Mapping"
06/2020	Nominee of RUG's Faculty of Science and Engineering for the **Wierenga Rengerink Prize** 2019
12/2019	**Van Swinderen Prize** (2nd place, €1k), Groningen Royal Physics Society for the PhD thesis
08/2012	**Erasmus Mobility Scholarship**

INVITED TALKS AND POSTERS

03/2024	Lecture at the **Masterclass "Applied Biocatalysis"** (Groningen, NL).
11/2023	Presented at the **Berendsen symposium** (Groningen, NL).
03/2023	Presented at the working group meeting **COZYME** cost action (Fuengirola, Spain).
12/2019	Lecture for Van Swinderen Prize at the Groningen Forum (to a non-specialist audience)
05/2019	MPI for Terrestrial Microbiology (Marburg, Germany) **group seminar talk**. Host: Prof. T. Erb
04/2019	MRC Laboratory of Molecular Biology (Cambridge, UK), **group seminar talk**. Host: Dr. A. Bertolotti
01/2019	University of Wageningen, **group seminar talk**. Host: Prof. M. Medema
03/2019	Netherlands' Catalysis and Chemistry Conference (Leiden, The Netherlands), **talk**
12/2017	CHAINS (Veldhoven, The Netherlands), **talk**
2016 – 2019	Regularly presented project progress at the biannual **ROBOX project meetings**
2016 – 2018	**Presented posters** at EMBO Workshop Enzymes, Biocatalysis & Chemical Biology (Pavia, IT), Gordon Research Conference Biocatalysis (Biddeford, USA), Enzyme Engineering (Toulouse, FR)**,** Flavin Symposium (Groningen, NL), Novel Enzymes (Groningen, NL)**,** Oxizymes (Wageningen, NL).

TRAINING & PROFESSIONALIZATION

2023	Obtained the University Teaching Qualification (UTQ) at the University of Groningen
2020 – 2021	Attended virtual conference (without presenting): BioDesign Research Conference 2020 & 2021, CINBI 2020, World CRISPR Day, RNA 2020, EFB Biocatalysis Open Day.
06/2020	Three-day course in **analysis of bulk RNA-seq data with R**, MRC LMB
11/2019	Four-day course in **Numeric Python and Deep Neural Network Basics**, MRC LMB
05/2016	Five-day training school **systems biocatalysis**, COST action, Siena, Italy
2015 – 2016	RUG: 1-day workshop in **numerical python**, 2-day course on **protein mass spectrometry,** 5-day masterclass **Computational Approaches for Discovery & Engineering of Enzymes**

ACADEMIC SERVICES

2023 – present	**Editorial board member** for *BBA advances*
2023 – present	**Member of the Nederlandse Biotechnologie Vereniging (NBV)**
2020 – 2021	**Refereeing** for journals including *ChemBioChem, Angewandte Chemie, ACS Catalysis*
03/2009 – 10/2013	Member of the LMU Faculty for Biology's **student representative organisation**
11/2011 – 08/2012	**Office assistant**, Prof. Michael Boshart, Genetics Department, LMU.

EDUCATION BREAKS

12/2013 – 11/2014	Gap year; solo backpacking the Indian subcontinent on a budget
09/2007 – 05/2008	Obligatory alternative civilian service; served full time as operating room nurse in a hospital

LANGUAGES

German – native	**Spanish** – fluent	**French** – basics
English – fluent	**Dutch** – conversational	**Programming**: Python, Bash, R

PUBLICATIONS

The Journal Impact Factor is indicated (IF). An up-to-date citation count can be inferred from my Google Scholar count on my personal site (M.J.L.J. Fürst, h-index = 16, https://scholar.google.com/citations?user=gVIpE-wAAAAJ&hl)

Key papers – peer-reviewed publications in international journals

(1) Fürst, MJLJ; Boonstra, M; Bandstra, S; Fraaije, MW; (**2019**) Stabilization of cyclohexanone monooxygenase by computational and experimental library design; *Biotechnol. Bioeng*. 116:2167. (IF 4.1)

(2) Fürst, MJLJ; Romero, E; Gómez Castellanos, JR; Fraaije, MW; Mattevi, A. (**2018**) Side-Chain Pruning Has Limited Impact on Substrate Preference in a Promiscuous Enzyme. *ACS Catal*. 8:11648. (IF 12.4)

(3) Fürst, MJLJ; Savino, S; Dudek, HM; Gomez Castellanos, JR; Gutierrez de Souza, C; Rovida, S; Fraaije, MW; Mattevi, A. (**2017**) Polycyclic Ketone Monooxygenase from the Thermophilic Fungus *Thermothelomyces thermophila*: A Structurally Distinct Biocatalyst for Bulky Substrates. *J. Am. Chem. Soc*. 139:627. (IF 14.6, highlighted paper in Thieme Synfacts 2017; 13: 0422)

(4) Fürst, MJLJ; Kerschbaumer, B; Rinnofner, C; Winkler, M; Fraaije, MW; (**2019**) Exploring the Biocatalytic Potential of a Self-Sufficient Cytochrome P450 from *Thermothelomyces thermophila. Adv. Synth. Catal.* 361:2487. (IF 5.9)

Co-authored, peer-reviewed publications in international journals

(5) Porebski, BT; Balmforth, M; Browne, G; Riley, A; Jamali, K; Fürst, MJLJ; Velic, M; Buchanan, A; Minter, R; Vaughan, T; Holliger, P. (**2023**) Rapid discovery of high-affinity antibodies via massively parallel sequencing, ribosome display and affinity screening. *Nat. Biomed. Eng.* https://doi.org/10.1038/s41551-023-01093-3 (IF 29.2)

(6) Marić, I; Guo, Y; Fürst, MJLJ; Van Aelst, K; Van den Bosch, S; De Simone, M; Martins, LO; Sels, BF; Fraaije, MW. (**2023**) A One-Pot, Whole-Cell Biocatalysis Approach for Vanillin Production using Lignin Oil. *Adv. Synth. Catal.* 365:3987. (IF 5.9)

(7) Aalbers, FS.; Fürst, MJLJ; Rovida, S; Trajkovic, M; Gómez Castellanos, JR; Bartsch, S; Vogel, A; Mattevi, A; Fraaije, MW. (**2020**) Approaching Boiling Point Stability of an Alcohol Dehydrogenase Through Computationally-Guided Enzyme Engineering. *Elife*. 9:e54639. (IF 7.1)

(8) Volkwein, WV; Krafczyk, R; Jagtap, PKA; Parr, M; Mankina, E; Macošek, J; Guo, Z; Fürst, MJLJ; Pfab, M; Frishman, D; Hennig, J; Jung, K; Lassak, J; (**2019**) Switching the Post-Translational Modification of Translation Elongation Factor EF P. *Front. Microbiol*. 10:1148. (IF 4.2)

(9)   Li, G; Garcia-Borràs, M; <u>Fürst, MJLJ</u>; Ilie, A; Fraaije, MW; Houk, KN; Reetz, MT. (**2018**) Overriding Traditional Electronic Effects in Biocatalytic Baeyer-Villiger Reactions by Directed Evolution. *J. Am. Chem. Soc.* 140:10464. (IF 14.6)

(10)   Delgove, MA; <u>Fürst, MJLJ</u>; Fraaije, MW; Bernaerts, KV; de Wildeman, SM. (**2018**) Exploring the Substrate Scope of Baeyer–Villiger Monooxygenases with Branched Lactones as Entry Towards Polyesters. *ChemBioChem* 19:354. (IF 2.6)

(11)   de Gonzalo, G; <u>Fürst, MJLJ</u>; Fraaije, MW. (**2017**) Polycyclic Ketone Monooxygenase (PockeMO): A Robust Biocatalyst for the Synthesis of Optically Active Sulfoxides. *Catalysts* 7:288. (IF 3.5)

(12)   Li, G; <u>Fürst, MJLJ</u>; Mansouri, HR; Ressmann, AK; Ilie, A; Rudroff, F; Mihovilovic, MD; Fraaije, MW; Reetz, MT. (**2017**) Manipulating the Stereoselectivity of the Thermostable Baeyer-Villiger Monooxygenase TmCHMO by Directed Evolution. *Org. Biomol. Chem*. 15:9824. (IF 3.6)

(13)   Valencia, D; Guillén, M; <u>Fürst, MJLJ</u>; López-Santín, J; Álvaro, G. (**2017**) An Immobilized and Highly Stabilized Self-Sufficient Monooxygenase as Biocatalyst for Oxidative Biotransformations. *J. Chem. Technol. Biotechnol*. 93:985. (IF 2.8)

(14)   Lassak, J; Keilhauer, EC; <u>Fürst, M</u>; Wuichet, K; Gödeke, J; Starosta, AL; Chen, J-M; Søgaard-Andersen, L; Rohr, J; Wilson, DN; Häussler, S; Mann, M; Jung, K. (**2015**) Arginine-Rhamnosylation as New Strategy to Activate Translation Elongation Factor P. *Nat. Chem. Biol*. 11:266. (IF 12.6)

(Co-)authored review articles and book chapters

(15)   Korbeld, KT; <u>Fürst, MJLJ</u>. (**2023**) Curse and Blessing of Non-proteinogenic Parts in Computational Enzyme Engineering; *ChemBioChem* 24:e202300192 (IF 3.5)

(16)   Gerecht, K; Freud, N; Liu W; Liu Y; <u>Fürst, MJLJ</u>; Holliger, P. (**2023**) The Expanded Central Dogma: Genome Resynthesis, Orthogonal Biosystems, Synthetic Genetics; *Annu. Rev. Biophys.* 52:413 (IF 19.76)

(17)   Freud, N; <u>Fürst, MJLJ</u>; Holliger, P. (**2021**) New chemistries and enzymes for synthetic genetics; *Curr. Opin. Biotechnol.* 74:129 (IF 9.74)

(18)   <u>Fürst, MJLJ</u>; Gran-Scheuch, E; Aalbers, FS; Fraaije, MW. (**2019**) Baeyer-Villiger Monooxygenases: Tunable Oxidative Biocatalysts; *ACS Catal*. 9:11207. (IF 12.4)

(19)   <u>Fürst, MJLJ</u>; Fiorentini, F; Fraaije, MW. (**2019**) Beyond Active Site Residues: Overall Structural Dynamics Control Catalysis in Flavin-Containing and Heme-Containing Monooxygenases. *Curr. Opin. Struct. Biol*. 59:29. (IF 6.9)

(20)   <u>Fürst, MJLJ</u>; Martin, C; Lončar, N; Fraaije, MW. (**2018**) Experimental Protocols for Generating Focused Mutant Libraries and Screening for Thermostable Proteins. In: *Methods in Enzymology*; Academic Press; 608:151. (IF 1.9)

(21)   Wijma, HJ; <u>Fürst, MJLJ</u>; Janssen, DB. (**2018**) A Computational Library Design Protocol for Rapid Improvement of Protein Stability: Fresco. In: *Methods in Molecular Biology*; Springer; 1685:69. (IF 10.7)