

Molecular Cryo-Electron Microscopy Unit

Professor Matthias Wolf



(From left to right). Vladimir Meshcheryakov, Higor Alves Iha, Makoto Tokoro Schreiber, Hideyuki Matsunami, Maya Ann Street, Melissa Matthews, Rika Yoshizawa, Rafael Ayala Hernandez, Nadishka Jayawardena, Keon-Young Kim, Chloé Minnai, Ting-Hua Chen, Matthias Wolf

Abstract

Wolf Unit is working on problems in structural biology and biophysics, using electron cryo microscopy (cryo-EM). Our research focus is mainly on microbiology (including archaea), virology and nucleic acid-protein complexes. A particular strength of the unit lies in image processing techniques.

1. Staff

- Dr. Matthias Wolf, Professor
- Dr. Hideyuki Matsunami, Staff Scientist
- Dr. Vladimir Meshcheryakov, Staff Scientist
- Dr. Takahide Kono, Staff Scientist
- Dr. Melissa Matthews, Postdoctoral Scholar
- Dr. Chloe Minnai, Postdoctoral Scholar
- Dr. Nadishka Jayawardena, Postdoctoral Scholar
- Dr. Rafael Ayala Hernandez, Postdoctoral Scholar
- Dr. Saacnicteh Toledo Patino, Interdisciplinary Postdoctoral Fellow
- Dr. Tzung Yang Hsieh, Staff Scientist
- Dr. Higor Alves Iha, Research Unit Technician
- Mr. Keon Young Kim, Graduate Student
- Ms. Ting-Hua Chen, Graduate Student
- Ms. Maya Ann Street, Graduate Student
- Mr. Daniel Gutierrez Del Rio, Graduate Student
- Ms. Monika Eggenberger, Graduate Student
- Ms. Anastasiia Balashova, Research Intern
- Ms. Rika Yoshizawa, Research Unit Administrator

2. Collaborations

2.1 RNA-processing enzymes

- Description: **APOBEC3H**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Hiroshi Matsuo, NIH NCI, USA
 - Dr. Kate Skorupka, NIH, NCI
 - Ting-Hua Chen, OIST Wolf Unit

- Description: **ADAR2**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Andrew Fisher, UC Davis, USA
 - Professor Peter Beal, UC Davis, USA
 - Dr. Melissa Matthews, OIST Wolf Unit

2.2 Bacteriophages

- Description: **Myophage RB43 and siphophage DT57C**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Olga Sokolova, Lomonosov University Moscow, RU
 - Professor Andrey Letarov, Winogradsky Institute of Microbiology
 - Dr. Rafael Ayala, OIST Wolf Unit

- Description: **Myophage pTE**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Mihnea Bostina, University of Otago, NZ
 - James Hodgkinson-Bean, University of Otago, NZ
 - Dr. Rafael Ayala, OIST Wolf Unit

2.3 COVID-19 Immunology

- Description: **Human immune and gut microbial parameters associated with inter-individual variations in COVID-19 mRNA vaccine-induced immunity**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Hiroki Ishikawa, OIST, Japan
 - Dr. Melissa Matthews, OIST Wolf Unit

2.4 Microbiology

- Description: **Conditional gene expression system in *Porphyromonas gingivalis* for study of the secretion mechanisms of lipoproteins and T9SS cargo proteins**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Mikijo Shoji, Nagasaki University, Japan
 - Dr. Melissa Matthews, OIST Wolf Unit
- Description: **Polymorphism in bacterial flagella**
- Type of collaboration: Joint Research
- Researchers:
 - Professor Shin-Ichi Aizawa, Hiroshima University, Japan
 - Dr. Hideyuki Matsunami, OIST Wolf Unit

2.5 Virology

- Description: **Pox virus (vaccinia)**
- Type of collaboration: Collaboration
- Researchers:
 - Professor Wen Chang, Academia Sinica, Taiwan
 - Dr. Rafael Ayala, OIST Wolf Unit

3. Activities and Findings

Wolf Unit published seven papers in 2023, including two in *Nature Communications*. A continuous research focus was on protein-RNA complexes and bacteriophages. We have also been continuously working on the structures of the Ebola virus nucleocapsid and on vaccinia virus. Furthermore, a long-standing research question is the polymorphism of bacterial flagella, in a collaboration with Prof. Shin-Ichi Aizawa. Several COVID-related projects have been concluded post-pandemic.

4. Publications

4.1 Journals

1. [Nearly complete structure of bacteriophage DT57C reveals architecture of head-to-tail interface and lateral tail fibers](#), R Ayala, AV Moiseenko, TH Chen, EE Kulikov, AK Golomidova, ... M Wolf, **Nature Communications** 14 (1), 8205
2. [Reconstruction of the Entire RB43 Bacteriophage by Single Particle Cryo-EM](#), R Ayala, M Street, A Moissenko, E Kulikov, A Kuznetsov, OS Sokolova, ..., M. Wolf, **Microscopy and Microanalysis** 29 (S1), 928-929
3. [A conditional gene expression system in *Porphyromonas gingivalis* for study of the secretion mechanisms of lipoproteins and T9SS cargo proteins](#), Y Sasaki, M Shoji, T Sueyoshi, S Shibata, T Matsuo, H Yukiitake, M Wolf, ..., **Molecular Oral Microbiology** 38 (4), 321-333

4. [Structural insights into RNA bridging between HIV-1 Vif and antiviral factor APOBEC3G](#), T Kouno, S Shibata, M Shigematsu, J Hyun, TG Kim, H Matsuo, M Wolf, **Nature Communications** 14 (1), 4037
5. [Human immune and gut microbial parameters associated with inter-individual variations in COVID-19 mRNA vaccine-induced immunity](#), M Hirota, M Tamai, S Yukawa, N Taira, MM Matthews, T Toma, Y Seto, M. Wolf, ..., **Communications Biology** 6 (1), 368
6. [A new electromagnetic lensing principle using the Aharonov-Bohm effect](#), MT Schreiber, C Cassidy, M Saidani, M Wolf, **arXiv** (2023)
7. [Temporal dynamics of charge buildup in cryo-electron microscopy](#), MT Schreiber, A Maigné, M Beleggia, S Shibata, M Wolf, **Journal of Structural Biology: X** 7, 100081

4.2 Books and other one-time publications

Nothing to report

4.3 Oral and Poster Presentations

1. 2023/11/28, Invited Opening Talk, New Zealand Society for Molecular Biology 50th Anniversary Conference, Hanmer Springs, New Zealand, "Assembly mechanism of the pleomorphic immature poxvirus scaffold"
2. 2023/11/29-30, Cryo-EM workshop, Hanmer Springs, New Zealand, Lectures on "Fourier Analysis", "Image Formation", "3D Reconstruction", "Modeling", "Validation".
3. 2023/12/04, Invited talk, University of Otago, Dunedin, New Zealand, "Structure of the APOBEC-Vif-RNA complex"
4. 2023/08/09, Invited talk, Academia Sinica IBC, Taipei, Taiwan, "Structure of the APOBEC-Vif-RNA complex"
5. 2023/06/12, 3DEM Gordon Conference, Sunday River, Maine, USA, Poster Presentation, "Electromagnetic lensing using the Aharonov-Bohm effect"
6. 2023/06, Poster, Nagasaki University, Japan, "Study of protein secretion mechanisms in Porphyromonas gingivalis"
7. 2023/06/07, RICCEM 2023, Moscow, Invited talk (Zoom) "Assembly mechanism of the pleomorphic immature poxvirus scaffold"
8. 2023/02/28, ISCO2023, OIST, Presentation, "Bacteriophage structure by cryo-electron microscopy paves the way towards phage therapy"
9. 2023/02/06, AMED BINDS Workshop, OIST, Keynote, Molecular insights into a T4-like coliphage using WALC, a novel method for iterative segmented cryo-EM reconstruction

5. Intellectual Property Rights and Other Specific Achievements

Provisional patent filing. Title of Invention: MAGNETIC VECTOR POTENTIAL-BASED LENS, Attorney Docket No. 24P0072OIS, filed on even date herewith or as a U.S. national phase application from PCT International application number: PCT/IB2022/059206, Filed on: September 27, 2022

6. Meetings and Events

See 4.3

7. Other

Nothing to report.