

Carl McCombe

[Website](#) | [Email](#) | [ORCID](#)

Positions

Resnick Pioneer Postdoctoral Fellow

2025 - 2027

California Institute of Technology, United States
Chemistry and Chemical Engineering
Advisor: Gözde S. Demirer

Postdoctoral Fellow

2024 - 2025

The Australian National University, Australia
Research School of Biology
Advisors: Simon J. Williams & David A. Jones

Education

The Australian National University, Australia

2020 - 2024

Ph.D. Research School of Biology
Advisor: Simon J. Williams

The Australian National University, Australia

2019

B.S. with First Class Honours in Biology. GPA: 7.00/7.00
Awarded University Medal

Flinders University, Australia

2016 - 2018

B.S. (Biotechnology) GPA: 6.95/7.00

Publications

For citation information: [Google Scholar](#)

1. **CL McCombe**, A Wegner, L Wirtz, CS Zamora, F Casanova, S Aditya, JR Greenwood, S Paula, E England, S Shang, DJ Ericsson, E Oliveira-Garcia, SJ Williams, U Schaffrath (2025). “Plant pathogenic fungi hijack phosphate signaling with conserved enzymatic effectors” *Science* <https://doi.org/10.1126/science.adl5764>
 - [Perspective](#) by Caroline Gutjahr published in *Science*
 - [Research highlight](#) by Andrea Du Toit published in *Nature Reviews Microbiology*
 - [Spotlight](#) by Guo *et al.*, published in *Trends in Plant Science*
2. DS Yu, MA Outram, A Smith, **CL McCombe**, PB Khambalkar, SA Rima, X Sun, L Ma, DJ Ericsson, DA Jones, SJ Williams (2024). “The structural repertoire of *Fusarium oxysporum* f. sp. *lycopersici* effectors revealed by experimental and computational studies” *eLife* <https://doi.org/10.7554/eLife.89280.1>
3. **CL McCombe**, AM Catanzariti, JR Greenwood, AM Desai, MA Outram, DS Yu, DJ Ericsson, SE Brenner, PN Dodds, B Kobe, DA Jones, SJ Williams (2023). “A rust-fungus Nudix hydrolase effector decaps mRNA *in vitro* and interferes with plant immune pathways” *New Phytologist* <https://doi.org/10.1111/nph.18727>
 - [Commentary](#) by Mark J. Banfield published in *New Phytologist*
4. **CL McCombe**, JR Greenwood, PS Solomon, SJ Williams (2022). “Molecular plant immunity against biotrophic, hemibiotrophic, and necrotrophic fungi.” *Essays in Biochemistry* <https://doi.org/10.1042/EBC20210073>

Honors, Awards, and Grants

RSB Best Thesis Prize (\$2000 AUD)	<u>2025</u>
Resnick Pioneer Postdoctoral Fellowship (\$180,000 USD)	<u>2025</u>
AINSE Research Spotlight	<u>2025</u>
Vice-Chancellor's HDR Travel Grant (\$1500 AUD)	<u>2023</u>
AINSE Travel Award (\$1000 AUD)	<u>2023</u>
IS-MPMI Shimamoto Travel Award (\$2000 USD)	<u>2023</u>
Hirota Naora award	<u>2022</u>
CPG award presentation at Combio	<u>2022</u>
Runner-up best student presentation at East Coast Protein Meeting	<u>2022</u>
AINSE Postgraduate research award (\$25000 AUD)	<u>2020 - 2023</u>
Australian Government research training program stipend (\$90000 AUD)	<u>2020 - 2023</u>
University medal, The Australian National University	<u>2019</u>
RSB director's prize in Honours, The Australian National University	<u>2019</u>
AINSE Honours scholarship (\$5000 AUD)	<u>2019</u>
Summer research scholarship, The Australian National University	<u>2018</u>
Summer research award, Flinders University	<u>2017</u>
Chancellor's letter of commendation, Flinders University	<u>2016/2017/2018</u>

Research experience

California Institute of Technology, *Resnick Pioneer Postdoctoral Fellow*

[Demirer Lab](#)

2025 - Present

- Development of sentinel nutrient sensing plants
- Engineering soil microbiomes for improved plant health

The Australian National University, *Postdoctoral fellow*

[Jones & Williams Labs](#)

2024

- Biophysical, biochemical, and *in planta* characterisation of effector proteins from pathogenic fungi.
- Experimental and computational design of *de novo* protein-binders for engineering plant immunity receptors.

The Australian National University, *PhD candidate*

[Williams Lab](#)

2020 - 2024

- [McCombe et al., \(2025\)](#) describes how fungal pathogens fabricate phosphate starvation in plant cells to increase disease. This seminal work published in *Science* was met with great interest from the scientific community, with research highlights on the article published in five separate journals (*Science*, *Nature Reviews Microbiology*, *Trends in Plant Science*, *Advanced Agrochem*, and *Science Bulletin*).
- [McCombe et al., \(2023\)](#) demonstrates that rust fungi use mRNA decapping enzymes to promote virulence during plant infection. The importance and novelty of the study are discussed by Professor Mark J. Banfield in a *New Phytologist* [commentary](#).

The Australian National University, *Technical assistant*

COVID-19 genomic sequencing team

2021

- COVID-19 genomic sequencing using long-read Nanopore technology during the COVID-19 pandemic in 2021 for monitoring transmission across the ACT and viral evolution

The Australian National University, *Honours student*

Williams Lab

2019

- Determining the function of flax rust effector AvrM14 using a structure-guided approach

Flinders University, *Research assistant*

Day Lab

2018

- Completed various general plant molecular biology techniques to aid legume research projects

Teaching experience

The Australian National University, *Biochemistry and human nutrition (BIOL2171)*

2021 - 2023

- Teaching and supervising students in biochemistry lab classes
- Marking of laboratory reports
- Directing advanced undergraduate workshops for students wishing to extend their learning
- Marking and providing feedback on student presentations

The Australian National University, *Advanced studies course (SCNC2101)*

2020, 2022/23/24

- Designing and supervising semester-long undergraduate research projects for second- and third-year undergraduate students

The Australian National University, *General microbiology (BIOL2142)*

2021/22

- Teaching and supervising students in microbiology lab classes
- Marking of scientific reports

The Australian National University, *Molecular gene technology (BIOL2162)*

2021/22

- Providing guidance to, and teaching, students who were completing online zoom workshops covering a variety of molecular biology research techniques

Supervisory experience

For all students listed below I designed their projects and directly supervised their laboratory work.

Teresa Rojas Rodriguez, graduate student rotation project 2025

Project title: *Developing targeted antimicrobial probiotics for soil microbiomes*

Hannah Bachmann, WAVE fellow summer student 2025

Project title: *A microbial delivery system for sustained plant peptide hormone release in soil*

Ben Silke, Honors student 2024 & PhD student 2025 to present

Project title: *Disarming plant pathogens with nanobodies*

Ben graduated with First-Class Honors, received the RSB director's prize, and I am a member of his PhD supervisory panel

Joy Peter, undergraduate student 2023/24

Project title: *Biophysical characterization of de novo designed protein-based enzyme inhibitors*

Riley Furbank, undergraduate student 2023

Project title: *In silico protein design to manipulate plant-pathogen interactions*

Sascha Shang, undergraduate student 2022

Project title: *Determining the function of rice blast effectors*

Sascha's research contributed to McCombe *et al.*, (2025) - <https://doi.org/10.1126/science.adl5764>

Eleanor England, undergraduate student 2020

Project title: *Identifying inositol pyrophosphate hydrolase effectors from pathogenic fungi*

Elly's research contributed to McCombe *et al.*, (2025) - <https://doi.org/10.1126/science.adl5764>

Professional service

Plant Services Team – Weekend watering 2023/24

On weekends and public holidays, our team maintained the diverse plants used in academic research at the Australian National University

Conference Chair

2022 ANU ECR conference

2023 Stromlo plant pathology conference

Journal reviewer

Plant Physiology	<u>2025</u>
Molecular Plant-Microbe Interactions	<u>2023</u>
Molecular Plant Pathology	<u>2023, 2024</u>
Journal of Experimental Botany	<u>2021, 2022</u>

Select Presentations

1. *International Plant Molecular Biology (IPMB2024) Congress*: Pathogenic fungi manipulate plant phosphate sensing. Cairns, Australia, June 2024
2. *Stromlo Plant Pathology Conference 2023*: Hijacking phosphate starvation signaling with conserved enzymatic effectors. Canberra, Australia, December 2023
3. *Australian Society for Biochemistry and Molecular Biology (ASBMB) 2023 Conference*: From mRNA decapping to phosphate starvation: Insights into fungal effector enzymes. Canberra, Australia, November 2023
4. *International Society for Molecular Plant-Microbe Interactions (IS-MPMI) Congress*: From mRNA decapping to phosphate starvation: Insights into fungal effector enzymes. Providence, USA, July 2023
5. *Stromlo Plant Pathology Conference 2022*: AvrM14, an mRNA decapping effector. Canberra, Australia, December 2022
6. *Research School of Biology (RSB) PhD Conference*: Rice blast effectors and plant phosphate sensing. Canberra, Australia, November 2022
7. *ComBio 2022*: Plant disease and Nudix hydrolases. Melbourne, Australia, September 2022
8. *Canberra Protein Group Early Career Researcher Showcase 2022*: Plant disease and Nudix hydrolases. Canberra Australia, June 2022
9. *East Coast Protein Meeting (ECPM) 2022*: Plant disease and Nudix hydrolases. Coffs Harbour, Australia, June 2022
10. *Society of Crystallographers in Australia and New Zealand (SCANZ) Crystal-lite 2022 Meeting*: A structure-guided characterisation of the Nudix hydrolases undermining plant immunity. Melbourne, Australia, May 2022