

### Contact

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### Career history

- 2021-current **Research Associate**, Sainsbury Laboratory and Cavendish Laboratory, Cambridge University, United Kingdom  
Modelling the evolution of noisy gene regulation in unpredictably fluctuating environments. Joint position in the groups of Dr. James Locke and Dr. Diana Fusco.
- 2018-2021 **Postdoctoral fellow**, Origins Center & Leiden University, the Netherlands  
I developed my independent research line on modelling 1) the evolutionary genomics and colony structure of *Streptomyces*, 2) the evolution of multicellularity, 3) the evolutionary genomics of the ribosomal RNA gene cluster. I also co-developed a pipeline to quantify the migration of zebrafish cardiomyocytes during embryonic development.
- 2017 **Research project**, Utrecht University, the Netherlands  
Research project on modelling the evolution of the mutational dynamics in the Eukaryotic ribosomal RNA gene cluster.
- 2011–2016 **Ph.D. candidate**, Utrecht University, the Netherlands  
Dissertation title: Multilevel evolution and the emergence of function. The research was carried out by developing mathematical and computational models of prebiotic and microbial systems. The aim was to understand how evolutionary systems generate novel functions as a result of self-organisation, and how they integrate this novel information. In the group of Prof. Paulien Hogeweg.
- 2010-2011 **Master's research projects**, Utrecht University, the Netherlands  
6 months internship on bioinformatic prediction of Hammerhead ribozyme in mouse genome, under supervision of Prof. Berend Snel and Prof. Paulien Hogeweg; 9 months internship on modelling eco-evolutionary dynamics of RNA replicators with variable mutation rates, under supervision of Prof. Hogeweg.

### Selected publications

- 2023 **Colizzi ES**, van Dijk B, Merks RMH, Rozen DE, Vroomans RMA, Evolution of genome fragility enables microbial division of labor. *Molecular Systems Biology* (2023) e11353.  
I initiated and led this collaboration with experimental researcher Dr. Rozen (Leiden University), to construct an experimentally-backed computational model of *Streptomyces* genome instability. The model shows that the genome adapts to the mutational dynamics implemented, and exploits them to generate beneficial mutations.
- 2020 **Colizzi ES**, Vroomans RMA, Merks RMH, Evolution of multicellularity by collective integration of spatial information. *Elife* 9 (2020) e56349.  
I initiated and led this project, in which multicellularity evolves as a byproduct of interactions between cells, in a cell-based model. This work has a high potential to explain the transition to differentiated multicellularity and the emergence of development. Model extensions are being developed in several directions, highlighting results robustness and model flexibility.

2014 **Colizzi ES**, Hogeweg P, Evolution of functional diversification within quasispecies. *Genome biology and evolution*, 6(8):1990–2007.

This model shows how the interactions between replicators can result in the evolution of novel functions and the genome structure to encode them. This work models an origin-of-life scenario, but shows non-trivial similarities with my work on *Streptomyces*, highlighting the power of my approach at discovering unexpected connections between seemingly unrelated topics.

## Teaching Experience

2023 **Workshop and lecture**, University of Cambridge, I led the practical of the course module on stochastic gene regulatory networks, and I gave a lecture on evolutionary modelling, in the course Systems Biology pt. III.

2018–2021 **Course Module**, Leiden University, Introduction to evolutionary modelling. Duration: 1 week. Tasks: lectures, exercises, exam questions, for the course Multiscale Mathematical Biology, Bachelor program: Biology)

2021 **Lecture and workshop**, *Origins Center*, Cell-based models: ecology, evolution and development.

2016 **Guest Lecture**, Utrecht University, Title: Multilevel evolutionary dynamics contribute to yeast genome integrity, for the course Computational Biology (Bachelor/Master Biology)

2010–2012 **Teaching assistant**, Utrecht University, Supervision and assistance with students' exercises for the course Theoretical Biology (Bachelor program: Biology), and Computational Biology (Bachelor/Master Biology)

## Student Supervision

2022-current Erasmus+ Project of Alexandre Fernandes, Cambridge University, co-supervised with Dr. RMA Vroomans

2022 Summer Project of Sean Thompson, Cambridge University, co-supervised with Dr. RMA Vroomans

2020 Master's Project of Chirag Chittar, Leiden University

2019 Erasmus + Project of Daniel Voros, Universiteit Leiden

2019 Bachelor's Project of Rafael Kraaikamp, Leiden University

2016 Master's Project of Sam von der Dunk, Utrecht University, co-supervised with Prof. Dr. P. Hogeweg.

## Education

2011–2016 **Ph.D. candidate, Theoretical Biology and Bioinformatics**, *Utrecht University*

2009–2011 **MSc Biology and Biocomplexity**, *Utrecht University*

2005–2008 **BSc Biotechnology**, *University of Padova*

## Separate courses

2017 Equilibrium Statistical Mechanics (self-study during sabbatical)

2014 Statistical Mechanics, Algorithms and Computation (Coursera)

2012 Mathematical Biology (University of Amsterdam); Complexity Winter School (NWO); Complex Systems Summer School (Santa Fe Institute)

2011–2012 Graduate course in Theoretical Ecology (multiple universities in the Netherlands)

## Outreach

2022 New Scientist piece on my work on *Streptomyces* <https://bit.ly/3nUuyoo>

2020 Leiden University News piece on my research [bit.ly/3717cLG](https://bit.ly/3717cLG)

2020 Interview by the Amsterdam science museum NEMO on my research (in Dutch): [bit.ly/37DSKV4](https://bit.ly/37DSKV4)

2019 Popular science video on the evolution of multicellularity: [youtu.be/jb6U54A76aU](https://youtu.be/jb6U54A76aU)

## Skills

OS Linux Ubuntu  
Programming c++, c, Python, Bash. Basic knowledge of: SLURM, JavaScript, R, html  
Modelling (Stochastic) Cellular Automata, ODEs, PDEs, Agent-based modelling, Event-based modelling (Gillespie Algorithm), Hybrid Cellular Potts Model, Dynamic Network Models, Evolutionary modelling, Genetic algorithms  
Editing Office, L<sup>A</sup>T<sub>E</sub>X, Inkscape  
Languages English, Italian, Dutch (basic knowledge), Spanish (basic knowledge)

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## Other activities

2022-current **Evolution journal club**, I co-initiated a well-attended journal club aimed at trans-departmental discussions on new articles about evolution and related fields  
2020-current **OoLEN**, Member of the Origin of Life Early career Network, a multidisciplinary group of early-career researchers working on a wide range of topics relevant to the Origin of Life  
2019-current **The Interactions Art-Science group**, Co-founder and organiser of a group working on bridging art, science and philosophy in IAS, Amsterdam  
2012-2016 **Coffee coordinator**, Coordinator of funds and people to ensure a much-needed steady coffee supply for the Theoretical Biology Group, Utrecht University

### Repositories and links

web enricosandrocolizzi.com  
github escolizzi

### Publications and software

- 2023 **Colizzi ES**, van Dijk B, Merks RMH, Rozen DE, Vroomans RMA. Evolution of genome fragility enables microbial division of labor. *Molecular Systems Biology* (2023) e11353.  
Software (model and analysis): <https://github.com/escolizzi/strepto2>. Language: c, Python.
- 2023 Wortel MT, ..., **Colizzi ES**, et al. Towards evolutionary predictions: Current promises and challenges. *Evolutionary applications*. 2023 Jan;16(1):3-21.
- 2022 **Colizzi ES**, Vroomans RMA, Hogeweg P, Modelling the Evolution of Novelty: a review. *Essays in Biochemistry*. 2022 Dec;66(6):727-35.
- 2022 Vroomans RM, **Colizzi ES**. Evolution of selfish multicellularity collective organisation of individual spatio-temporal regulatory strategies. *bioRxiv*. Under revision in *BMC Ecology and Evolution*.  
Software (model and analysis): [https://github.com/RenskeVroomans/regulation\\_evolution](https://github.com/RenskeVroomans/regulation_evolution). Language: c++, Python.
- 2021 Tessadori F, Tsingos E, **Colizzi ES**, Kruse F, van den Brink SC, van den Boogaard M, Christoffels VM, Merks RM, Bakkers J. Twisting of the zebrafish heart tube during cardiac looping is a tbx5-dependent and tissue-intrinsic process. *Elife*. 2021 Aug 10;10:e61733.  
Software (analysis): <https://github.com/rmerks/heartbending>. Language: Python.
- 2020 **Colizzi ES**, Vroomans RMA, Merks RMH. Evolution of multicellularity by collective integration of spatial information. *Elife* 9 (2020) e56349.  
Software (model and analysis): [https://github.com/escolizzi/Cell\\_Evolution\\_stickymoves](https://github.com/escolizzi/Cell_Evolution_stickymoves). Language: c++, Python.
- 2019 **Colizzi ES**, Hogeweg P; Transcriptional mutagenesis prevents ribosomal DNA deterioration: The Role of Duplications and Deletions. *Genome biology and evolution* 11.11 (2019): 3207-3217.  
Software (model and analysis): [https://github.com/escolizzi/rDNA\\_duplications\\_deletions](https://github.com/escolizzi/rDNA_duplications_deletions). Language: c, Python.
- 2017 von der Dunk S, **Colizzi ES**, Hogeweg P; Evolutionary Conflict Leads to Innovation: Symmetry Breaking in a Spatial Model of RNA-Like Replicators. *Life* 7.4 (2017): 43.
- 2016 **Colizzi ES**. Multilevel Evolution and the Emergence of Function. Doctoral dissertation, University Utrecht.
- 2016 **Colizzi ES**, Hogeweg P; Parasites Sustain and Enhance RNA-Like Replicators through Spatial Self-Organisation. *PLoS Comput Biol*, 12(4):e1004902.  
Software (model and analysis): [https://github.com/escolizzi/rnas\\_and\\_parasites\\_origin\\_of\\_life](https://github.com/escolizzi/rnas_and_parasites_origin_of_life). Language: c, Python.
- 2016 **Colizzi ES**, Hogeweg P; High cost enhances cooperation through the interplay between evolution and self-organisation. *BMC evolutionary biology*, 16(1):1.  
Software (model and analysis): [https://github.com/escolizzi/evolution\\_cooperation](https://github.com/escolizzi/evolution_cooperation). Language: c, Python.
- 2014 **Colizzi ES**, Hogeweg P, Evolution of functional diversification within quasispecies. *Genome biology and evolution*, 6(8):1990–2007.