Enrico Sandro Colizzi

I am broadly interested in Science and fascinated by the staggering complexity of living beings and their interactions. My research focuses on the mechanisms and dynamics of evolutionary innovations and multi-scale information processing, motivated by open problems in the origin of life, multicellularity, and genome structuring, with the aim of identifying general patterns in the evolution of biological systems.

Research Experience

2018-current **Independent research fellow**, *Origins Center, hosted at Leiden University*, Fellowship award: €227000.

I developed my independent research line on evolutionary emergence and downward causation. I built an evolutionary model to study how reproductive division of labor can be coordinated by mutations, as observed in experiments. I co-developed a pipeline to quantify the migration of zebrafish cardiomyocytes during embryonic develoment. I developed a cell-based simulation system to investigate the evolution of multicellularity as a by-product of collective behaviour. I am currently extending this model to study the evolution of cell differentiation. I extended a previous model of the evolution of ribosomal DNA mutational dynamics, and generalised the results to other clusters of repeated genes. I am constructing a model of experimentally observed antibiotic production vs. growth tradeoff, and trade-off resolution through a division of labour organized by mutations.

2017 **Research project**, *Utrecht University*.

Research project on modelling the evolution of the mutational dynamics in the Eukaryotic ribosomal DNA gene cluster.

2011–2016 **Ph.D.: Multilevel evolution and the emergence of function**, *Utrecht University*.

The research was carried out by developing mathematical and computational models of prebiotic and cellular 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.

2011 **Minor research project**, *Utrecht University*.

6 months internship on bioinformatic prediction of Hammerhead ribozyme in mouse genome, under supervision of Prof. Dr. B. Snel and Prof. Dr. P. Hogeweg.

2010 **Major research project**, *Utrecht University*.

9 months internship on the eco-evolutionary dynamics of RNA replicators with variable mutation rates, under supervision of Prof. Dr. Hogeweg.

Publications

2021 **Colizzi ES**, van Dijk B, Merks RMH, Rozen DE, Vroomans RMA; Evolution of genome fragility enables microbial division of labor. *Submitted*

2021 Tessadori F, Tsingos E, **Colizzi ES**, Kruse F, van den Brink SC, van den Boogaard M, Christoffels VM, Merks RMH, Bakkers J: Twisting of the heart tube during cardiac looping is a tbx5-dependent and tissue-intrinsic process. *Under revision at Elife*

2020 **Colizzi ES**, Vroomans RMA, Merks RMH; Evolution of multicellularity by collective integration of spatial information. Elife 9 (2020): e56349

Nieuwe Uilenburegerstraat – 1011 LM, Amsterdam – the Netherlands

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

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**, Hogeweg P; Parasites Sustain and Enhance RNA-Like Replicators through Spatial Self-Organisation. PLoS Comput Biol, 12(4):e1004902

2016 **Colizzi ES**, Hogeweg P; High cost enhances cooperation through the interplay between evolution and self-organisation. BMC evolutionary biology, 16(1):1

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

Teaching Experience

2018-current **Yearly Guest Lectures**, *Leiden University*.
Introduction to modelling pre-biotic evolution (module duration: 4 hrs), for the course Multiscale Mathematical Biology (Bachelor program: Biology).

2016 **Guest Lecture**, *Utrecht University*.
Showing how multilevel evolutionary dynamics contribute to yeast genome integrity, for the course Computational Biology (Bachelor/Master program: Biology)

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

2010 **Teaching assistant**, *Utrecht University*.
Supervision and correction of students' exercise for the course Theoretical Biology (Bachelor program: Biology)

Student Supervision

2020 Master's Project of Chirag Chittar, Leiden University. The project was about assessing the evolutionary stability of genetic elements in RNA-world protocells.

2019 Bachelor's Project of Rafael Kraaikamp, Leiden University. The project was about assessing the evolutionary potential of chromosomes in RNA-world protocells.

2016 Master's Project of Sam von der Dunk, Utrecht University, in co-supervision with Prof. Dr. P. Hogeweg. The project was about the evolution of symmetry breaking in RNA-like replicators with complementary strands.

Skills

OS Linux Ubuntu

Programming languages c++, c, Python, Bash, R (basic knowledge), SLURM (basic knowledge)

Modelling (Stochastic) Cellular Automata, ODEs, PDEs, Agent based modelling, (Hybrid) Cellular Potts Model

Text editing LaTeX, Office

Languages English, Italian, Dutch (basic knowledge), Spanish (basic knowledge)

Education

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

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

Separate courses

2017 Equilibrium Statistical Mechanics (self-study during 3 months sabbatical)

2014 Statistical Mechanics, Algorithms and Computation (Coursera)

2012 Mathematical Biology (University of Amsterdam)

2012 Complexity Winter School (NWO)

2012 Complex Systems Summer School (Santa Fe Institute)

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

Outreach

2020 Leiden University News piece on my research `bit.ly/37I7cLG`

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

2019 Popular science video on the evolution of multicellularity: `youtu.be/jb6U54A76aU`

Other activities

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 around the theme of Origin of Life

2019-current **Art-Science group**.
Co-organiser of a discussion group 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.