Ricard Solé's CV

PERSONAL INFORMATION
Date of birth: 5 November, 1962
Nationality: Spanish
Current position: ICREA Research Professor
Current Address: Complex Systems Lab, Department of Experimental and Health Sciences, Universitat Pompeu Fabra (UPF), Barcelona Biomedical Research Park (PRBB), Barcelona, Spain
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EDUCATION

1991	Ph.D. in Physics	Politechnic University of Catalonia (UPC), Spain
1989	B.S. in Physics	University of Barcelona (UB), Spain
1986	B.S. in Biology	University of Barcelona (UB), Spain

CURRENT POSITIONS

2001-present	ICREA Research Professor	Universitat Pompeu Fabra (UPF), Spain
1998-present	External Professor	Santa Fe Institute, New Mexico USA
2010-2019	External Faculty	Center for Evolution and cancer UCSF, USA
2016-present	Fellow	European Centre Living Technology, Venice
2017-present	External Faculty	Complexity Science Hub, Vienna

PREVIOUS POSITIONS

1997-2001	Full Professor (Physics)	Universitat Politécnica de Catalunya, Spain
1997-2005	Senior/Founding Member	NASA-associated Center for Astrobiology, Spain
1993-1997	Associate Professor, Physics	Universitat Politécnica de Catalunya, Spain
1989-1993	Lecturer, Physics	Universitat Politécnica de Catalunya, Spain

FELLOWSHIPS AND AWARDS

- 2004: Barcelona City award for my work on the emergence of human language
- 2006: James McDonnell Award from the McDonnell foundation for doing research on the origins of innovation in complex networks
- 2013: La Vanguardia de la Ciencia Award
- 2017–present: Member of the Academia Europaea

SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS

I have supervised 16 PhD thesis students since 2000 (https://www.icrea.cat/en/Web/ScientificStaff/rsole/theses#researcher-nav). Since 2010, 12 postdocs and four Fulbright MIT students have also trained in my lab.

In the last five years, five PhD students completed their thesis in the last five years (three more will defend their PhDs in the next year):

Nuria Conde; November 2015, awarded *cum laude*, UPF
Distributed computation in synthetic cellular consortia

Salvador Duran-Nebreda; January 2016, awarded *cum laude*, UPF
Artificial multicellularity and pattern formation

Ben Shirt-Ediss; January 2016, awarded *cum laude*, UPF/UPV
Modelling early transitions toward autonomous protocells
Best PhD Thesis Prize

Luis Seoane; May 2016, awarded *cum laude*, UPF
Multiobjective Optimization in Models of Synthetic and Natural Living Systems

Aina Ollé-Vila; February 2020, awarded *cum laude*, UPF
From simple to complex multicellularity: Preconditions, design spaces and evolution of neural agents

Previous supervised PhDs:

Title: Dynamics, Evolution and Information in Nonlinear Dynamical Systems of Replicators
Student: Josep Sardanyés
University: Universitat Pompeu Fabra
Date: May 6th, 2009.
Graduated cum Laude. Premi Extraordinari del Programa de Doctorat en Biomedicina

Title: A unified approach to the emergence of complex communication
Student: Bernat Corominas
University: Universitat Pompeu Fabra
Date: July 12th, 2011.

Title: Topological complexity of the electricity transmission network
Student: Marti Rosas i Casals
University: Politechnic University of Catalonia
Date: December 18th, 2009.
Graduated cum Laude.

Title: Evolution and Dynamics in Information Networks
Student: Sergi Valverde
University: Politechnic University of Catalonia
Date: June 12th, 2006
Graduated cum Laude

Title: Micelles as Containers for Protocells
Student: Harold Fellermann
University: University of Osnabrück (GermDate)
Date: December 15th, 2005
Graduated cum Laude

Title: Levy processes in animal movement and dispersal.
Student: Fede Bartomeus
University: University of Barcelona
Date: June 17th, 2005
Graduated cum Laude. Best PhD Award in 2005.

Title: Macroevolutionary Algorithms
Student: Jesus Marin
University: Politechnic University of Catalonia
Date: January 18th, 2005
Graduated cum Laude

Title: The Architecture of Ecological Fragility
Student: Jose M. Montoya
University: University of Alcalá
Date: September 17th, 2004
Graduated cum Laude

Title: The Stochastic Nature of Ecological Interactions
Student: David Alonso
University: Politechnic University of Catalonia
Date: January 30th, 2004
Graduated cum Laude

Title: Language: Universals, Principles and Origins
Student: Ramon Ferrer Cancho
University: Politechnic University of Catalonia
Date: December 12th, 2003
Graduated cum Laude. Best PhD Award in 2003.

Title: Gene network models in embrionary development and evolution
Student: Isaac Salazar-Ciudad
University: University of Barcelona
Date: March 12th, 2002
Graduated cum Laude

Title: Nonlinear dynamics and control in ecosystems
Student: Javier G. P. Gamarra
University: Politechnic University of Catalonia
Date: February 1st, 2002
Graduated cum Laude

Title: Phase Transitions and Complexity in Random Boolean Networks
Student: Bartolo Luque
University: Politechnic University of Catalonia
Date: January, 29th 1999
Graduated cum Laude

Title: On Collective Computation
Student: Jordi Delgado
University: Politechnic University of Catalonia
Date: December, 15th of 1997
Graduated cum Laude

Title: Self-organized Criticality in Ecology and Evolution
Student: Susanna C. Manrubia
University: Politechnic University of Catalonia
Date: December, 12th of 1996
Graduated cum Laude. Best PhD Award 1996

Title: Spatiotemporal dynamics in ecosystems: nonlinear phenomena and dissipative structures
Student: Jordi Bascompte
University: University of Barcelona
Date: July 1st, 1994
Graduated cum Laude

RESEARCH PROJECTS

Along my scientific career I have led more than 20 Research Grants from public and private bodies. Within the last 10 years, they represented a total amount (for my Lab/Institution) of more than 5.5 Million euros. Within the last five years, these are/were the active projects:

Principal Investigator: Ricard Solé
Institution: ERC European Commision
Title: SYNCOM
Grantcode: EC-VII PM ERC- 294294 (ERC-2011-ADG)
Period: 2012-2016

Principal Investigator: Ricard Solé
Institution: European Commision FET_OPEN
Title: Microbial deployment of new-to-nature chemistries for refactoring the barriers between living and non-living matter (MADONNA)
Grantcode:766975
Period: 2018-2021

Principal Investigator: Ricard Solé
Institution: AGENCIA ESTATAL DE INVESTIGACIÓN
Title: Synthetic criticality
Grant code: PID2019-111680GB-I00
Period: 2020-2023

Principal Investigator: Ricard Solé
Institution: AJUNTAMENT DE BARCELONA
Title: BCN Microbiome Map
Grant code: 19S01402-006
Period: 2019-2021

Principal Investigator: Ricard Solé
Institution: EUROPEAN COMMISSION
Title: Microbial deployment of new-to-nature chemistries for refactoring the barriers between living and non-living matter.

Grant code: 766975.
Period: 2018-2021

Principal Investigator: Ricard Solé
Institution: Fundación Marcelino Botín
Title: Colaboración en materia de apoyo a la Transferencia Tecnológica en el campo de la biotecnología.
Grant code: Private non competitive
Period: 2010-2020

Principal Investigator: Ricard Solé
Institution: AGÈNCIA GESTIÓ AJUTS UNIVERSITARIS I RECERCA
Title: Evolució de Sistemes Complexos.
Grant code: 2017 SGR 866.
Period: 2017-2021

Principal Investigator: Ricard Solé
Institution: Ministerio de economía y competitividad
Title: Hacia una física de las grandes transiciones evolutivas
Grant code: FIS2015-67616-P
Period: 2016-2018

Principal Investigator: Ricard Solé
Institution: Agencia gestio ajuts universitaris i recerca
Title: Evolució de Sistemes Complexes
Grant code: 2014 SGR 497
Period: 2014-2016

Principal Investigator: Ricard Solé
Institution: Ministerio de economía y competitividad (mineco)
Title: Física estadística de cánceres inestables genómicamente.
Grant code: FIS2012-39288
Period: 2013-2016

TEACHING ACTIVITIES

2016-2020 Modelling Complex Diseases, Biomedical Engineering Degree, UPF, Barcelona

2010-2020 Principles of Biological Design, Biomedical Engineering Degree, UPF, Barcelona

2010-2016 Mathematical Biomodeling, Biomedical Eng. Degree, UPF, Barcelona

2012-2014 Engineering Cells and Tissues (Modelling part), Biomedical Eng. Degree, UPF, Barcelona

2004-2010 Mathematical Biology, Degree in Human Biology, 1st course. UPF, Barcelona

1989-2000 First-course Physics/ Introduction to Complex Systems / General Physics, UPC, Barcelona

ORGANIZATION OF SCIENTIFIC MEETINGS

2020 Co-organizer (along with Simon Levin, Princeton) of the workshop “Ecological complexity and the 6th extinction: Intervention scenarios”, approved and funded.

Location: Virtual Meeting. Hosted by Santa Fe Institute, USA; 2–6 November.
Website: https://www.santafe.edu/events/ecological-complexity-and-6th-extinction

2017 Co-organizer of the Workshop "*Liquid brains, solid brains*"
Location: Santa Fe Institute, New Mexico USA
Theme issue available at: https://royalsocietypublishing.org/toc/rstb/374/1774

2016 Co-organizer of the Workshop "*The major synthetic evolutionary transitions*"
Location: Santa Fe Institute, New Mexico USA
Theme Issue available at: http://rstb.royalsocietypublishing.org/content/371/1701

2013 Co-organizer of the "*ICREA Conference on the evolution of multicellularity*"
Location: Biomedical Research Park, Barcelona, Spain

8. INSTITUTIONAL RESPONSIBILITIES

2014-2020 Coordination and teaching of Complex Diseases course (BME)
2012-2020 Coordination and teaching of Principles of Biological Design course (BME)
2005-2018 Evaluator of Postdoc candidates for Santa Fe Institute Omydiar Fellowships
2001-2020 Member of Artificial Life Committees for several ECAL workshops
2012-2015 Coordination and teaching of Mathematical Biomodelling course (BME)
2010-2012 Development of BME course contents for the UPF Department of Life Sciences
2009-2010 Coordination/design of the UPF 4-yr degree of Biomedical Engineering (BME)

9. REVIEWING ACTIVITIES

- Member of the **Editorial Boards** of: *Biology Direct* (2010-), *PLoS ONE* (2005-), and *Philosophical Transactions Royal Society B* (2020-).
- Frequent reviewer of more than **15 scientific journals**, including: *Science, iScience, Science Advances, Science Robotics, Nature, Nature Communications* (including writing several News & Views and Perspectives pieces), Nature Human Behaviour, Nature Robotics, *BMC Systems Biology, Evolution, J. Theor Biol, Physical Review, Physical Review Letters, PLoS Biology, PLoS Computational Biology, PLoS ONE, PNAS, Proceedings Royal Society B, PRS Interface,* and *Science Advances*

10. MAJOR COLLABORATIONS

I have long-term research collaborations with different institutions and researchers at:

Santa Fe Institute (New Mexico, USA), where I have been affiliated as External Professor since 1997; There I have collaborated and co-authored papers with many researchers, including Stuart Kauffman, Eric Bonabeau, Eric Smith, Doyne Farmer, and more recently (last 5 years) with Chris Kempes, Artemi Kolchinsky and Geoffrey West.

European Center for Living Technology in Venice (IT), where I am a fellow (2018–). I have collaborated and co-authored papers with Steen Rasmussen, Norman Packard and John McCaskill. This collaborations keep moving now under the new location at University of Rome (ca Foscari).

A long-term collaborator of special relevance to this project is **Guy Theraulaz** (CNRS, France). We published papers on self-organized ant colonies) and critical fluctuations in ant droplets. Ongoing collaborations also include **Melanie Moses** (University New Mexico,

USA) and **Stephanie Forrest** (Arizona State University, USA). We co-organized the SFI workshop on "Liquid Brains, Solid Brains" and were co-editors of a Theme Issue in *Philosophical Transactions R Soc B* with the same title.

In the last year, we have been setting up a new collaboration with **EMBL** towards a common experimental test (starting 2021) of my proposed **Terraformation** scenario based on synthetic biology, to avoid tipping points (Solé 2015, *Ecol. Complexity* 22,40-49; Solé et al, 2015. *Biology Direct* 10,37).

Patents:

Title: *Reprogrammable Multicellular Synthetic Circuits.*
Patent ID: MLS/CO-28289
Date: 16.08.10
Inventors: Macia J, Solé RV, Posas F, de Nadal E, Hohmann S.
10**-Year-Track-Record**

TEN-YEAR TRACK-RECORD

I have authored /co-authored **more than 250 scientific papers** (a complete list can be found at Google Citations for "**RV Solé**"), with **24,000+ total citations** and an **overall H=77 index** (as of 6 December, 2020). **From 2010-2020**, my publications were cited on **average 1400+ times per year**. These publications include all the scientific domains that I have worked on: **bio-computation, complex systems, information theory, systems and synthetic biology, cognitive networks, swarm intelligence, statistical physics, network science, ecology and evolution**.

My main interests over the last 30 years have revolved around the problem of **how complexity emerges and evolves in both natural and artificial systems**. I have been involved as a leading researcher in the exploration of these topics at many different scales and using very different systems as case studies, from proteins and cells to ant colonies and ecosystems. **Interdisciplinary studies have been always at the core of my interests**, and I was trained both as a biologist and as a physicist (I completed both five-year bachelor degrees). My work within complex ecosystems was done in parallel with a study of nonlinear dynamical systems and chaos in biology. I became involved in several problems associated with the emergence of complex patterns and processes in biological systems and published many papers within the fields of Theoretical and Mathematical Biology/Ecology.

In 1991, directly after my PhD, **I started my own research group (the Complex Systems Research Group)** and led the group into a cross-disciplinary study of ecological, genetic, evolutionary, and computational problems. This seeded my *Complex Systems Lab*, which is established as one of the leading research groups worldwide for the study of complex systems (http://complex.upf.edu). It currently comprises 8 members of biologists, physicists, and computer scientists (with 1 post-doc, 5 PhD students, and 1 lab technician).

In the early '90s, I did several postdoc stays at: Brian Goodwin's Lab at the Open University, Stuart Kauffman's group at the Santa Fe Institute, as well as with Per Bak (Brookhaven's Lab). With Bak I published a seminal paper exploring the idea that extinction dynamics might be connected with complex dynamical states (***Nature*, 1997**). Later on I also collaborated and Jose Costa at Yale's pathology department with whom I published the first paper showing the presence of spatial heterogeneity in advanced malignant tumors (***PNAS*, 2001**). In 1998, I became an **external professor at the Santa Fe Institute (SFI),** considered the leading institution for the study of complex systems. Both at SFI and in my home institution of UPF in Barcelona, **I became involved in the initial development of network theory** starting in the early 2000 with seminal papers that became very influential on small world and scale-free networks in ecological, cellular, computational (software and hardware), and linguistic net-

works. The impact of our work was immediate, and several of these papers have now hundreds of citations. One particularly important result was to show that ecological webs might be very fragile against the removal of keystone species, dues to co-extinction cascades (***Nature* 2006**).

In 2001, I became **an ICREA research professor at UPF**. Shortly thereafter, I was involved as PI in three large EU projects (the DELIS, ECAGENTS, and PACE projects). The later involved how to engineer protocells (see R. Solé et al., editor, special issue, *Towards the artificial cell*). I was then also awarded with a **James McDonnell Foundation grant** for studying the evolution of biological networks. These projects canalized my attention to the problem of how to explore the evolution of complexity using an engineering perspective; specifically: can we understand biological innovations by actually *building* them? This drew my attention to synthetic biology, and I got fully involved as a PI in the CELLCOMPUT project (FP6), in which the conceptual idea of distributed computation was shown [***Nature* (2011)**], which we fully explored in my ERC AdG SYNCOM. In parallel, I was awarded a Botin Foundation Grant (2010-2020) to build our own Synbio WetLab, where we have developed the tools required to experimentally formulate questions regarding biological complexity.

A theoretical roadmap to understanding the origins of complexity became a reality when I proposed and organized two workshops on "**Major Synthetic evolutionary transitions**" and "Liquid Brains, Solid Brains" held at SFI in Dec 2015 and Dec 2017, respectively. Both meetings provided the basis for two full Theme Issues in Phil. Trans. B. The first meeting resulted in the creation of an extended network of collaborators to explore the space of possible designs in biology and the definition of morphospaces allowing the formulation of new unified theories of biological complexity. Among other topics, viruses where a central piece of enquiry and we recently published **a book on "Viruses as complex adaptive Systems"** in Princeton U. Press (R. Solé and S. Elena, 2019). Similarly, the **Liquid Brains, Solid Brains** workshop consolidated several threads and collaborations with top-notch scientists (such as Michael Levin) that are now being explored in my Lab. These include among others understanding the computational/cognitive potential of assemblies of non-neural agents, the potential for engineering organs/organoids and other system-level structures beyond the existing, natural examples, and how novel behavioral (intelligent) attributes can be implemented using multicellular consortia. **Two new single-authored books "*Liquid Brains*" (Solé, Princeton U. Press) and "*Synthetic Evolutionary Transitions*" (Solé, Oxford U. Press) will be published in 2021.**

Finally, at the crossroads of my research interests between ecology and synthetic biology, I proposed in 2015 the possibility of **Bioengineering the Biosphere** as a potential scenario to avoid ecological tipping points. Specifically, I defined the idea of **"Terraforming" ecosystems**, where synthetic biology could be used to engineer endangered habitats (such as drylands) in such a way that catastrophic shifts towards undesirable states (deserts, species-poor communities) could be avoided. This was inspired in my early suggestion that to understand tipping points, a new synthesis between statistical physics and ecology was needed (**Solé, *Nature* 2007**). Along with an active development of mathematical and computer models of Terraformed ecosystems, we are pursuing very actively the experimental implementation of controlled experiments as well as collaborating with field ecologists dealing with massive data sets (***Science* 2020**). Along with Princeton ecologist Simon Levin, we co-organized under the support of the Santa Fe Institute a (virtual) **workshop on "Ecological complexity and the sixth extinction"** (November 2-6, 2020; https://www.santafe.edu/events/ecological-complexity-and-6th-extinction). This workshop is expected to provide a roadmap to future interventions to avoid the rapid loss of biodiversity.

I am passionate about teaching and science communication. I co-designed a large part of the 4-year degree on Biomedical Engineering at the UPF (in place since 2013), which provides a highly interdisciplinary approach to the field with some non-standard components, such as complex systems, synthetic biology (on a multiscale basis) and evolutionary dynamics. Several experimental methods used within SYNTEL will take advantage from experimental techniques developed in our WetLab for iGem and other specific projects. I teach full cour-

ses on *Mathematical Biomodeling*, *Biological Design*, and *Complex Diseases*. I am also strongly involved in Science Communication and Outreach. I frequently give lectures in public libraries and have been the organizer (since 2014) of the Xmas Lectures (Ciencia al Nadal) for the public delivered in Barcelona's cultural center CCCB (for instance, our 2017 "Blade Runner Xmas" involved a discussion on the future of synthetic biology within technology, AI and climate). And Scientific advisor of human exposition at CCCB (2015). I am also the author of several popular science books. I was also a commissioner of the Barcelona's Science Biennale 2019 and will also play that role in the forthcoming 2021 event.

LIST OF PUBLICATIONS IN THE PAST FIVE YEARS (2016-2020)

Aguade G, Kauffman S and Solé R. Transition Therapy: Tackling the Ecology of Tumour Phenotypic Plasticity. **Preprints** 2020

Solé RV, Sardanyés J and Elena S. Phase Transitions in Virology. **Preprints** 2020.

Vidiella B, Guillamon, T., Maull, V., Conde-Pueyo N, and Solé R. Engineering self-organized criticality in living cells. Accepted, **Nature Communications.**

Duran-Nebreda S, Pla J, Vidiella B, Piñero J, Conde-Pueyo N, and Solé R. Synthetic Turing patterns in engineered microbial consortia. Accepted, **ACS Synthetic Biology.**

Solé R and Aguadé G. The ecology of cancer differentiation therapy. **Journal of Theoretical Biology**. 511 (2021) 110552

Solé R and Aguadé G. Tumor neoantigen heterogeneity thresholds provide a time window for combination immunotherapy. **Journal of the Royal Society interface** 2020; 17: 20200736.

Alsedà Ll, Vidiella B, Solé R, Lázaro JT, Sardanyés J. Dynamics in a time-discrete food-chain model with strong pressure on preys. **Communications in nonlinear science & numerical simulation** 2020; 84.

Berdugo M, Delgado-Baquerizo M, Soliveres S, Hernández-Clemente R, Zhao Y, Gaitán JJ, Gross N, Saiz H, Maire V, Lehmann A, Rillig MC, Solé RV, Maestre FT. Global ecosystem thresholds driven by aridity. **Science** 2020; 367(6479): 787-790.

Conde-Pueyo N, Vidiella B, Sardanyés J, Berdugo M, Maestre FT, De Lorenzo V, Solé R. Synthetic biology for terraformation lessons from Mars, Earth, and the microbiome. **Life** (Basel) 2020; 10(2).

Ollé-Vila A, Seoane LF, Solé R. Ageing, computation and the evolution of neural regeneration processes. **Journal of the Royal Society interface** 2020; 17(168).

Seoane LF, Solé R. Criticality in Pareto Optimal Grammars?. **Entropy** 2020; 22(2).

Solé R, Valverde S. Evolving complexity: how tinkering shapes cells, software and ecological networks. **Philosophical Transactions of the Royal Society. B: Biological Sciences** 2020; 375(1796).

Solé R. Using information theory to decode network coevolution. **Science** 2020; 368(6497): 1315-6.

Vidiella B, Sardanyés J, Solé RV. Synthetic soil crusts against green-desert transitions: a spatial model. **Royal Society Open** Science 2020; 7(8)

Aguadé-Gorgorió G, Solé R. Genetic instability as a driver for immune surveillance. **Journal for Immunotherapy of Cancer** 2019; 7(1).

Ollé-Vila A, Solé R. Cellular heterogeneity results from indirect effects under metabolic tradeoffs. **Royal Society Open Science** 2019; 6(9).

Piñero J, Solé R. Statistical physics of liquid brains. **Philosophical Transactions of the Royal Society. B** 2019; 374(1774).

Sardanyés, J.; Piñero, J.; Solé, R. Habitat loss-induced tipping points in metapopulations with facilitation. **Population Ecology** 2019; 61(4): 436-449.

Solé R, Moses M, Forrest S. Liquid brains, solid brains. **Philosophical Transactions of the Royal Society. B: Biological Sciences** 2019; 374(1774).

Aguadé-Gorgorió G, Solé R. Adaptive dynamics of unstable cancer populations: the canonical equation. **Evolutionary Applications** 2018; 11(8): 1283-1292.

Corominas-Murtra B, Sànchez Fibla M, Valverde S, Solé R. Chromatic transitions in the emergence of syntax networks. **Royal Society Open Science** 2018; 5(12).

Corominas-Murtra B, Seoane LF, Solé R. Zipf's Law, unbounded complexity and open-ended evolution. **Journal of the Royal Society interface** 2018; 15(149).

Piñero J and Solé R. Nonequilibrium entropic bounds for Darwinian replicators. **Entropy** 2018; 20(2): 98

Seoane LF, Solé R. The Morphospace of language networks. **Scientific Reports** 2018; 8(1).

Seoane LF, Solé RV. Information theory, predictability and the emergence of complex life. **Royal Society Open Science** 2018; 5(2).

Solé R and Conde-Pueyo N. Ultrasound approach tracks gut microbes. **Nature** 2018; 553: 36-37

Solé R, Ollé-Vila A, Vidiella B, Duran-Nebreda S, Conde-Pueyo N. The road to synthetic multicellularity. **Current Opinion in Systems Biology** 2018; 7: 60-67.

Solé R. Cooperation in an RNA world. **Nature ecology & evolution** 2018; 2(10): 1527-1528.

Solé RV, Montañez R, Duran-Nebreda S, Rodriguez-Amor D, Vidiella B, Sardanyés J. Population dynamics of synthetic terraformation motifs. **Royal Society Open Science** 2018; 5(7).

Valverde S, Piñero J, Corominas-Murtra B, Montoya J, Joppa L, Solé R. The architecture of mutualistic networks as an evolutionary spandrel. **Nature ecology & evolution** 2018; 2(1): 94-99.

Vidiella B, Sardanyés J, Solé R. Exploiting delayed transitions to sustain semiarid ecosystems after catastrophic shifts. **Journal of the Royal Society interface** 2018; 15(143).

Amor DR, Montañez R, Duran-Nebreda S, Solé R. Spatial dynamics of synthetic microbial mutualists and their parasites. **PLoS Computational Biology** 2017; 13(8).

Macia J, Vidiella B, Solé R. Synthetic associative learning in engineered multicellular consortia. **Journal of the Royal Society interface** 2017; 14(129).

Maestre FT, Solé R, Singh BK. Microbial biotechnology as a tool to restore degraded drylands. **Microbial Biotechnology** 2017; 10(5): 1250-1253.

Sardanyés J, Martínez R, Simó C, Solé R. Abrupt transitions to tumor extinction: a phenotypic quasispecies model. **Journal of mathematical biology** 2017; 74(7): 1589-1609.

Seoane L and Solé R. Systems poised to criticality through Pareto selective forces. Submitted, https://arxiv.org/abs/1510.08697

Bonforti A, Duran-Nebrada S, Montañez R, Solé R. Spatial self-organization in hybrid models of multicellular adhesion. **Chaos** 2016; 26(10).

de Lorenzo V, Marlière P, Solé R. Bioremediation at a global scale: from the test tube to planet Earth. **Microbial Biotechnology** 2016; 9(5): 618-625.

Duran-Nebreda S, Bonforti A, Montañez R, Valverde S, Solé R. Emergence of protoorganisms from bistable stochastic differentiation and adhesion. **Journal of the Royal Society interface 2016**; 13(117).

Duran-Nebreda S, Solé R. Toward Synthetic Spatial Patterns in Engineered Cell Populations with Chemotaxis. **ACS Synthetic Biology** 2016; 5(7): 654-661.

Macia J, Manzoni R, Conde N, Urrios A, de Nadal E, Solé R, Posas F. Implementation of complex biological logic circuits using spatially distributed multicellular consortia. **PLoS Computational Biology** 2016; 12(2): 1004685-1004685.

Ollé-Vila A, Duran-Nebreda S, Conde-Pueyo N, Montañez R and Solé R. Design principles for synthetic organs and organoids: the possible and the actual. **Integrative Biology** 2016; 8: 485 - 503

Ollé-Vila A, Duran-Nebreda S, Conde-Pueyo N, Montañez R, Solé R. A morphospace for synthetic organs and organoids: the possible and the actual. **Integrative Biology** 2016; 8(4): 485-503.

Solé R, Amor DR, Duran-Nebreda S, Conde-Pueyo N, Carbonell-Ballestero M, Montañez R. Synthetic collective intelligence. **BioSystems** 2016; 148: 47-61.

Solé R, Amor DR, Valverde S. On singularities and black holes in combination-driven models of technological innovation networks. **PLoS ONE** 2016; 11(1).

Solé R. Back from the brink. **New scientist** 2016; 232(3093): 36-37.

Solé R. Synthetic transitions: Towards a new synthesis. **Philosophical Transactions of the Royal Society. B: Biological Sciences** 2016; 371(1701).

Solé R. The major synthetic evolutionary transitions. **Philosophical Transactions of the Royal Society. B: Biological Sciences** 2016; 371(1701).

Urrios A, Macia J, Manzoni R, Conde N, Bonforti A, de Nadal E, Posas F, Solé R. A Synthetic Multicellular Memory Device. **ACS Synthetic Biology** 2016; 5(8): 862-873.