

M. GABRIELA M. GOMES

FEBRUARY 2012

PERSONAL DETAILS

Full Name and Title: Maria Gabriela Miranda Gomes, PhD
Date of birth: 17 November 1965
Nationality: Portuguese
Children: 3 daughters, born in 1993, 1995, 1997
Phone: 351-214- 464-626
Email: ggomes@igc.gulbenkian.pt
Webpage: www.igc.gulbenkian.pt/research/unit/50

CURRENT APPOINTMENT

Title: Principal Investigator
Affiliation: Instituto Gulbenkian de Ciência, Apartado 14, 2781-901 Oeiras, Portugal

EDUCATION/QUALIFICATIONS

PhD in Mathematics	University of Warwick, UK (Supervisor: IN Stewart)	1993
MSc in Mathematics	University of Warwick, UK	1990
BSc in Applied Mathematics	Universidade do Porto, Portugal	1987

ACADEMIC APPOINTMENTS

2005 – 2009	Marie Curie Excellence Team Leader	Instituto Gulbenkian de Ciência, Portugal
2002 – 2005	Principal Investigator	Instituto Gulbenkian de Ciência / University of Warwick
1999 – 2002	Wellcome Trust Research Training Fellow	Department of Biological Sciences, University of Warwick, UK
1997 – 1999	Research Fellow	Centro de Matemática Aplicada, Universidade do Porto, Portugal
1997 – 1998	Visiting Researcher	Institute for Mathematics and Applications, University of Minnesota, USA
1995 – 1997	Post-Doctoral Research Fellow	Mathematics Institute, University of Warwick, UK
1994 – 1995	Lecturer	Universidade Fernando Pessoa, Porto, Portugal
1993 – 1994	Post-Doctoral Research Fellow	Mathematics Institute, University of Warwick, UK
1987 – 1988	Teaching Assistant	Departamento de Matemática Pura, Universidade do Porto, Portugal

RESEARCH INTERESTS

Nonlinear dynamics, symmetry, pattern formation; Ecology and evolution of infectious diseases, host-pathogen interactions; Statistical inference, model selection, experimental design.

RESEARCH STATEMENT

I have 20 years of research experience in the general theme of nonlinear dynamics. With initial interests in the abstraction of symmetries governing pattern formation in natural and experimental systems, in the last 10 years my research activity has focussed on the application of mathematical concepts and formalisms to the ecology and evolution of infectious diseases. I am currently interested in developing unified mathematical formalisms that integrate nonlinear dynamics and statistical inference, with expectable impact in two aspects of infectious disease research: design and interpretation of host-pathogen studies (in the laboratory and in the field); and translation of genetic sequence data into knowledge about the ecology and evolution of pathogens. Both aspects have potential implications for the optimization of infectious disease control policies.

Dynamics, Symmetry and Pattern Formation: The second half of last century witnessed intense activity in the study of pattern formation. The sophistication of structures observed experimentally, in laboratories of physics, chemistry, biology, posed constant challenge to the never ending refinement of mathematical models, with explanatory and predictive capacities. This was the context for my PhD, developed under the supervision of Professor Ian Stewart, at the Mathematics Institute, University of Warwick. We demonstrated how certain degenerate structures were due to "hidden symmetries" (see publication **3**), and the results had application in a large class of patterns observed experimentally and computationally.

My most recent contribution in this topic was a dimensionality issue arising in experimentally observed Turing patterns. Available visualisation techniques required reaction-diffusion experiments to be performed in thin domains, motivating the development of two-dimensional models. However, experimentalists observed patterns that were unexpected in two dimensions. These discrepancies were resolved with the discovery of symmetries in the three-dimensional model that were hidden by the collapse of one dimension (**8**).

In a more computational approach, I have collaborated with Professor Dwight Barkley in the characterization of three-dimensional instabilities in fluid dynamics (**10**).

Ecology and Evolution of Infectious Diseases: Ecology and evolution are the branches of science where the engagement of mathematics has the longest history. Studies in ecology and evolution often adopt parasites as model organisms, benefiting from the relative facility in access to data in natural environments, and the perspectives for translation in the health of humans, animals and plants. Just over 10 years ago, I was awarded a Wellcome Trust Fellowship in Mathematical Biology, which enabled me to initiate research in the ecology and evolution of infectious diseases, under the supervision of Professor Graham Medley, in the Department of Biological Sciences, University of Warwick. Since 2002, at the Instituto Gulbenkian de Ciência, I have been responsible for a research group in this topic, with various forms of support from the European Commission, the Fundação para a Ciência e a Tecnologia, the Fundação Calouste Gulbenkian, the Portuguese Ministry of Health, and various collaborative agreements with the United Kingdom, Brazil and Mexico, in a total of 3m€

My first contribution was a mathematical formulation for the emergence of polymorphisms in pathogen populations as a symmetry-breaking phenomenon giving rise to pattern formation in the abstract space of pathogen variants. Generic models for the transmission of pathogen variants in a host population support an endemic equilibrium where all the variants are prevalent in a steady state. Nevertheless, variants compete for susceptible hosts with an intensity that increases with the extent of cross-immunity and transmission, and there is a state transition when either cross-immunity or transmission increase across a critical value that was later named the "reinfection

threshold" (13). This concept was the basis for mechanisms that we have proposed to explain the marked geographical variability in the effects of vaccination against tuberculosis, the increase in whooping-cough cases despite reductions in the transmission of the causing bacterium, the antigenic drift of influenza viruses, and enabled the identification of an unstable equilibrium in malaria transmission indicating a threshold for the elimination and emergence of the disease.

Model Selection and Experimental Design: Exposure to experimental biomedical science, at Instituto Gulbenkian de Ciência, stimulated my interest for revising specific study designs, in immunity and evolution, from the viewpoint of extracting the most meaningful measures. Currently, I am primarily interested in two questions. The first follows from my research over the last years, that uncovered critical implications of the mode of immunity (partial resistance, tolerance) on the utility of current measures used to express vaccine efficacy. With an ultimate goal to define more informative efficacy measures, we are developing models for alternative experimental designs. The second reflects recent trends in ecology and evolution of infectious diseases showing the utility of pathogen genotyping in the inference of ecological processes, namely selection and parameterization of transmission models. My research group is developing Bayesian inference procedures to adjust disease transmission models to pathogen genotyping data.

Both question described here require dynamical systems to formalize plausible hypotheses for the biological processes of interest, as well as statistical inference to select the model that best explains the data and has the best predictive power. In general, the challenges posed by the life sciences call for unification of formalisms within mathematics itself and motivate mathematical novelty.

TEACHING STATEMENT

Biomedical research is increasingly associated with the integration of discoveries at various scales, emerging from laboratory and community based studies. Unification across biological scales requires suitable mathematical formalisms, most often requiring convergence within mathematics. As science becomes a single connected component, we must prepare today's young scientists for tomorrow's science.

At Instituto Gulbenkian de Ciência, I have supervised 10 postdoctoral researchers, 3 PhD students, 10 short-term trainees, and conceived and taught a number of short graduate courses on mathematical biomedicine. Standing on this experience, I am developing a proposal for a Research Training Programme on Mathematical Biomedicine, conceived to receive researchers with a PhD, or equivalent experience, and provide them with three years of funding to attend a broad spectrum of courses in biomedical and mathematical sciences in the first year, followed by two years of research in a laboratory of their choice (subject to criteria set by the Programme Direction). The proposal follows very closely the model of Gulbenkian Doctoral Programmes established by Professor António Coutinho, since 1993.

OUTREACH STATEMENT

Major difficulties faced by data analysts and modellers include the lack of access to public health data and the lack of a collaborative interface with public health agencies. Moreover, the data required in modelling are often not considered in traditional surveillance infrastructures.

I have been involved in the design and deployment of innovative systems for data collection, such as Gripenet, an internet-based system to monitor influenza-like illness with the direct participation of volunteers recruited from the general population. The system is based on a website – www.gripenet.pt – specially developed to inform and educate the population about the disease, and

gather information on the population health through online surveys. The system permits graphic representation, processing and analysis of data, in real time, and modelling on the development of epidemics.

A different approach is to gather data that are traditionally collected by different sectors of national health systems and integrate them in a unified database. I coordinate an initiative to integrate clinical and genotypic data on tuberculosis in Portugal. This project involves the Portuguese Direcção-Geral da Saúde, the Instituto Nacional de Saúde Dr Ricardo Jorge, and the Genomics and Bioinformatics Units at Instituto Gulbenkian de Ciência.

I currently co-chair a European Large-Scale Integrating Project, coordinated by Alessandro Vespignani, to develop the framework for an epidemic forecast infrastructure, funded by a grant of 5m€

THESES

Gomes MGM. Hidden Symmetries in Rectangular Domains. MSc Thesis, University of Warwick, 1990.

Gomes MGM. Symmetries in Bifurcation Theory: The Appropriate Context. PhD Thesis, University of Warwick, 1993.

PUBLICATIONS

1. Crawford JD, Golubitsky M, Gomes MGM, Knobloch E, Stewart IN (1991) Boundary Conditions as Symmetry Constraints, in *Singularity Theory and Its Applications, Warwick 1989*, Part II, (eds. Roberts RM, Stewart IN), Lecture Notes in Mathematics 1463, Springer-Verlag, Heidelberg, 63-79.
2. Gomes MGM, King GP (1992) Bistable chaos II. Bifurcation analysis. *Phys Rev A* **46**: 3100-3110.
3. Gomes MGM, Stewart IN (1994) Steady PDEs on generalized rectangles: A change of genericity in mode interactions. *Nonlinearity* **7**: 253-272.
4. Gomes MGM, Stewart IN (1994) Hopf Bifurcations in Generalized Rectangles with Neumann Boundary Conditions, in *Dynamics, Bifurcation and Symmetries: New Trends and New Tools, Cargèse 1993*, (ed. Chossat P), NATO ASI Series C: Mathematical and Physical Sciences 437, Kluwer Academic Publishers, 139-158.
5. Owen M, Gomes MGM, King GP (1995) Detecting Symmetric Chaos, in *Complex Stochastic Systems and Engineering* (ed. Titterton M), IMA Conference Proceedings Series 54, Oxford University Press, 29-55.
6. Gomes MGM (1996) Nearest Neighbour Pulse-Coupled Oscillators, in *International Conference on Differential Equations - Equadiff95* (eds. L.T. Magalhães, C. Rocha and L. Sanchez), World Scientific, 380-385.
7. Gomes MGM, Stewart IN (1997) Symmetry of Generic Bifurcations in Cubic Domains. *Int Jour Bif and Chaos* **7**: 147-171.
8. Gomes MGM (1999) Black-eye patterns: A representation of three-dimensional symmetries in thin domains. *Phys Rev E* **60**: 3741-3747.

9. Gomes MGM, Labouriau IS, Pinho EM (1999) Spatial Hidden Symmetries in Pattern Formation, in *Pattern Formation in Continuous and Coupled Systems* (eds. Golubitsky M, Luss D, Strogatz S), IMA Volumes in Mathematics and its Applications, **115**, Springer-Verlag, New York, 83-100.
10. Barkley D, Gomes MGM, Henderson RD (2002) Three-dimensional instability in flow over a backward-facing step. *J Fluid Mech* **473**: 167-190.
11. Gomes MGM, Medley GF (2002) Dynamics of multiple strains of infectious agents coupled by cross-immunity: A comparison of models, in *Mathematical Approaches for Emerging and Reemerging Infectious Diseases: Models, Methods and Theory* (eds. Blower S, Castillo-Chavez C, Cooke KL, Kirschner D, van der Driessche P), IMA Volumes in Mathematics and its Applications, **125**, Springer-Verlag, New York, 171-191.
12. Gomes MGM, Medley GF, Nokes DJ (2002) On the Determinants of Population Structure in Antigenically Diverse Pathogens. *Proc R Soc Lond. B* **269**: 227-233.
13. Gomes MGM, White LJ, Medley GF (2004) Infection, reinfection, and vaccination under suboptimal immune protection: Epidemiological perspectives. *J Theor Biol* **228**: 539-549.
14. Gomes MGM, Franco AO, Gomes MC, Medley GF (2004) The reinfection threshold promotes variability in tuberculosis epidemiology and vaccine efficacy. *Proc R Soc Lond B* **271**: 617-623.
15. Gomes MGM, White LJ, Medley GF (2005) The Reinfection Threshold. *J Theor Biol* **236** : 111-113.
16. Gonçalves G, Machado E, Gouveia E, Santos MA, Castro L, Águas R, Gomes MGM (2005) Resurgence of whooping cough in the North of Portugal. Two severe cases of among very young unvaccinated children. *Euro Surveill* **10**(25): pii=2731.
17. Gomes MGM, Margheri A, Medley GF, Rebelo C (2005) Dynamical behaviour of epidemiological models with suboptimal immunity and nonlinear incidence. *J Math Biol* **51**: 414 – 430.
18. Nunes A, Telo da Gama MM, Gomes MGM (2006) Localized contacts between hosts reduce pathogen diversity. *J Theor Biol* **241**: 477-487.
19. Águas R, Gonçalves G, Gomes MGM (2006) Pertussis: Increasing disease as a consequence of reducing transmission. *Lancet Infect Dis* **6**: 112-117.
20. Parker MJ, Gomes MGM, Stewart IN (2006) Forced symmetry-breaking of square lattice planforms. *Journal of Dynamics and Differential Equations* **18**: 223-255.
21. White LJ, Mandl JN, Gomes MGM, Bodley-Tickell AT, Cane PA, Perez P, Siqueira MM, Portes SA, Straliootto SM, Waris M, Medley GF, Nokes DJ (2007) Understanding the transmission dynamics of RSV: Multiple time series and nested models. *Math Biosci* **209**: 222-239.
22. Gökaydin D, Oliveira-Martins JB, Gordo I, Gomes MGM (2007) The reinfection threshold regulate pathogen diversity: The case of influenza. *J R Soc Interface* **4**: 137-142.
23. Rodrigues P, Rebelo C, Gomes MGM (2007) Drug resistance in tuberculosis: A reinfection model. *Theor Popul Biol* **71**: 196-212.

24. van Noort SP, Muehlen M, Rebelo de Andrade H, Lourenço J, Koppeschaar C, Gomes MGM (2007) Gripenet: an internet-based system to monitor influenza-like illness uniformly across Europe. *Euro Surveill* **12**(7): pii=722.
25. Gomes MGM, Rodrigues P, Hilker FM, Mantilla-Beniers NB, Muehlen M, Paulo AC, Medley GF (2007) Implications of partial immunity on the prospects for tuberculosis control by post-exposure interventions. *J Theor Biol* **248**: 608-617.
26. Paulo AC, Gomes MC, Gomes MGM (2008) Dynamics and control of measles in Portugal: high coverage with MMR I is crucial to sustain elimination. *Vaccine* **26**: 2418-2427.
27. Águas R, White LJ, Snow RW, Gomes MGM (2008) Prospects for malaria eradication in sub-Saharan Africa. *PLoS ONE* **3**(3): e1767.
28. Parker MJ, Stewart IN, Gomes MGM (2008) Examples of forced symmetry-breaking to homoclinic cycles in three-dimensional Euclidean-invariant systems. *Int Jour Bif and Chaos* **18**: 83-107.
29. Parker MJ, Stewart IN, Gomes MGM (2008) Partial classification of heteroclinic behaviour associated with the perturbation of hexagonal planforms. *Dynamical Systems* **23**: 137-162.
30. Parker MJ, Gomes MGM, Stewart IN (2009) Examples of forced symmetry-breaking to heteroclinic cycles and networks in three-dimensional Euclidean-invariant systems. *Int Jour Bif and Chaos* **19**: 1655-1678.
31. Gordo I, Gomes MGM, Reis DG, Campos PRA (2009) Genetic variation in the SIR model of pathogen evolution. *PLoS ONE* **4**(3): e4876.
32. Mantilla-Beniers NB, Gomes MGM (2009) Mycobacterial ecology as a modulator of tuberculosis vaccine success. *Theor Popul Biol* **75**: 142-152.
33. Rodrigues P, Margheri A, Rebelo C, Gomes MGM (2009) Heterogeneity in susceptibility to infection induces unexpectedly high reinfection rates. *J Theor Biol* **259**: 280-290.
34. Águas R, Lourenço JML, Gomes MGM, White LJ (2009) The impact of IPTi on malaria clinical burden – in silico perspectives. *PLoS ONE* **4**(8): e6627.
35. Bacaër N, Gomes MGM (2009) On the final size of epidemics with seasonality. *Bull Math Biol* **71**: 1954-1966.
36. van Noort SP, Nunes MC, Weedall GD, Hviid L, Gomes MGM (2010) Immune selection and within-host competition can structure the repertoire of variant surface antigens in *Plasmodium falciparum* - A mathematical model. *PLoS ONE* **5**(3): e9778.
37. Kretzschmar M, Gomes MGM, Coutinho RA, Koopman JS (2010) Unlocking pathogen genotyping information for public health by mathematical modelling. *Trends Microbiol* **18**: 406-412.
38. Stollenwerk N, van Noort SP, Martins J, Aguiar M, Hilker FM, Pinto A, Gomes MGM (2010) A spatially stochastic epidemic model with partial immunization shows in mean field approximation the reinfection threshold. *Journal of Biological Dynamics* **4**: 634-649.
39. Coelho FC, Codeço CT, Gomes MGM (2011) A Bayesian framework for parameter estimation in dynamical models. *PLoS ONE* **6**(5): e19616.
40. Águas R, Ferreira MU, Gomes MGM (2012) Modeling the effects of relapse in the transmission dynamics of malaria parasites. *J Parasitol Res*: 921715.

41. van Noort SP, Águas R, Ballesteros S, Gomes MGM (2012) The role of weather on the relation between influenza and influenza-like illness. *J Theor Biol* 298C: 131-137.
42. Gomes MGM, Águas R, Lopes JS, Nunes MC, Rebelo C, Rodrigues P, Struchiner CJ (2012) How host selection governs tuberculosis reinfection. *Proc R Soc Lond B*. (In press).
43. van Noort SP, Codeço CT, Koppeschaar CE, van Ranst M, Faustino V, Gomes MGM (2012) The Influenzanet self-reporting system warrants consistency in epidemic monitoring across countries and seasons. *Submitted*.
44. Parisi A, Nunes A, Gomes MGM (2012) Heterogeneity in antibody range and the antigenic drift of influenza viruses. *Submitted*.

OTHER PUBLICATIONS FROM MY RESEARCH GROUP

- André J-B, Godelle B (2005) Within-host evolution and virulence in microparasites. *J Theor Biol* **241**: 402-409.
- André J-B, Gandon S (2005) Vaccination, within-host dynamics, and virulence evolution. *Evolution* **60**: 13-23.
- Hilker FM, Westerhoff FH (2006) Paradox of simple limiter control. *Physical Review E* **73**.
- Hilker FM, Malchow H, Langlais M, Petrovskii SV (2006) Oscillations and waves in a virally infected plankton system: Part II: Transition from lysogeny to lysis. *Ecological Complexity* **3**: 200-208.
- Hilker FM, Malchow H (2006) Strange periodic attractors in a prey-predator system with infected prey. *Mathematical Population Studies* **13**(3): 119-134.
- Stollenwerk N, Martins J, Pinto A (2007) The phase transition lines in pair approximation for the basic reinfection model SIRS. *Phys Lett A* **371**: 379-388.
- Malchow H, Hilker FM (2007) Pattern formation in models of nonlinear plankton dynamics: a minireview. *In: Multiple Scales in Ecology* (Schröder B, Reuter H, Reineking B, eds) *Theorie in der Ökologie*, vol. 13, Peter Lang Verlag, 3-20.
- Hilker FM, Westerhoff FH (2007) Triggering crashes in chaotic dynamics. *Physics Letters A* **199**: 476-485.
- Hilker FM, Langlais M, Petrovskii SV, Malchow H (2007) A diffusive SI model with Allee effect and application to FIV. *Mathematical Biosciences* **206**, 61-80.
- Hilker FM, Westerhoff FH (2007) Preventing extinction and outbreaks in chaotic populations. *Am Nat* **170**: 232-241.
- André J-B, Day T (2007) Perfect reciprocity is the only evolutionary stable strategy in the continuous iterated prisoner's dilemma. *J Theor Biol* **247**: 11-22.
- Gerrish PJ (2008) A simple formula for obtaining markedly improved mutation rate estimates. *Genetics* **180**: 1773-1778.
- Brooke ML, Butchart, SHM, Garnett ST, Crowley GM, Mantilla-Beniers NB, Stattersfield AJ (2008) Rates of Movement of Threatened Bird Species between IUCN Red List Categories and toward Extinction, *Conservation Biology* **22**: 417-427.
- Massad E, Chen M, Ma S, Struchiner CJ, Stollenwerk N, Aguiar M (2008) Scale-free network for a dengue epidemic. *Appl Math Comp* **159**: 376-381.

- Aguiar M, Kooi B, Stollenwerk N (2008) Epidemiology of dengue fever: A model with temporary cross-immunity and possible secondary infection shows bifurcations and chaotic behaviour in wide parameter regions *Math Model Nat Phenom* **3**: 48-70.
- Hilker FM, Schmitz K (2008) Disease-induced stabilization of predator-prey oscillations. *J Theor Biol* **255**: 299-306.
- Gonçalves R, Pinto A, Stollenwerk N (2009) Cycles and Universality in Sunspot Numbers Fluctuations. *Astrophysical Journal* 691,1583-1586.
- Maude RJ, Pongtavornpinyo W, Saralamba S, Aguas R, Yeung S, Dondorp AM, Day NP, White NJ, White LJ (2009) The last man standing is the most resistant: eliminating artemisinin-resistant malaria in Cambodia. *Malar J* **8**:31.
- Martins J, Pinto A, Stollenwerk N (2009) A scaling analysis in the SIRI epidemiological model. *Journal of Biological Dynamics* **1168**: 1527-1530.
- Sá-Leão R, Nunes S, Brito-Avô A, Frazão N, Simões A, Crisóstomo MI, Paulo ACS, Saldanha J, Santos-Sanches I, de Lencastre H (2009) Changes in pneumococcal serotypes and antibiotypes carried by vaccinated and unvaccinated day-care center attendees in Portugal, a country with widespread use of the seven-valent pneumococcal conjugate vaccine. *Clin Microbiol Infect* **15**: 1002-1007.
- Coelho FC, Codeço CT (2009) Dynamic Modeling of Vaccinating Behavior as a Function of Individual Beliefs. *PLoS Comp Biol* **5**: e1000425.
- Friesema IHM, Koppeschaar CE, Donker GA, Dijkstra F, van Noort SP, Smalenburg R, van der Sande MAB, van der Hoek W (2009) Internet-based monitoring of influenza-like illness in the general population: experience of five influenza seasons in the Netherlands. *Vaccine* **27**: 6353-6357.
- Black AJ, McKane AJ, Nunes A, Parisi A (2009) Stochastic Fluctuations in the SIR model with distributed infectious periods. *Phys Rev E* **80**: 021922.
- Aguiar M, Stollenwerk N, Kooi B (2009) Torus bifurcations, isolas and chaotic attractors in a simple dengue fever model with ADE and temporary cross immunity. *Intern Journal of Computer Mathematics* **86**: 1867-1877.
- White LJ, Maude RJ, Pongtavornpinyo W, Saralamba S, Águas R, Van Effelterre T, Day NP, White NJ (2009) The role of simple mathematical models in malaria elimination strategy design. *Malar J* **8**: 212.
- White NJ, Pongtavornpinyo W, Maude RJ, Saralamba S, Águas R, Stepniewska K, Lee SJ, Dondorp AM, White LJ, Day NP (2009) Hyperparasitaemia and low dosing are an important source of anti-malarial drug resistance. *Malar J* **8**: 253.
- Oliveira NM, Hilker FM (2010) Modelling disease introduction as biological control of invasive predators to preserve endangered prey. *Bull Math Biol* **72**: 444-68.

GRANTS

Source of Funds	Title of Project	Duration (Months)	Starting date	Total Value	Other Comments
Instituto de Ciencia e Tecnologia del Distrito	Sistema ciudadano de monitoreo de enfermedades	12	Oct 2010	1,000,000 Pesos	International Cooperation

<i>Source of Funds</i>	<i>Title of Project</i>	<i>Duration (Months)</i>	<i>Starting date</i>	<i>Total Value</i>	<i>Other Comments</i>
Federal (Mexico)	respiratorias - Reporta				PI: N.Mantilla-Beniers
Fundação para a Ciência e a Tecnologia	Exploring pathogen diversity in disease epidemiology and vaccine research	36	Feb 2010	163,000 €	Research Grant PI:G.Gomes
Fundação Nacional de Saúde / Secretaria de Vigilância em Saúde (Brazil)	Dengue Web: Sistema online de informação de dengue em tempo real	24	Jan 2010		Research Contract PI: M.G.Teixeira
FCT-CAPES	Sistemas complexos na dinâmica de infecção da tuberculose e dengue	24	Jan 2009	10,000 €	Co-PIs: G.Gomes; M.Barreto
European Commission	Developing the framework for an epidemic forecast infrastructure	48	Feb 2009	4,850,000 €	Co-chairs: A.Vespignani; G.Gomes
Fundação para a Ciência e a Tecnologia	Molecular epidemiology of Mycobacterium tuberculosis in Portugal	36	Sep 2008	171,750 €	Research Grant PI: G.Gomes
The Royal Society	Strain dynamics: theoretical framework for antigenic diversity	24	Jan 2007	£ 12,000	Joint Project Applicants: J.Gog; G.Gomes
Fundação Calouste Gulbenkian	Gripenet	18	Jan 2006	50,000 €	Research Grant
Ministry of Health	Geographical heterogeneity of tuberculosis incidence in Portugal	18	Oct 2005	24,260 €	Research Contract
Marie Curie Actions, European Commission	Reinfection thresholds and the management of recurrent infections	48	Apr 2005	1,884,679 €	Marie Curie Excellence Team
Fundação para a Ciência e a Tecnologia	Reinfection thresholds and the management of recurrent infections	36	Jan 2005	25,000 €	Research Grant PI: G.Gomes
GRICES – British Council	Epidemiology and control of leishmaniasis		Dec 2003	300 €	Visiting Grant
Fundação para a Ciência e a Tecnologia	Epidemiology and evolution of infectious diseases: influenza and malaria	36	Jun 2003	30,000 €	Research Grant PI: G.Gomes
Fundação para a Ciência e a Tecnologia	Population structure of hosts and pathogens	36	Apr 2002	64,555 €	Fellowship
Wellcome Trust	Evolutionary epidemiology of strain structure in pathogen populations		Jan 2001	£ 5,000	Workshop
Wellcome Trust	Symmetry and symmetry-breaking approaches to strain formation in pathogen populations	36	Apr 1999	£ 114,370	Fellowship
Fundação para a Ciência e a Tecnologia	Hidden symmetries in degenerate rectangles	24	Apr 1997	8m PTE	Fellowship
Fundação para a Ciência e a Tecnologia	Geometry and singularities in nonlinear dynamics	36	Oct 1997	20,000,000 PTE	Research Grant PI: I.Labouriau
Junta Nacional de Investigação Científica e Tecnológica	Bifurcation to spatio-temporal chaos	7	Oct 1995	1,000,000 PTE	Visiting Fellowship

INVITED SEMINARS AND CONFERENCES

- Workshop - Dynamics, Bifurcation and Symmetry: New Trends and New Tools. Cargèse, France, September 1993.
- Workshop - Dynamics and Symmetry. Oberwolfach, Germany, July 1995.
- Conference - International Conference on Differential Equations. Lisboa, Portugal, July 1995.
- Workshop - Pattern Formation in Continuous and Coupled Systems. IMA, Minnesota, USA, May 1998.
- Summer School - Mathematical Biology. Universidade de Lisboa, Lisboa, Portugal, July 2002.
- Workshop - Mathematics, Biology and Statistics of Repeated Infections. Wellcome Trust Research Centre, Kilifi, Kenya, July 2003.
- Workshop - Evolutionary Consequences of Vaccine Use. DIMACS, USA, June 2005.
- National Meeting - General Practitioner Sentinel Network. Luso, Portugal, January 2006.
- National Meeting - XII Congress of Medicine, Porto, Portugal, March 2006.
- National Meeting - Portuguese Mathematical Society. Instituto Superior de Engenharia de Lisboa, Portugal, June 2006.
- National Meeting - Portuguese Investigator International Forum. Porto, Portugal, September 2006.
- National Meeting - IV Congress of the Portuguese Epidemiological Society. Cascais, Portugal, October 2006.
- Conference - VIII Meeting on Molecular Epidemiology and Evolutionary Genetics of Infectious Diseases. Bangkok, Thailand, November 2006.
- National Meeting - XXII Congress of Lung Diseases. Estoril, Portugal, December 2006.
- Workshop - Immuno-epidemiology. DIMACS, USA, December 2006.
- International Meeting - XII Annual Meeting of the European Influenza Surveillance Scheme. Malaga, Spain, May 2007.
- National Meeting - International Centre for Mathematics. Coimbra, Portugal, May 2007.
- Workshop - Modelling of Control Strategies for Health Threats. Luxemburg, May 2007.
- Workshop - IX Workshop of Applied Biology. Universidade do Minho, Portugal, September 2007.
- National Meeting - Portuguese Mathematical Society. Coimbra, Portugal, June 2008.
- National Meeting - Computational Biology Forum. Instituto Gulbenkian de Ciência, Oeiras, Portugal, July 2008.
- Workshop - III Workshop on Statistics, Mathematics and Computation. Universidade Aberta, Lisboa, Portugal, July 2008.
- Workshop - Modeling the Impact of Policy Options during Public Health Crises. BIRS, Canada, July 2008.
- Conference - Dynamics and Application. Universidade do Minho, Portugal, September 2008.
- Workshop - Facing the Challenge of Infectious Diseases: Integrating mathematical modeling, computational thinking and ICT applications. ISI Foundation, Turin, Italy, October 2008.
- Conference - International Symposium on Operational Research. Alger, Algeria, November 2008.

Workshop - ESF Workshop on Mathematical Modelling to Link Contact Network Analysis and Molecular Typing of Pathogens. Utrecht University, The Netherlands, November 2008.

Workshop - Mathematical Modelling of Epidemics. University of Bristol, UK, September 2009.

Workshop - Design and Analysis of Infectious Disease Studies. Oberwolfach, Germany, November 2009.

Workshop - Modelling, Computation, and Measurement of Multiple Carriage. Saariselkä, Finland, December 2009.

Workshop - Theoretical Epidemiology. International Centre for Mathematics, Coimbra, Portugal, January 2010.

Conference - HIV/AIDS: Closing the Gap between Basic Research and Clinical Practice, Instituto de Medicina Molecular, Universidade de Lisboa, Portugal, January 2010.

Workshop - First Dynamical Systems Applied to Biology and Natural Sciences. Universidade de Lisboa, Portugal, February 2010.

Conference - III Conference on Computational and Mathematical Population Dynamics. Bordeaux 2 University, France, June 2010.

Workshop - Joint WHO/VMI Dengue Modelling Workshop. WHO Geneva, August 2010.

Symposium - Infection Dynamics: Bridging the Gap between Theory and Application. Utrecht Centre for Infection Dynamics, The Netherlands, March 2011.

Workshop - Phylodynamics. NESCent - National Evolutionary Synthesis Center, Durham, USA, May 2011.

Conference - VIII European Conference on Mathematical and Theoretical Biology, Krakow, Poland, June 2011.

Workshop - From Chaos to Complexity, Mathematics Interdisciplinary Research, University of Warwick, UK, July 2011.

Workshop - Second Workshop "Facing the Challenge of Infectious Diseases: Integrating mathematical modeling, computational thinking and ICT applications". Pré-Saint-Didier, Aosta, Italy, January 2012.

Workshop - Third Workshop "Dynamical Systems Applied to Biology and Natural Sciences". Universidade de Lisboa, Portugal, February 2012.

SCIENTIFIC MEETINGS ORGANIZED

Workshop on Turing Patterns and Their Symmetries, Mathematics Institute, University of Warwick, June 1999.

Workshop on Evolutionary Epidemiology of Strain Structure in Pathogen Populations (Organisers: Gabriela Gomes, Sunetra Gupta, Simon Levin, Robert Mackay, Graham Medley, James Nokes) Mathematics Institute and Department of Biological Sciences, University of Warwick, January, 2001. With reports published in: *Trends in Ecology and Evolution* **16**, 272; and *Trends in Microbiology* **9**, 199-200.

Summer School on Mathematics in Biology and Medicine I (Organisers: Jorge Carneiro, Pedro Coutinho, Jose Faro, Francisco Dionisio, Gabriela Gomes, Isabel Gordo) CIM-IGC, Instituto Gulbenkian de Ciência, September 2004.

Workshop on Pathogen Diversity and Disease Epidemiology I, Instituto Gulbenkian de Ciência, September 2004.

Advanced Course on Tuberculosis: Scientific Basis for Control (Organisers: Fonseca Antunes, Gabriela Gomes, Guilherme Gonçalves, Ana Cristina Paulo), Instituto Gulbenkian de Ciência, September 2005.

Advanced Course on Epidemiology of Infectious Diseases (Organisers: Gabriela Gomes, Eduardo Massad, Claudio Struchiner, Lisa White), Instituto Gulbenkian de Ciência, April 2006.

Summer School Mathematics in Biology and Medicine II (Organisers: Jorge Carneiro, Francisco Dionisio, Gabriela Gomes, Isabel Gordo) CIM-IGC, Instituto Gulbenkian de Ciência, September 2006.

Workshop on Pathogen Diversity and Disease Epidemiology II (Organisers: Gabriela Gomes, Natalia Mantilla-Beniers, Nico Stollenwerk), Instituto Gulbenkian de Ciência, September 2006.

Workshop on Evolution in Health and Disease (Organisers: Alexei Drummond, Philip Gerrish, Gabriela Gomes, Kalet Leon, Raquel Sá-Leão), Instituto Gulbenkian de Ciência, September 2008.

GRADUATE COURSES TAUGHT

Equivariant Bifurcation Theory, in "MSc in Mathematics", Mathematics Institute, University of Warwick, jointly with Ian Stewart (1998-1999).

Pattern Formation, in "Programa Gulbenkian de Doutoramento em Biomedicina", Instituto Gulbenkian de Ciência (2000-2001).

Population Dynamics of Multi-Strain Pathogens, in "Summer School on Mathematical Biology", Universidade de Lisboa (July 2002).

Population Dynamics and Epidemiology, in "Programa Gulbenkian em Bioinformática", Instituto Gulbenkian de Ciência (2002-2005).

Population Biology: Epidemiology and Immune Systems, in "Programa Gulbenkian em Biologia Computacional", Instituto Gulbenkian de Ciência (2005-2009).

Mathematical Models in Infectious Diseases, in "Mestrado em Epidemiologia", Faculdade de Medicina de Lisboa (2007-2011).

RESEARCH SUPERVISION

Eliana Manuel de Matos Oliveira Pinho. "Simetrias escondidas em equações diferenciais parciais", MSc Thesis, Universidade do Porto, 1998, in joint supervision with Isabel Labouriau.

Martyn Parker. "Forced symmetry-breaking of Euclidean-equivariant partial differential equations, pattern formation and Turing instabilities", PhD Thesis, University of Warwick, 2003, in joint supervision with Ian Stewart.

José Nuno Barros de Oliveira Martins. "Modelação de epidemiologia e evolução do vírus influenza A", Graduation Thesis, Universidade de Évora, 2003.

Ricardo Jorge Alexandre Águas. "Modelação da epidemiologia da tosse convulsa: a dicotomia imunidade parcial vs imunidade temporária", Graduation Thesis, Universidade de Évora, 2004.

Dinis Sequeira do Couto Gökyaydin. "Modelação estocástica dos fenómenos de 'shift' e 'drift' no vírus influenza A", Graduation Thesis, Universidade de Lisboa, 2005.

Paula Cristiana Patricio Rodrigues. "Modeling tuberculosis: A compromise between biological realism and mathematical tractability", PhD Thesis, Universidade de Lisboa, 2009, in joint supervision with Carlota Rebelo.

Ricardo Jorge Alexandre Águas. "The versatility of mathematical models: From biological mechanisms to epidemiological scenarios", PhD Thesis, Universidade Nova de Lisboa, 2010.

PARTICIPATION IN ACADEMIC COMMITTEES

PhD Thesis: Ana Cristina de Almeida Santos Paulo, Universidade de Lisboa, Portugal, April 2004.

PhD Thesis: Eliana Manuel de Matos Oliveira Pinho, Universidade do Porto, Portugal, May 2006.

PhD Thesis: Maria Inês Crisóstomo Ramos, ITQB, Universidade Nova de Lisboa, Portugal, November 2006.

PhD Thesis: Barbara Boldin, Department of Mathematics, University of Utrecht, The Netherlands, September 2007.

PhD Thesis: Jaime Manuel Pinto Combadão, ITQB, Universidade Nova de Lisboa, Portugal, February 2008.

MSc Thesis: Delphine Pessoa, Universidade de Lisboa, Portugal, December 2010.

HONOURS AND AWARDS

Marie Curie Excellence Team Leader (European Commission, 2005-2009).

Best Practices Award for Gripenet (Rede Comum do Conhecimento, 2009).

PROFESSIONAL ACTIVITIES

Board of Directors, Fórum Internacional de Investigadores Portugueses (2007-2008).

Board of Directors, Sociedade Portuguesa de Matemática (2008-2010).

Editorial Board, Statistical Communications in Infectious Diseases (2009-present).

OUTREACH

Public Lecture - Mathematics, Science and Art, Universidade de Lisboa, Portugal, November 2002.

Gripenet - We have implemented an internet-based system to monitor influenza epidemics with the voluntary participation of the Portuguese population. The system, running since 2005, was recognized with the Best Practices Award 2009, Rede Comum de Conhecimento.

Public Debate - The possible impact of tropical diseases in Europe, Viana do Castelo, Portugal, April 2008.