



Building Immune Digital Twins



Dr Anna Niarakis

Lead Chair of the Research Data Alliance Working Group on IDTs

**Twinsanté: Les jumeaux numériques pour la santé et la
recherche médicale**

Webinaire INSERM en partenariat avec l'Alliance internationale
des Données de la Recherche, RDA

26 September 2025

Building digital twins of the human immune system: toward a roadmap

- Develop sufficiently powerful and detailed simulation models of the human immune system.
- Acquire the appropriate real-world data to train and validate the simulation models.
- Personalize and customize the simulation models to individual patients and for particular purposes.

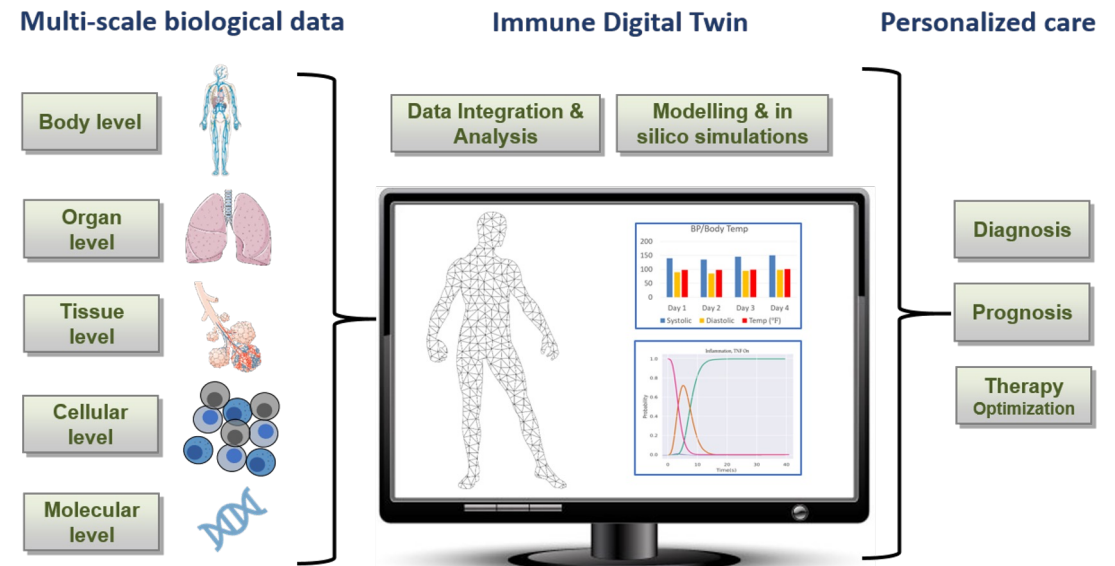


Image Credit: Anna Niarakis and Bruce Shapiro from Laubenbacher et al, 2022 npj Digital Medicine

Working together at a larger-scale:

a) minimizing communication barriers

b) shaping a common language



**3-week workshop on Immune Digital Twins –
Institute Pascal, Paris Saclay May –June 2023**

Statistics:

100 participants

19 countries: France, Netherlands, USA, India, Spain, UK, Norway, South Africa, Switzerland, Luxembourg, Greece, Denmark, Israel, Germany, Spain, Portugal, Belgium, Italy, Sweden

Interdisciplinary backgrounds:

Immunologists, clinicians, engineers, biologists, mathematicians, informaticians, bioinformaticians, modellers, biochemists, computational biologists, pharmacists

Early career and senior scientists

Around 30-35% women

Institute Pascal - Université de Paris-Saclay

An international scientific hub, dedicated to the exchange of knowledge and the development of new ideas.



Bringing stakeholders together!

Keynotes

Jasmin Fisher, UCL, UK
Mustafa Kammash, ETH Zurich, CH
Julio Saez Rodriguez, University of Heidelberg, DE
Emmanuel Barillot, Institut Curie, France
Maria Rodriguez Martinez, IBM Zurich, CH
Yaron Ilan University of Jerousalem, IL
Kristin Reiche, Fraunhofer Institute for Cell Therapy and Immunology, Leipzig, DE

Advanced talks

Reinhard Laubenbacher, University of Florida, US
François Fages, INRIA Saclay, FR
Irene Vignon Clementel, INRIA Saclay, FR
Dagmar Waltemath, University of Greifswald, DE
Gary An, University of Vermont, US
James Glazier, University of Indiana Bloomington, US
Gaetane Nocturne, Hopitaux Universitaires Paris-Sud, FR
Tomas Helikar, University of Nebraska Lincoln, US
Benjamin Hall, UCL, UK
Anna Niarakis, University of Evry, Paris-Saclay and INRIA Saclay, FR
Anabelle Balesta, INSERM and Institut Curie, FR
Asmund Flobak, NTNU, NO

Advanced tutorials

Laurence Calzone, Institut Curie, Paris, FR
Gaultier Stoll, INSERM U1138, Université Paris
Descartes, Gustave Roussy, FR
Vincent Noel, Institut Curie, Paris, FR
Pedro Monteiro, Technical University of Lisbon, POR
Sylvain Soliman, INRIA Saclay, FR
Anna Niarakis, University of Evry, Paris Saclay & INRIA Saclay, FR
Arnau Montagud, Barcelona Supercomputing Centre, ESP
Tomas Helikar, University of Nebraska Lincoln, US
TJ Tiego, University of Florida, US

Platforms and private sector presentations/ panel discussion participation

Christophe Lanneau, Genopole
Franck Augé, SANOFI
Markus Rehberg, SANOFI
Nicola Gaudenzio, Genoskin
Vassili Soumelis, Owkin
Alexander Kulesza/ Shiny Martis, Novadiscovery
Rachel Clipp, Brian Helba, KITWARE
Serkawt Khola - EvoPlexus Medics
Andrei Zinovyev - Evotec



**Building Immune
Digital Twins**

Goal: continue to work together

- **Enhance communication** between the three communities involved in digital twin construction:

- clinicians, immunologists/experimental biologists, and modelers.



- **Create a transatlantic community**, bringing together researchers from Europe, the U.S., and other countries.



RDA TIGER

Research Data Alliance facilitation of Targeted International working Groups for EOSC-related Research solutions (**RDA TIGER**)



Funded by
the European Union

New Global Support
Services for RDA
Working Groups



In this page:

- Open Calls for RDA Support Services
- Background: RDA supporting EOSC
- Objectives
- Workplan
- Groups currently supported by RDA TIGER
- Partners
- Deliverables
- Contact us

Open calls for RDA TIGER support

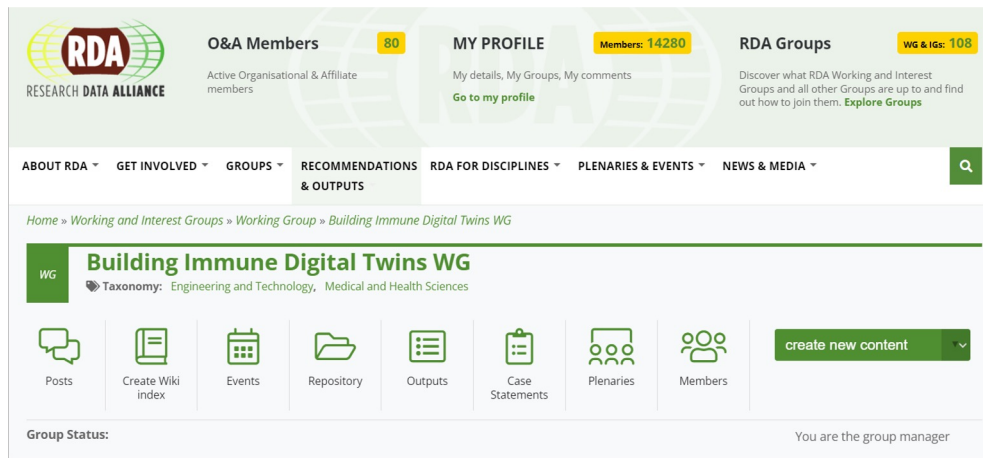
The RDA TIGER Open Calls seek applications from existing or potential Research Data Alliance (RDA) Working Groups (WGs) that wish to receive RDA TIGER support for their WG activities. The call is continuously open, with four selection rounds per year. Each round has a deadline by which the applications have to be submitted in order to be reviewed.

RDA Working Group

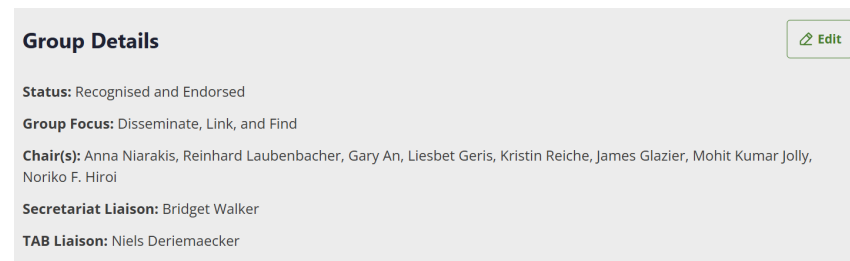
Statistics:
82 RDA member groups

>20 countries

The BIDT WG has been awarded RDA TIGER support, which provides facilitation, communication, landscape analysis, and output services for EOSC-related research.



The screenshot shows the RDA Working Group interface for the Building Immune Digital Twins WG. The header includes the RDA logo, navigation tabs (ABOUT RDA, GET INVOLVED, GROUPS, RECOMMENDATIONS & OUTPUTS, RDA FOR DISCIPLINES, PLENARIES & EVENTS, NEWS & MEDIA), and user statistics (O&A Members: 80, MY PROFILE: 14280 Members, RDA Groups: 108 WG & IGs). The main content area displays the group name, taxonomy (Engineering and Technology, Medical and Health Sciences), and a grid of icons for Posts, Create Wiki index, Events, Repository, Outputs, Case Statements, Plenaries, and Members. A 'create new content' button is also visible. The footer shows the group status and the user's role as the group manager.



The screenshot shows the RDA Working Group interface for the Building Immune Digital Twins WG, specifically the Group Details section. The header includes the group name and an 'Edit' button. The main content area displays the group status (Recognised and Endorsed), group focus (Disseminate, Link, and Find), chair(s) (Anna Niarakis, Reinhard Laubenbacher, Gary An, Liesbet Geris, Kristin Reiche, James Glazier, Mohit Kumar Jolly, Noriko F. Hiroi), secretariat liaison (Bridget Walker), and TAB liaison (Niels Deriemaeker).



Chairs & RDA facilitator



Dr Anna
Niarakis



Dr Reinhard
Laubenbacher



Dr Liesbet Geris



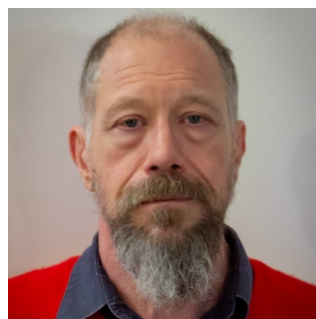
Dr Gary An



Dr Peter Hunter



Dr Kristin Reiche



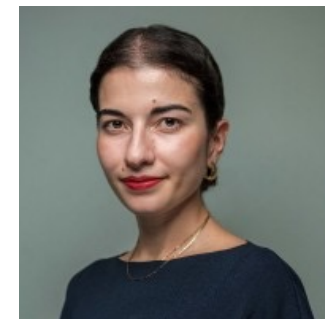
Dr James Glazier



Dr Noriko Hiroi



Dr Mohit Kumar Jolly



Athina Papadopoulou

Task Managers



Luiz Ladeira



Lorenzo Veschini



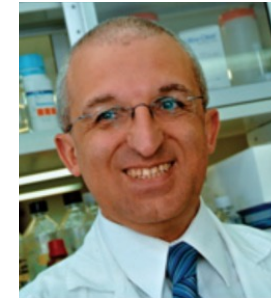
Malvina Marku



Eirini Tsirvouli



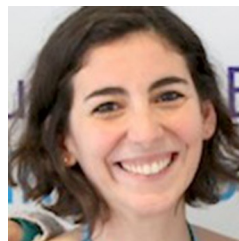
Yaswanth
Subbannayya



Yaron Ilan



Arnau Montagud



Laurence
Calzone



Martina Kutmon



Haçan Balci



Philippe Moingeon



Francis P. Crawley

Adressing challenges

Our work addresses the scientific, technical, ethical, and societal challenges of building and deploying IDTs.

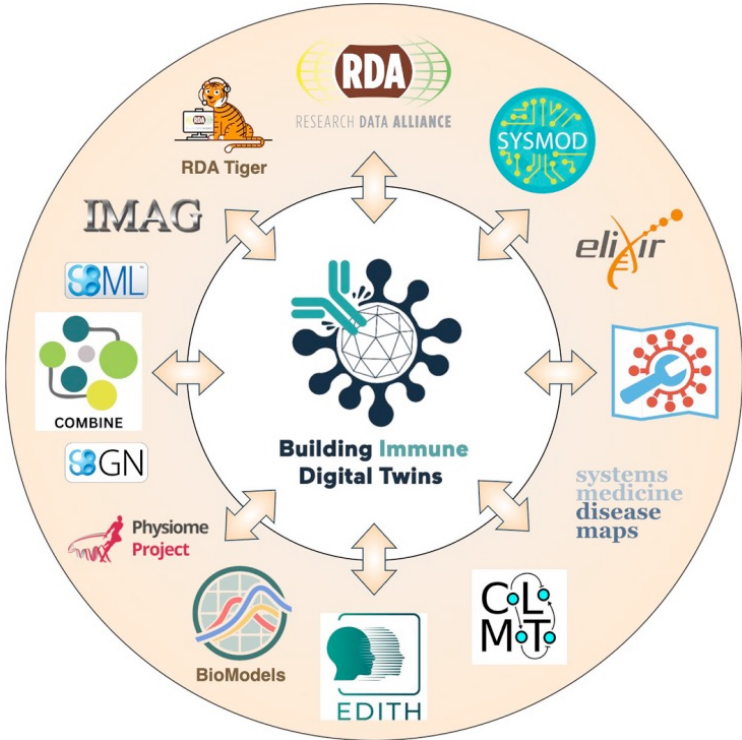
Key objectives include:

- Developing community standards for data formats, metadata, and model sharing
- Ensuring interoperability across platforms, tools, and datasets
- Advancing global collaboration through open science practices
- Designing a long-term roadmap for sustainable IDT ecosystems



18 months to deliver:

Deliverable	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
	Data curation and repository																	
D1. Literature repository						D1												
D2. Model metadata catalogue							D2											
D3. Model repository - Dedicated BioModels section																		D3
	Communication and Dissemination																	
D4. IDT git and webpage										D4								
D5. IDT virtual 1-day workshops				D5			D5			D5			D5					
D6. IDT Summer school																D6		
	Recommendation document																	
D7. Building IDTs best practices Recommendation document																		D7



In parallel, we are implementing FAIR principles and aligning with recommendations from other Communities, and RDA groups to ensure coherence, reusability, and impact across the broader research data community.

Slack channel, shared working files, monthly meetings, group activities, grant writing, workshops!

immunedt.github.io



Building Immune Digital Twins

A community effort to make IDTs a reality!

Projects Models Webinars Team Publications Events RDA BIDT

Building Immune Digital Twins

Welcome to the Building Immune Digital Twins (BIDT) initiative — a global, community-driven effort to develop computational replicas of the human immune system. Our goal is to advance our understanding and treatment of diseases by simulating immune responses tailored to individuals.

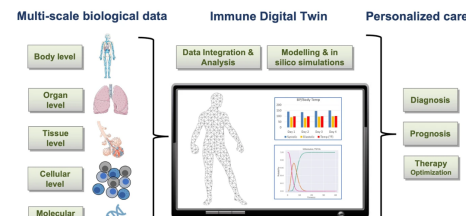
Whether you're a researcher, clinician, or data scientist, join us in shaping the future of personalized medicine.

What are immune digital twins?

Immune digital twins are dynamic computational models designed to simulate how an individual's immune system responds to infections, therapies, and vaccines. By integrating biological knowledge, clinical data, and modeling techniques, we aim to support:

- Personalized diagnostics

edit: aishwariya.dutta@univie.ac.at



In addition, we received the RDA Cascading Grant and RDA Experts' Call Grant to develop a centralised digital portal, aimed at consolidating WG activities and enhancing the dissemination of outputs.

The screenshot shows a Slack channel interface. The channel name is 'Building an Immune Digital Twin'. The left sidebar shows a list of channels, with '# général' selected. The main area shows a conversation with messages from Anna Niarakis, Kristin Reiche, and Vincent Noél. The messages discuss the need to launch a website, the importance of having stable meetings, and the goal of getting the RDA group running.

Past Events

 [9th Disease Maps Community Meeting 2025](#)
15th to 17th of April 2025 - Leuven - BE

 [Building Immune Digital Twins mini-symposium 2024](#)
15th of July 2024 - 9am - 12am. Amsterdam - NL

 [Building Immune Digital Twins Workshop 2023](#)
15 May - 2 June 2023, Institut Pascal - Paris - France

Scientific articles



Building immune digital twins: An international and transdisciplinary community effort

Anna Niarakis^{a,b,*}, Gary An^c, Luiz Ladeira^d, Noriko F. Hiroi^{e,f}, Athina Papadopoulou^g, Francis P. Crawley^{h,i}, Niloofar Nikaein^{j,k}, Laurence Calzone^l, Eirini Tsirvouli^{m,n}, Hasan Balci^o, Marina Esteban Medina^{p,q}, Lorenzo Veschini^{r,s}, Ozan Ozisik^t, Francesco Messina^u, Malvina Marku^v, Van Du T. Tran^w, Arnau Montagud^{x,y}, Nikola Schlosserova^{z,aa}, Yashwanth Subbannayya^{ab,ac}, Martina Kutmon^o, Michael L. Blinov^{ad}, Rahuman S Malik Sheriff^{ae,af,ag}, Robert Phair^{ag}, Peter Hunter^{ah}, Kristin Reiche^{aj,ak}, Jasmin Fisher^{al}, Liesbet Geris^{d,am,an}, Yaron Ilan^{ao}, James A. Glazier^s, Philippe Moingeon^{ap}, Reinhard Laubenbacher^{aq}

npj | systems biology and applications

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nature > npj.systems biology and applications > perspectives > article

Perspective | Open access | Published: 30 November 2024

Immune digital twins for complex human pathologies: applications, limitations, and challenges

Anna Niarakis[✉], Reinhard Laubenbacher, Gary An, Yaron Ilan, Jasmin Fisher, Åsmund Flobak, Kristin Reiche, María Rodríguez Martínez, Liesbet Geris, Luiz Ladeira, Lorenzo Veschini, Michael L. Blinov, Francesco Messina, Luis L. Fonseca, Sandra Ferreira, Arnau Montagud, Vincent Noël, Malvina Marku, Eirini Tsirvouli, Marcella M. Torres, Leonard A. Harris, T. J. Sego, Chase Cockrell, Amanda E. Shick, ... James A. Glazier + Show authors

npj Systems Biology and Applications 10, Article number: 141 (2024) | Cite this article

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npj | digital medicine

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nature > npj.digital medicine > perspectives > article

Perspective | Open access | Published: 20 May 2022

Building digital twins of the human immune system: toward a roadmap

R. Laubenbacher[✉], A. Niarakis, T. Helikar, G. An, B. Shapiro, R. S. Malik-Sheriff, T. J. Sego, A. Knapp, P. Macklin & J. A. Glazier

npj Digital Medicine 5, Article number: 64 (2022) | Cite this article

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Perspective | Open access | Published: 01 August 2025

Design specifications for biomedical virtual twins in engineered adoptive cellular immunotherapies

Ulrike Weirauch, Markus Kreuz, Colin Birkenbihl, Miriam Alb, Maria Quaranta, Laurence Calzone, Sophia Orozco-Ruiz, Stefanie Binder, Luise Fischer, Solène Clavreul, Morine Maguri, Maximilian Ferle, Michael Rade, Guillaume Azarias, Jay R. Hydren, Jakub Jamarik, Daniel Schwarz, Zsolt Sebestyen, Jürgen Kuball, Georg Popp, Chloé Antoine, Manon Knockaert, Clara T. Schoeder, David Fandrei, On behalf of the CERTAINTY Consortium + Show authors

npj Digital Medicine 8, Article number: 493 (2025) | Cite this article

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Article | Open access | Published: 24 December 2024

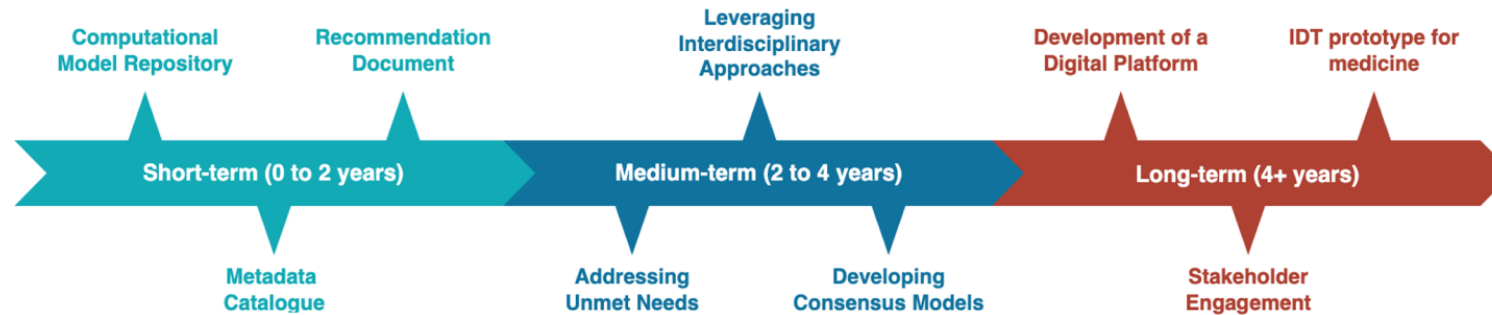
Building a modular and multi-cellular virtual twin of the synovial joint in Rheumatoid Arthritis

Naouel Zerrouk, Franck Augé & Anna Niarakis[✉]

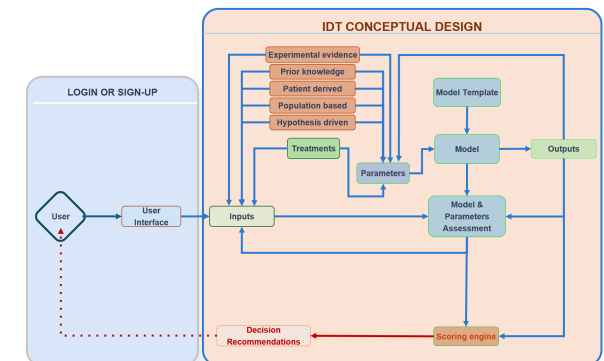
npj Digital Medicine 7, Article number: 379 (2024) | Cite this article

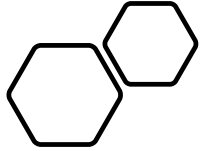
4360 Accesses | 6 Citations | 2 Altmetric | Metrics

Going forward



Building the **Inflammation** Digital Twin Workshop
 Institut Pascal, 2nd edition
 2 weeks – 2027





**Building Immune
Digital Twins**

Thank you!