



Strategic Plan

2023-28

Artwork by Marcus Woodley

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Unlocking embryonic development

Each one of us started life as a single cell: the fertilized egg. To produce our complex tissues, composed of trillions of cells, this single cell gave rise to a set of progeny – “stem cells” – that have the potential to generate any cell type in our body through the process of differentiation. Remarkably, the orchestrated dance between stem cells that progress in space and time to build our tissues is not led by a conductor. Rather, **each cell is a simple autonomous machine** that contains a DNA-based “processor”, akin to computer circuitry, composed of an interconnected network of genes that engage in regulatory biochemical interactions with one another. This genetic network, in which genes influence one another’s expression, is used by cells to make fate decisions, whether to divide, die or differentiate. The processor interprets input signals from the cellular microenvironment, be they short- or long-range molecules sent by neighbouring cells, allowing cells to coordinate to produce functional tissues with prescribed structures and cell types.

Stem cells are a cornerstone for regenerative medicine, owing to two key properties: the ability to multiply extensively in culture and to differentiate into all cell types of the body. Ongoing clinical trials are looking to harness the potential of stem cells to **produce lab-grown cells and tissues on-demand for transplantation**, opening the door to treating degenerative and otherwise intractable diseases, such as diabetes, stroke, Parkinson’s, etc. However, we still lack a fundamental understanding of how stem cells and their progeny interpret the rules carried in their processor and how they coordinate to give rise to our tissues.

This is the **grand challenge we seek to tackle through the Virtual Human Development Consortium**. The key to meeting this challenge is to understand how information flow carries across biological scales – from genes to cells to multicellular systems with emergent structure and function. To do this, there is a need to **bridge disciplines**: computational biology to mine rich biological datasets, mathematical biology to extract the underlying rules that govern the behavior of cells in embryonic development, and synthetic biology to implement model-generated predictions using state-of-the-art genetic engineering tools. Taking this approach, we seek to launch the age of computer-aided stem cell engineering by building a computer-based simulator of how stem cells build our bodies in human embryonic development. A **virtual twin of human development** would revolutionize stem cell and developmental biology by predicting cell decisions during time and tissue scales outside of our reach – due to ethical considerations. Most importantly, a virtual twin will help us unravel the rules that govern how stem cells build our bodies during human embryonic development so we can better control them and improve bioprocessing and manufacturing sectors.

The Virtual Human Development Consortium

Our Vision

Unlocking the marvels of human development so we can understand disease and program cells for regenerative medicine.

Our Mission

The Virtual Human Development Consortium brings together a global community of scholars and policy makers around the central goal of **creating a computer-based simulator of human embryonic development**. Our mission is to produce a state of the art simulator with the ability to predict efficiently and effectively the outcome of cellular tissue and potential regenerative therapies.

The simulator will be a powerful tool that will:

- (1) Provide a **window into the formation of the human body**, catalyzing new hypotheses for the developmental biology field to push the boundaries outside of what we know about our origins; and
- (2) Serve as a **platform for rational cellular design**, allowing us to engineer biological substrates for regenerative medicine. The model can also be adapted for personalized medicine approaches.

Our Impact

The VHD simulator will be a **tool for the biotechnology sector**, fueling the design-build-test cycle through rapid rounds of computational simulation. Analogous to simulation platforms from physics and chemistry that have facilitated the rapid growth of complex engineered systems, such as computing platforms, our simulator will catalyze advancement in the life sciences. It will be a **platform for cellular engineering**, leading to robust bioprocesses for manufacturing lab-grown cells and tissues.

Application areas for the simulator:

- **Manufacturing cell and tissue therapies:** the simulator will allow for rapid rounds of computational experiments, identifying media conditions and genetic perturbations that allow for rapid and reproducible derivation of cell types and tissues from stem cells for regenerative medicine applications.
- **Personalized medicine:** the simulator will connect the genome to cell and tissue function, allowing for patient-specific variations in DNA to be incorporated and their impact explored. The simulator will allow for personalized medicine approaches to engineering patient-derived cells for cell therapies, gene therapies, and drug screening.
- **Designer cells, tissues, and organs on-demand:** the simulator will be a platform for exploring how engineered genetic perturbations can be used to derive new and custom functions in cells for therapeutic applications, such as the creation of stem cell lines with broad immune

compatibility, molecular devices that sample and store information on cell and tissue function, and new sensors for detecting disease.

- **An atlas of embryonic development:** the simulator will be a window into the formation of our body and its tissues. It will be a platform for revealing gaps in our fundamental biological understanding of these processes, as well as a tool for hypothesis testing and discovery. It will serve as a computational sandbox that connects international scientists, allowing them to connect their datasets and computational models of development on a common platform.
- **Advancing In Vitro Fertilization (IVF):** a strategic starting point for VHD is a simulator of the early stages of embryonic development, from inception of the fertilized egg until blastocyst formation. As such, the simulator will serve as a tool to enable embryo screening in IVF clinics, predicting which molecular and morphological markers are predictive of embryo viability and health following transfer to the uterus.
- **Virtual clinical trials in embryos:** the simulator will allow for large-scale, rapid experimentation on virtual human embryos, exploring the effect of genetic and chemical perturbations on embryo growth and survival.

Our Values

Virtual Human Development will serve as an **intellectual sandbox for international groups** to understand and build biology together, guided by our common mission. We will collectively develop and integrate our knowledge into a human embryo simulation platform in line with the ethics, legal and social implications of embryo simulation. To enable this, we have three core values:

Collaboration: We will take an open-science approach, fostering best practices in equity, diversity and inclusivity to intersect experts from diverse fields, ways of thinking, and geographical locations. In particular, we strategically intersect experts from both empirical and theoretical backgrounds, a unique feature of our consortium.

Integrity: We will foster an environment of scientific integrity, ensuring we apply best practices and know-how to generate reliable experimental datasets and modeling frameworks. We will emphasize scientific practices that ensure reproducibility and transparency. We will also incorporate experts and stakeholders in bioethics and public policy to ensure that our mandate and scientific approaches are aligned with ethical best practices.

Posterity: We believe in the importance of training and guiding the next generation of innovators who will build on and expand our consortium's progress in developing a human embryo simulator. To do this, we will embed trainees in our governance structure and dedicate resources to ensure they are well-supported and trained in professional and technical skills.

Our Team

The Virtual Human Development Consortium was co-founded by Drs. Maria Abou Chakra, Nozomu Yachie, and Nika Shakiba, who act as the Founding Directors of the consortium. Under their leadership, the consortium now consists of over 40 world leading scientists and their teams, bridging experimentalists and theoreticians. The consortium strategically intersects experts and technologies from divergent disciplines to drive robust **experiment-to-theory research cycles**. The consortium leverages expertise in stem cells and developmental biology, stem cell bioengineering, synthetic biology, systems biology, evolutionary biology, bioinformatics, machine learning, and mathematical biology. We are also actively recruiting in the area of bioethics.

Core members: The consortium is composed of core members, which are early and mid-career researchers (Principal Investigators and Research Associates) from around the world, spanning experts with research programs that take experimental and theoretical approaches to understanding stem cell and developmental biology. As the first such team to pursue this vision of creating a simulator of human embryonic development, these individuals compose the core scientific cluster of experts that collectively work towards the mission of Virtual Human Development (**Figure 1**). We believe that the key ingredient to building a simulator of human embryonic development is a **marriage between experimental data and computational modeling**; There is a need to **bridge disciplines**: computational biology to mine rich biological datasets, mathematical biology to extract the underlying rules that govern the behavior of cells in embryonic development, and synthetic biology to implement model-generated predictions using state-of-the-art genetic engineering tools. Taking this approach, we seek to launch the age of computer-aided stem cell engineering by building a computer-based simulator, **a virtual human**.

These members are emerging world-leaders, who collectively span the expertise required to meet our grand challenge, including theoretical (mathematical and computational models), experimental expertise (genetic engineering, synthetic systems and in vitro models), and technology developers on both the experimental and computational sides. The individual biosketches of our members are available in the **Appendix**. Collectively, we are capable of producing an accurate and validated system.

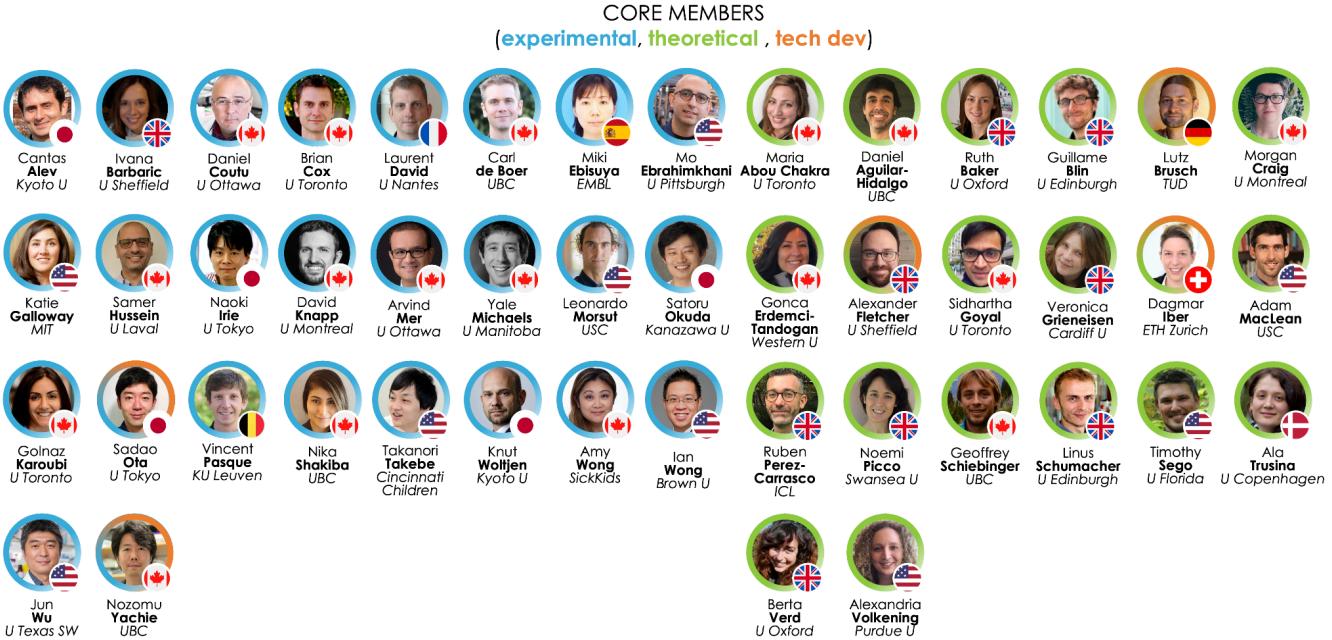


Figure 1: Core membership of VHD Consortium, including global early- and mid-career researchers that span interdisciplinary fields.

Advisory board members: Advisory members are well-established and world-renowned senior researchers and leaders in their specific field (**Figure 2**). They provide guidance around the scientific and logistical elements of the consortium.



Figure 2: Advisory members of the VHD Consortium, featuring well-established and world-renowned international experts.

Trainee council members: Trainee council members are students or postdoctoral fellows from the labs of core members that are taking a leadership role in organizing trainee activities as part of the consortium (**Figure 3**). The council will identify and facilitate opportunities that support trainee learning, including initiating participation of trainees in ongoing consortium projects, supporting collaborative technique exchange, presenting at consortium seminars, and fostering community. The individual biosketches of our trainee council members are available in the **Appendix**.



Figure 3: Members of the trainee council embedded within the VHD Consortium.

VHD Phase I: Seeding a strong foundation for growth (2021-2023)

During the launch phase of the Virtual Human Development Consortium, we have gathered an impressive membership of international experts, built a common vision for Virtual Human Development consortium direction and priorities, and communicated the goals of the consortium on the international stage. These important achievements, summarized in **Figure 4**, lay a solid and necessary foundation for subsequent phases of consortium activity.

(1) Organizing around a central vision

Supported by the Canadian Stem Cell Network, we hosted the **1st Annual Meeting** of the Virtual Human Development Consortium on October 5-6th, 2022 in Vancouver, Canada (hybrid format).

The meeting included discussions around scientific themes:

- Tools for tracking biology across scales
- Theoretical & computational modeling across scales
- Combining *in silico*, *in vitro* and *in vivo* models
- A roadmap to a human embryo simulator

As a group we have identified our target goals and have worked on a **White Paper** (in preparation), in which we outline the mission and approach of the consortium. Subgroups were formed around the preparation of this piece, which continued after the meeting. Concurrently, we have discussed the proposal for this piece with a *Cell Systems* editor, who has invited the submission for their journal once ready.

At the meeting, trainees of the core members formed the **Trainee council**, which self-organized and has formed a meeting schedule and mandates around creating opportunities for training and learning.

(2) Sharing our vision with the community

To share the vision of the consortium, an ongoing virtual **seminar series** started in January 2023. The series, entitled "*Bridging Theory and Experiments (BiTE)*" has served as a platform not only for collaborative knowledge and idea exchange, but also to assist the consortium in evaluating the feasibility of experimental routes and building consensus on strategic direction. Each monthly seminar features presentations from two members of the consortium (including trainees), typically one theoretical and one experimental. These members are paired based on a possibility for intersecting scientific interests or expertise around a developmental window of time,

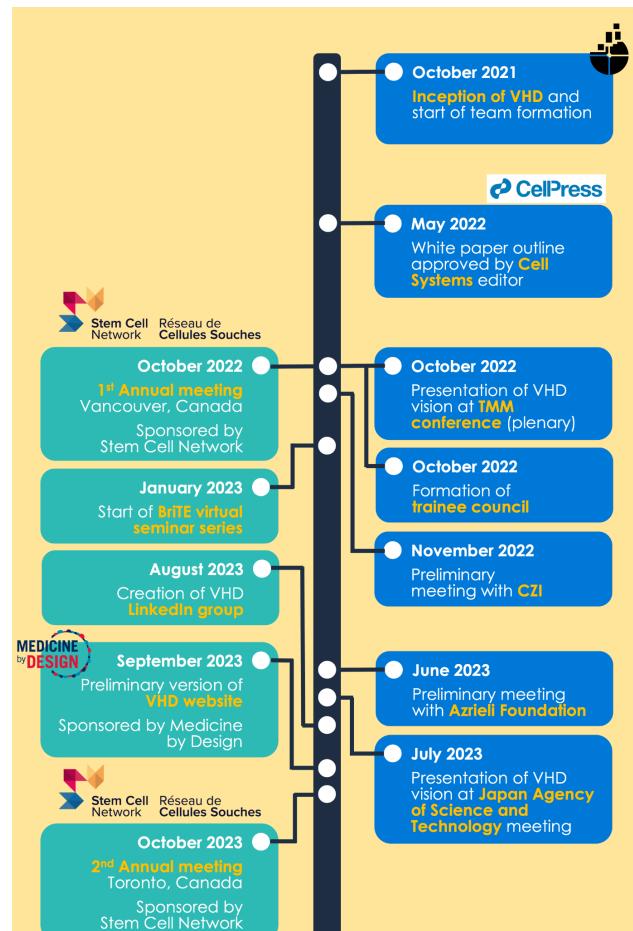


Figure 4: Timeline of progress in Phase I of Virtual Human Development.

cell type, model system, or other concepts. Following presentations, the speakers engage in open discussion with the audience through a question and answer period, moderated by Dr. Maria Abou Chakra (co-founder and core member). To date, 10 speakers have presented. Each meeting is captured visually in a sketchnote, created by Dr. Abou Chakra (**Figure 5**).

We have also presented the launching of the Virtual Human Development Consortium and discussed its vision and mission at the following **scientific conferences and seminars**:

- July 2023, 1st Japan Agency of Science and Technology (JST) International Symposium: "Dynamics of Cellular Interactions in Multicellular Systems" (Kyoto, Japan)
- July 2023, University of Osaka WPI-PRIMe Omnibus Seminar (Osaka, Japan)
- July 2023, ASHBi Workshop: Towards engineering embryonic development (Kyoto, Japan)
- May 2023, University of Alberta Medical Genetics Seminar (Edmonton, Canada)
- May 2023, Stem Cell Network Early Career Researcher Symposium (Montreal, Canada), "Cellular inequality in cell fate programming and development"
- April 2023, Allen Frontiers Symposium (Seattle, USA), Fueling Connection session,
- April 2023, Lund Stem Cell Center 20th Anniversary Conference (Lund, Sweden), Stem Cells & Their Niches session
- March 2023, WG Miniseminar, <https://www.youtube.com/watch?v=7JawkSpH1XY>
- October 2022, Till and McCulloch Meetings (Vancouver, Canada)

Recently, we have also established our presence online:

- **Website** under development (sponsored by Medicine by Design): <http://virtualhumandevlopment.org/>
- **LinkedIn** group: <https://www.linkedin.com/company/virtual-human-development/>
- **Twitter/X** account: https://twitter.com/VHD_Consortium

(3) Catalyzing organically forming collaborative clusters within the consortium

The consortium identified early human embryonic development as a strategic starting point. Further, as this stage in development involves relatively few cells with relatively simple spatial complexity and cell fate heterogeneity, it presents a suitable starting point.

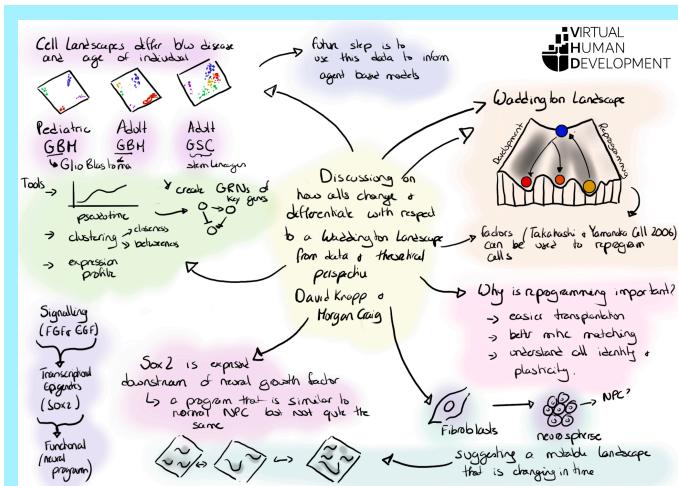


Figure 5: Sketchnote from the February 22, 2023 BriTe Seminar. Speakers: Morgan Craig and David Knapp. Theme: Waddington landscape.

ting point for creating our *in silico* model, which can be seeded using both *in vitro* and *in vivo* embryonic datasets. As a result, collaborations have organically started to emerge among our members (**Figure 6**). These serve as starting points for building momentum, since they are projects for which funding has already been secured. By cataloguing these collaborations and through discussions with core members, we have identified target areas of expertise around which we can focus the initial scientific short term goals of the consortium.

We have categorized the priorities of our 5-year plan into two areas that described critical types of scientific activity for reaching our goals:

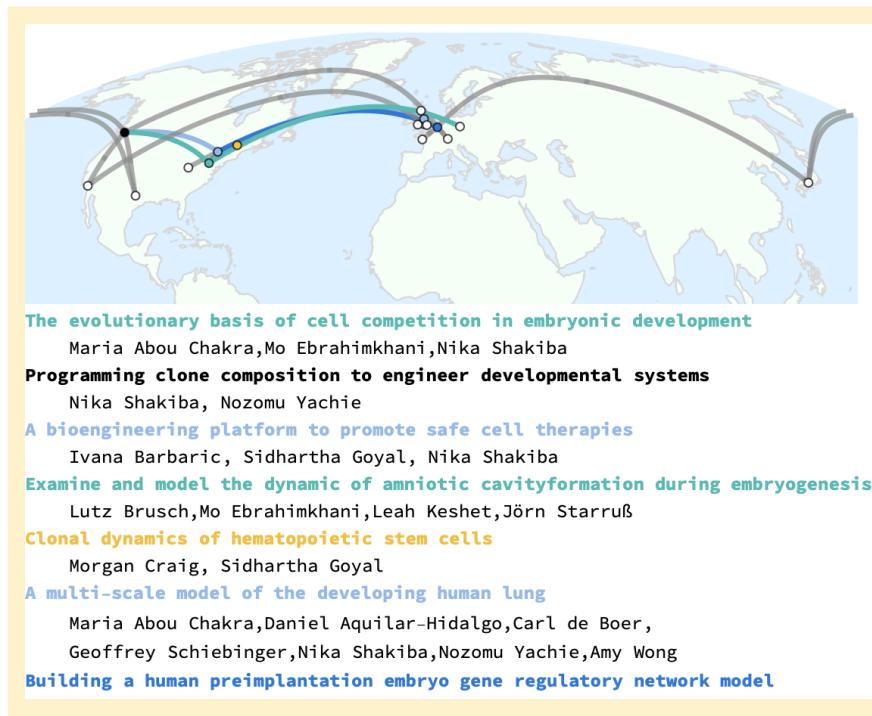


Figure 6: Highlighted collaborations between core members.

Foundational pieces include the development of underlying frameworks needed to enable the human development simulator, including data management, standardization of semantics across experimental datasets and theoretical models, and devising a modeling platform on which the simulator is built.

Developmental windows involve segments of time along human embryonic development around which milestones can be set and progress can be tracked towards the goal of developing our simulator. We define the developing embryo as a system that can be captured on two axes: (1) *time*, given that the embryo is a dynamic system; and (2) *biological scale*, since the embryo involves information flow that connects the genetic networks embedded in cells to their behaviours of single cells, as well as the emergent structure and function of the tissues and organs that they compose. The regions of this two-dimensional plane represent transverse themes around which we can set milestones and goals on route to our mission.

VHD Phase II: Building on momentum (2023-2028)

The next phase of the Virtual Human Development Consortium will implement short- and medium-term goals within a 5-year plan that will ensure momentum towards our defined scientific deliverables, operations and governance. Realizing these short and medium-term goals will establish an organization framework and research outputs that will ensure longevity of our collective vision and ultimately the delivery of our long-term goals. We will pursue three immediate scientific priorities (**Table 1**) and 3 immediate governance priorities (**Table 2**), detailed below.

Scientific progress towards the human development simulator

As a group we identified three immediate scientific priorities. To support the progression of our priority areas, we will pursue operating funding to enable the continued pursuit of our scientific aims across geographical boundaries (see **Table 1**). In strategically filling these outlined funding gaps, we will report our scientific progress in peer-reviewed literature, which align with our mandate for open-access science and serve as a reporting mechanism to transparently track our progress.

Scientific Priority 1

Predicting cell fate from cell state [foundational]

We will create a gene regulatory network (GRN) that captures the interconnected network of 20,000 genes in the human genome. This GRN will be able to capture the dynamic cell state during cell fate transitions as embryonic cells make lineage commitments.

Scientific Priority 2

Building a multi-scale model of the early embryo [developmental window]

We will create a database of spatial transcriptomics, lineage tracing, and live cell imaging and develop a simulator of early embryonic development, spanning the zygote to pre-implantation development.

Scientific Priority 3

Developing a standardized framework for connecting models and experimental datasets to one another [foundational]

We will develop a framework that allows for expansion of the simulation at all scales and times in biology. Our framework will allow for the evolvability of our simulation and allow for other members of the community to contribute to its growth.

Scientific Priorities			Metric of Success			
Priority 1: Predicting cell fate from cell state			The outcome of this priority will be a complete GRN and a model that can capture the single-cell transcriptome of cells as they transition across cell states of the early embryo.			
Maria Abou Chakra Gary Bader Carl de Boer Laurent David	David Knapp Arvind Mer Vincent Pasque Nika Shakiba	Geoffrey Schiebinger Amy Wong Nozomu Yachie				
1A	Creating a database of existing data on single-cell omics datasets of human embryos [Comp]					
1B	Seeding a universal GRN [Comp]					
1C	Perturb-seq experiments to validate GRN [Exp]					
1D	Use model with GRN to validate cell fate transitions [Comp]					
Priority 2: Building a multi-scale model of the early embryo			The outcome of this priority will be a platform that can be used by all VHD members. It will be deemed successful when current models developed in various labs can be connected and used to address a new problem that is only possible using the new framework.			
Maria Abou Chakra Daniel Aquilar-Hidalgo Cantas Alev Gary Bader Ivana Barbaric	Laurent David Carl de Boer Mo Ebrahimkhani Samer Hussein Arvind Mer	Vincent Pasque Nika Shakiba Knut Woltjen Jun Wu Nozomu Yachie				
2A	Creating a spatial and lineage database on spatial transcriptomics, lineage tracing, and live cell imaging of human embryos and embryo-like models [Comp]					
2B	Creating a 3D agent based model [Comp]					
2C	Creating a bank of engineered human pluripotent stem cells [Exp]					
2D	Using <i>in vitro</i> models of early development [Exp]					
2E	Embedding universal GRN in agent-based model [Comp]					
Priority 3: Developing a standardized framework for connecting models and experimental datasets to one another			The outcome of this priority will be a platform that connects models into one framework.			
Lutz Brusch	James Glazier					
Alexander Fletcher						
3A	Develop an integrator for the inputs/outputs of models [Comp]					
3B	Develop an interpreter between models and experiments [Comp]					
Anticipated 5-year timeline for the pursuit of our scientific priorities						
	1A	1C				
	1B	1D				
	2A					
	2B					
	2C					
	2D	2E				
	3A					
	3B					
2024	2025	2026	2027	2028	2029	

Table 1: Summary of scientific objectives, metric of success, and gaps in operating funds. Lead members on priorities are bolded. The subaims are indicated as experimental [Exp] or computational [Comp].

Related projects with funding acquired

While direct operational funds have not yet been acquired to support the scientific progress towards our vision, we are strategically aligning our plans with ongoing collaborative projects for which members of the team have already acquired funds. We highlight a number of these projects in the **Appendix**.

For example, a recent Sponsored Research Agreement (\$8.2M, 3 years) between several core members of the team and industry partner, **United Therapeutics**, seeks to develop a multi-scale *in silico* model of the developing human lung. As an outcome of this effort, we will produce a universal GRN, capable of capturing changes in cell state as pluripotent stem cells give rise to lung cell types. Additionally, we will embed this GRN into an agent based model of individual cells, overlaying cell cycle as biological time. Thus, the outcomes of this project are expected to dovetail with our scientific priority areas, catalyzing our concurrent progress on modeling early embryonic development. The following VHD members are involved in this collaborative effort: Nozomu Yachie, Nika Shakiba, Carl de Boer, Peter Zandstra, Gary Bader, Maria Abou Chakra, Daniel Aquilar-Hidalgo, and Amy Wong.

Governance: Building an operational and organization structure

As a group, we identified three immediate governance priorities. To support the progression of our priority areas, we will pursue operating funding to enable the continued administrative needs.

Governance Priority 1: Seeking funding

We will seek funding to support our **scientific operations**, as well as ongoing **scientific programming and logistics**, including the maintenance of our website and convening of our annual meetings. We will also pursue funding for **administrative support**, allowing us to maintain our scientific programming (seminar series, quarterly meeting of subgroup members), manage our social media accounts, and to develop a governance structure to manage membership.

Funding will be sought from:

Local sources: universities and institutes

National sources: government funding entities

International sources: not-for-profits, industry partners, and foundations

To maintain the cohesion of our group and facilitate collaborations, we will maintain our regular interactions through the following: **monthly seminar series**, **quarterly subgroup meetings**, and an **annual meeting**.

To promote our group to gain financial support, grow our membership, and advertise our progress to non-members,

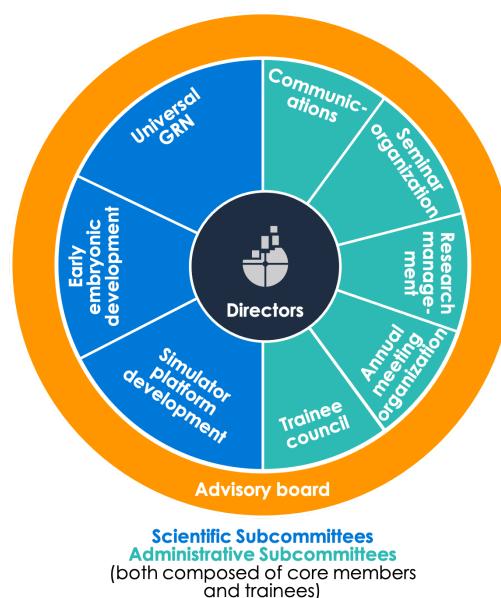


Figure 8: Governance structure of the Virtual Human Development Consortium.



we will maintain our presence on social media platforms as well as our website, featuring our members and their teams, scientific progress and deliverables, as well as upcoming seminars.

Governance Priority 2: Establishing a governance structure

In the next phases of our development, the Virtual Human Development Consortium will create a governance structure (**Figure 8**).

The **Directors** are responsible for making decisions around strategic planning, annual budgets, performance management, and scientific direction, with input from the Advisory Board as well as Scientific and Administrative Subcommittees. Currently, Drs. Nozomu Yachie, Maria Abou Chakra, and Nika Shakiba serve as the **Founding Directors**. Future Directors will be selected by nomination, followed by a democratic vote from the membership.

The **Advisory Board** provides strategic advice around the scientific and administrative priorities of the consortium. This group meets with the Directors biannually to review progress and plans. Additionally, individual members are consulted as needed to request input on specific matters.

The **Scientific Subcommittees** are responsible for progress towards our central mission of creating a simulator of human development. In the absence of centralized funding for VHD projects, these subcommittees form naturally, emerging from networks of collaboration that connect VHD members according to their existing research projects and interests. Once centralized funding for VHD is secured, the subcommittees will be structured such that their mandates map to the scientific priorities of the consortium, with milestones defined by each scientific priority area. Each committee has the mandate of managing its own budget, with funding secured by the Research management committee. They are also required to host quarterly subgroup meetings, reporting on their progress biannually to the Directors through meeting minutes and update meetings. Currently, the following subcommittees have been created:

The **Administrative Subcommittees** are responsible for managing the logistical elements of the consortium. Each subcommittee will host quarterly subgroup meetings, reporting on their progress biannually to the Directors through meeting minutes and update meetings. The Directors will manage efforts across committees to find synergies, fill gaps, and avoid duplicated efforts. The following subcommittees have been created, with mandates specified:

Communications committee: The mandate of this committee is to manage outwards-facing communications for our consortium, including oversight of social media content and website maintenance. Additionally, they will establish an organizational structure that details the use of logos and standard templates for our communications.

Seminar organization: The mandate of this committee is to oversee the organization and planning of the seminar series, including inviting speakers, coordinating with the Communications committee to advertise upcoming seminars, and managing logistics of the virtual seminar via Zoom. The seminar should take place roughly once a month.

Research management committee: The mandate of this committee is to identify opportunities and secure funding to support the operating costs of research towards the scientific priorities of the consortium. They also interface with the Scientific Subcommittees to track their budgets and financial needs.

Annual meeting organization committee: The mandate of this committee is to oversee the organization and planning of the annual consortium meeting, including securing funding, managing the budget, and managing logistics.

Trainee council: The mandate of this committee is to advance trainee participation and training, providing programming and advice on integration of trainees into priority areas of the consortium. An advisory core member will serve on this committee alongside trainee members.

Governance Priority 3: Map a budget and identify resources to perpetuate the consortium

A central piece to ensuring our longevity is the creation of a budget that aligns financial and human resources, projects our usage, and identifies funding gaps. As part of this effort, we will establish a membership structure with clear expectations around categories of membership that allow us to delineate members who are actively engaged in developing the human development simulator from those who interact with our scientific programming but are not active participants in the scientific priorities. These core members will feed into our budget and contribute to acquiring further external funding. The two tiers of membership are described below:

Core members:

Expectations:

- Actively engaged in developing the human development simulator
- Commit research funds to the consortium scientific priority areas
- Participate in our Scientific and Administrative Subgroups

Resources accessed:

- Travel and accommodation support to attend annual meetings
- Featured biosketch on our website and social media platforms
- Trainees from their team are eligible to participate in programming developed by the Trainee council to support professional and scientific development
- Access to scientific programming, such as virtual seminars, via our mailing list

General members:

Resources accessed:

- Access to scientific programming, such as virtual seminars, via our mailing list

Governance Priorities	
Priority 1: Establishing a governance structure	
Directors	
	Founding Directors: Nozomu Yachie, Maria Abou Chakra, and Nika Shakiba Future Directors will be voted in
Advisory Board	
	Provides strategic advice around the scientific and administrative priorities of the consortium.
Scientific subcommittees	
	Responsible for progress towards our central mission
	Universal GRN (Scientific Priority 1, see page 16) Early embryonic development (Scientific Priority 2, see page 17) Simulator platform development (Scientific Priority 3, see page 18)
Administrative subcommittees	
	<p>Communications: Maria Abou Chakra, Nozomu Yachie, Nika Shakiba Seminar organization: Maria Abou Chakra Research management: TBD Annual meeting organization: Miki Ebisuya, Ruben Perez-Carrasco, Mo Ebrahimkhani Trainee council members: Mia Brunetti, Harry Cheng, Yeganeh Dorri, Matthieu Heitz, Arvind Mer (advisor)</p> <p>2023 2024 2025</p> <p>Legend: Annual Meeting (blue square), Seminars (teal bar), Media Communication (blue square), Organization (orange square)</p>
Priority 2: Seeking funding	
Establish legal agreements/status that would enable the consortium to receive and manage funds	
Identifying funding opportunities at the local, national and international levels	
Forming subcommittees to develop targeted applications for each opportunity, aligning with the needs of the budget	
Priority 3: Map a budget and identify financial/human resources to perpetuate the consortium	
Establish a membership structure in consultation with team and with advisory input	
Develop a budget around existing human/financial resources, identifying further gaps requiring funding	

Table 2: Summary of governance priorities.

The road ahead: long-term plan

In the long term, we seek to implement the human development simulator as an **open-source platform** that teams around the world can access, contributing datasets and models as modules in the simulator.

We also seek to leverage the predictive power of the model towards **translational goals**, such as improving the robustness of commercial bioprocesses for deriving stem cell-derived cell and tissue therapies. We will also explore opportunities to refine the model to address specific health/disease or economic needs.

Appendix

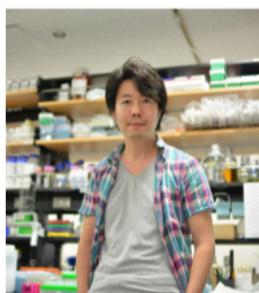
Member biosketches



Nika Shakiba

Nika is an Assistant Professor in the School of Biomedical Engineering at the University of British Columbia. Shakiba's group applies a combined systems and synthetic biology approach to reverse- and forward-engineer the competitive interactions between cells in developmental systems. Nika has unique expertise at the intersection of stem cells, mathematical modeling, and synthetic biology. She has served as a leading node for interdisciplinary collaboration with stem cell and developmental biologists, biophysicists, engineers, and mathematical biologists.

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Nozomu Yachie

Nozomu is an Associate Professor and Canada Research Chair (Tier 2) in Synthetic Biology in the School of Biomedical Engineering at the University of British Columbia. Yachie's group has focused on the development of "DNA event recording" technologies, by which high-resolution molecular and cellular information of individual cells in a multicellular organism can be progressively stored in cell-embedded synthetic "DNA tapes." Harnessing genome editing, cell engineering, mouse genetics, and high-performance computing, his research team aims to establish "Sense," "Write," "Store," and "Read" technologies for the high-resolution reconstruction of molecular and cellular dynamics in animal development.

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Maria Abou Chakra

Maria is a Senior Research Associate at the University of Toronto. She is a theoretical biologist with a focus on complex biological phenomena. She has broad expertise in developing multiscale mathematical and computational models in the fields of evolutionary biology, behavioural ecology, theoretical morphology, and cell development. During her graduate degree she developed a mathematical model that predicted both growth and form of sea urchin skeletons. After graduating she worked at the Max Planck Institute for Evolutionary Biology, where she gained expertise in evolutionary game theory and developed various models that capture behaviors in complex social dilemmas such as Climate Change negotiations and Host parasite interactions. Currently she has applied her expertise to cell development and produced a 3D model that can explore and predict cell diversification in a developing tissue.

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<https://www.linkedin.com/in/maria-abou-chakra-31834a4a/>



Daniel Aguilar-Hidalgo

Daniel is a Research Associate in the Stem Cell Bioengineering Lab led by Peter Zandstra at the School of Biomedical Engineering in the University of British Columbia. A physicist by training, Daniel did their postdoc at the Max Planck Institute for the Physics of Complex Systems where they studied growth control mechanisms in developmental systems and how this relates to morphogen transport properties and critical behaviour. Daniel's current research aims to understand self-organized fate control in cell populations to advance both our understanding of developmental processes and to create complex tissues with regenerative engineering.

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[@emergentcell](https://twitter.com/emergentcell)
[@googlescholar](https://scholar.google.com/citations?user=HgkzQAAJAAQ&hl=en)
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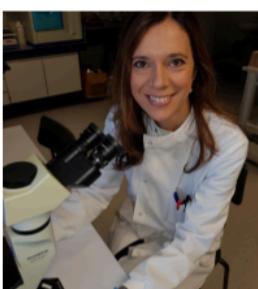
Ruth Baker



Ruth is Professor of Applied Mathematics at the University of Oxford. Her group focuses on developing and applying new mathematical, computational and statistical techniques for investigating a variety of problems in cell and developmental biology. Recent work has considered the mechanisms by which cell motility is influenced in the presence of electric fields, and how cellular heterogeneity and self-generated chemotaxis gradients lead to collective cell motility and long-distance invasion in the developing embryo.



Ivana Barbaric



Ivana is a Professor of Stem Cell Biology at the University of Sheffield, UK. Her research is focused on the basic biology of human pluripotent stem cells (hPSCs) and their applications in regenerative medicine and disease modelling. In particular, her group is investigating the causes and consequences of aneuploidy in stem cells, including the impact of aneuploidy on stem cell fate decisions and lineage specification during early development. Her work on culture-acquired genetic changes in hPSCs is also informing strategies for reliable detection and minimising the occurrence of genetically variant cells, necessary for safe and efficient clinical translation of hPSC-based therapies. She is a member of the Steering Committee of the International Stem Cell Initiative, a Board member of the British Society for Cell and Gene therapy, a lead for the genetic stability of stem cells within the UK Regenerative Medicine Platform and a member of the ISSCR Task Force on Standards for Stem Cell Research, co-chairing the Working Group on Genomic Characterization



Guillaume Blin

Guillaume is a lecturer in stem cell biology at the University of Edinburgh. Guillaume obtained his PhD from the University of Montpellier in France where he studied stem cell biology and regenerative medicine of the infarcted heart. He then moved to the Lowell lab in 2012, in Edinburgh. There he obtained a Sir Henry Wellcome postdoctoral fellowship. This allowed him to develop imaging and microfabrication techniques to understand how cells organise in 3D space during development. Guillaume started his lab in 2019 in the Center for Regenerative Medicine in Edinburgh where his group aims to understand the molecular, cellular and physical principles that drive the emergence of the progenitors of the spine.

Publications: <https://www.research.ed.ac.uk/en/persons/guillaume-blin/publications/>



Lutz Brusch

Lutz is a research group leader at Technische Universität Dresden, Germany, and is heading the development of Morpheus (<https://Morpheus.gitlab.io>). Morpheus is a widely used open-source modeling and simulation framework for the study of multi-scale and multicellular systems, with a public model repository (<https://Morpheus.gitlab.io/model>). The team also develops modeling languages and concepts to facilitate collaborative modeling and standardized model exchange following the FAIR principles (<https://MultiCellML.org>). They co-develop the advanced parameter estimation software FitMultiCell (<https://FitMultiCell.gitlab.io>) and apply it in close collaborations with experimentalists to mechanistic models of spatio-temporal patterning processes in tissues for unraveling the underlying regulatory principles. Lutz did his PhD in physics at the Max Planck Institute for the Physics of Complex Systems in Dresden, Germany and, as a postdoc, worked at the Centre de Bioingénierie Gilbert Durand in Toulouse, France and the Riken Omics Science Center in Yokohama, Japan. He was awarded the Otto Hahn Medal by the Max Planck Society.



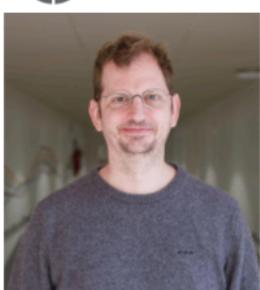
Morgan Craig



Morgan is a Researcher at the Sainte-Justine University Hospital Research Centre and an Assistant Professor in the Department of Mathematics and Statistics at the University of Montréal. The Quantitative and Translational Medicine Laboratory that she runs focuses on the application and implementation of quantitative approaches, particularly computational biology, to study how heterogeneity impacts on disease and treatment outcomes. Her research focuses on the development of predictive, mechanistic models in a variety of disease contexts to identify pathophysiological mechanisms and tailor therapeutic regimens according to patient-specific characteristics. Recent work has focused on hematopoietic stem cell dynamics in health and disease, and the influence of cell-to-cell crosstalk on hematopoiesis and immunogenesis.



Laurent David



Laurent is an Associate Professor in the Med School of Nantes Universités (France). As a post-doctoral fellow at the University of Toronto, Laurent performed transcriptomic profiling of somatic cell reprogramming followed by siRNA screens to determine regulators of the initiation and maturation phase of reprogramming (in J. Wrana lab, Toronto). Laurent has been recruited as associate professor and director of the iPSC core facility of Nantes (the French biggest core). Laurent's lab is focused on understanding human pre- and post-implantation development in order to improve IVF success rates. To do so, we have generated new stem cell model through reprogramming (induced naive PSC and induced TSC) and established transcriptomic map of molecular event leading to a human mature blastocyst, ready to implant. The next steps of our research is to pursue the understanding of human implantation using blastoid models, extending the mapping of human embryo signatures and perturb human embryo culture conditions. Among our approaches, we are aiming to implement a "virtual embryo" by generating Boolean networks predicting cell fate transitions in the human embryo, in collaboration with Dr Carita Guzilowski (Ecole Centrale Nantes). Of note, we are grateful to be tightly collaborating with Nantes IVF department, the French most active IVF department.

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I love dumplings :)



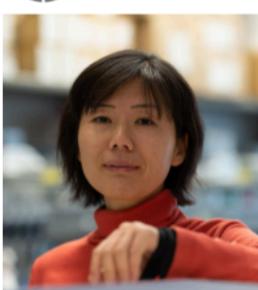
Carl de Boer



Carl is an Assistant Professor in the School of Biomedical Engineering at the University of British Columbia. De Boer's group studies regulation of the genome. A current focus is on developing experimental techniques for measuring how cells interpret regulatory DNA sequences (e.g. promoters and enhancers) in high throughput, using Pluripotent Stem Cells (PSCs) and PSC-derived cells as model systems. De Boer's group also uses Bioinformatic and Machine Learning techniques to learn complex models of gene regulation using high-throughput omics data. An ultimate goal is to learn how every cell type in the human body interprets genomic sequence so that we can better understand how changes in the genomic sequence affect its function and design new DNA sequences with desirable properties.



Miki Ebisuya



Miki is a group leader at the European Molecular Biology Laboratory (EMBL) Barcelona. The research interest of her group is to reconstitute developmental mechanisms in cell culture. She has so far created synthetic cell differentiation, synthetic cellular patterning, and synthetic tissue deformation mechanisms. She also uses pluripotent stem cells to recapitulate early human embryonic development, such as the segmentation clock. Currently her group is setting up a stem cell zoo in the lab, expanding the research to multiple mammalian species and studying species-specific developmental time. She is a recipient of the ERC (European Research Council) consolidator grant.



Mo Ebrahimkhani



Mo is an Associate Professor of Pathology and Bioengineering in Division of Experimental Pathology at University of Pittsburgh as well as McGowan Institute for Regenerative Medicine. He performed his postdoctoral training at the Department of Biological Engineering in Massachusetts Institute of Technology (MIT) and was awarded the European Association for Study of Liver Sheila Sherlock fellowship to study organ regeneration. His lab combines synthetic biology, genetic engineering, machine learning algorithms and multicellular systems to "read and write" human organogenesis and develop novel technologies to program these processes. Using this approach, his team has developed genetically encoded human liver tissues. Dr. Ebrahimkhani is the recipient of several research awards including NSF RECODE award, NIH R01s, Mayo Clinic Accelerated Regenerative Medicine Award, New Investigator Award from Arizona Biomedical Research Council as well as Charles E. Kaufman Foundation New Initiative award.



Gonca Erdemci-Tandogan



Gonca is an Assistant Professor in the Department of Physics and Astronomy at Western University. Her research focuses on theoretical and computational biophysics with specific expertise in modelling mechanics of cells and tissues, and viruses. She received her Ph.D. in Physics from the University of California, Riverside, where she studied the physics of self-assembly of virus particles and discovered the role of the genome and membrane during viral assembly. After her Ph.D., she worked as a postdoctoral associate at Syracuse University, investigating the mechanisms underlying tissue and organ formation. Her work resulted in a novel model to define and control material properties of epithelial tissues, which has key implications for embryonic development and disease. She was then a postdoctoral fellow at the University of Toronto, where, in close collaborations with experimentalists, she continued to develop verifiable mathematical models and predictions to study the role of tissue mechanics on various embryonic developmental processes. Based on her contributions to the field she was selected as a Rising Star in Engineering in Health by Columbia University in 2020.



Alexander Fletcher

Alexander is a Lecturer in the School of Mathematics and Statistics and a group leader at the Bateson Centre at the University of Sheffield. His group develops and applies a range of mathematical and computational modelling approaches to understand the formation, dynamics, and evolution of multicellular tissues. Recent applications include the patterning and morphogenesis of epithelia. He is a founding developer of Chaste, a fully tested, open-source software library for multiscale modelling (<https://github.com/chaste>), which has been downloaded >5,000 times by academic and industrial research groups in >50 countries, enabling >150 peer-reviewed scientific papers to date.



Katie Galloway

Katie is the Charles and Hilda Roddey Career Development Professor in Chemical Engineering at MIT. Katie earned her BS in Chemical Engineering from UC Berkeley, PhD in Chemical Engineering at Caltech, and did her postdoc at USC Stem Cell before starting at MIT in the fall of 2019. As a chemical engineer working in molecular systems biology, her research focuses on elucidating the fundamental principles of constructing and integrating synthetic circuitry to drive cellular behaviors. Her team leverages synthetic biology to transform how we understand cellular transitions and engineer cellular therapies. Her research has been featured in Science, Cell Stem Cell, Cell Systems, and Development. She has won multiple fellowships and awards including the NIH Maximizing Investigators' Research Award (MIRA) (R35), NIH F32, and Caltech's Everhart Award.



Sidhartha Goyal



Sidhartha is a physicist working on understanding collective behavior of large heterogeneous populations of cells. His recent work on clonal dynamics in cellular reprogramming and tumor progression addressed long standing questions about competition in such populations. He is best known for his work for the study of bacterial networks and most recently on understanding adaptive immunity in microbes. Sid is an associate professor in the Dept. of Physics and IBME at U Toronto. He got his PhD from Princeton University and his first degree was in Electrical Engineering from the Indian Institute of Technology (IIT-Bombay), India.



Samer Hussein



Samer is an associate professor and researcher at Université Laval and its affiliated Cancer Research Center. Dr. Hussein completed his Ph.D. in Neurological Sciences at McGill University, Montréal, Canada, and his post-doctoral training at the University of Helsinki, Finland, and later at the Lunenfeld-Tanenbaum Research Institute in Toronto, Canada. He has published seminal work in the field of reprogramming demonstrating several key findings on how reprogramming to induced pluripotent stem cells (iPSCs) affects the chromatin state, genetic stability, and gene expression of cells undergoing this process of induced cell fate change. His team now focuses on understanding the molecular underpinnings governing cell fate decision during embryonic stem cell (ESC) differentiation and during the reprogramming process towards iPSCs. They use several bioinformatics and sequencing approaches, such as long read RNA sequencing, and ESC differentiation models, such as human cerebral organoids, to understand the molecular mechanisms and functional interactions of long non-coding RNAs during development and cancer.

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Dagmar Iber



Dagmar is a Professor of Computational Biology at ETH Zurich. Dagmar Iber's group develops data-based, predictive models to understand the spatio-temporal dynamics of signaling networks and the influence of biomechanical constraints. Her group works in close collaborations with experimental laboratories and has established its own experimental laboratory to enable a cycle of model testing and improving. Before joining ETH, she worked at the University of Cambridge and the University of Oxford on B cell immunology and on cell differentiation in the bacterium *Bacillus subtilis*. Her recent work focuses on problems in developmental biology, with a particular focus on mouse organogenesis (limb, lung, kidney, pancreas, central nervous system), and simpler patterning systems to address fundamental questions regarding the organisation of cells in tissues, the control of tissue growth, the timing of developmental processes, and the evolution of biological mechanisms.

Publications: <https://scholar.google.com/citations?user=oL33MEYAAAAJ&hl=en>



Naoki Irie



Naoki is an Associate Professor at the University of Tokyo in the School of Biological Sciences, mainly working in the field of development and evolution. He is also a co-founder of AsiaEvo meeting, and a member of the Science Council of Japan. What are the general rules between ontogeny and phylogeny of animals? International research groups led by him supported that "the developmental hourglass model" stands for vertebrates and echinoderms, rather than the classic idea that the earliest developmental stages retain the most ancestral information (originates from the idea by Ernst Haeckel in the 19th century). He is also seeking for the biological roles of maternal cells which migrate during pregnancy in placental mammals. In addition to previously known roles, such as possible contribution to regeneration and fetal-maternal tolerance, Naoki and his collaborators proposed that maternal cells could be the common factor behind some of the non-inherited, congenital inflammatory diseases, such as biliary atresia.



Adam L. MacLean



Adam is an assistant professor in the Department of Quantitative and Computational Biology at the University of Southern California. The MacLean lab seeks to understand how cell fate decisions regulate organs during development, homeostasis, and cancer. To do so, we develop new mathematical models rooted in dynamical systems theory and new methods for machine learning and statistical inference. These methods draw on recent advances in single-cell measurement technologies and computation for numerical systems biology. Methods and models are tightly integrated with data through close collaborations with experimental laboratories. Our recent work has led to insight into gene expression dynamics during kidney development and stem cell fate decisions underlying hematopoietic lineage specification.



Leonardo Morsut



Leonardo is an Assistant Professor in the department of Stem Cell Biology and Regenerative Medicine at the Keck School of Medicine of USC. He is also co-director of the Center for Integrated Electronics and Biological Organisms (CIEBORG) at the USC Viterbi School of Engineering, where he holds a dual appointment. Morsut is a co-inventor of a new class of synthetic receptors, synthetic Notch (synNotch) receptors, that have far-reaching implications for cell therapies for cancer, autoimmunity, and regenerative medicine. Grounded in synthetic biology, the Morsut Lab at USC uses a blend of protein engineering, stem cell biology, computational modeling, and tissue engineering approaches to drive morphogenetic and developmental trajectories in multicellular mammalian systems.



Saturo Okuda



Dr. Satoru Okuda is an Associate Professor in the Nano Life Science Institute at Kanazawa University. He is a mechanical engineer with an interest in the self-organizing structure formation of living systems, especially the mechanics in 3D multicellular dynamics. His lab has established computational frameworks to simulate 3D multicellular dynamics at single-cell resolution and integrated them with pluripotent stem cell-derived organoid culture, micromechanical testing, and mechanics-based theoretical analysis. With this combined technology, his lab aims to achieve comprehensive, quantitative prediction and highly accurate manipulation of multicellular dynamics.



Sadao Ota



Sadao is a Director of Laboratories of Systems Biology and Medicine (LSBM), an associate professor of Research Center for Advanced Science and Technology at the University of Tokyo, Japan, and a co-founder and CSO of a start-up company, ThinkCyte Inc. Ota's lab is a trans-disciplinary research group in engineering of quantitative life science, with expertise in optical and electrical measurements, microfluidics, material engineering, genomics, and biotechnologies. His group aims to create new physical tools to probe biological structures and realize approaches of networking biological measurement. Applications of interest span from basic biophysical science to healthcare-industrial domains.



Vincent Pasque

Vincent Pasque is a Belgian Associate Professor of Stem Cell and Developmental Biology at the University of Leuven. He specializes in gene regulation, epigenetics, and chromatin dynamics during early human development and pluripotency. He was one of the first researchers in the world to identify chromatin barriers to cell fate changes during cell fate reprogramming and in human naïve pluripotent stem cells, and he demonstrated for the first time that naïve human pluripotent stem cells can model extraembryonic mesoderm cells. Pasque also discovered that mammalian cells can sense the number of X chromosomes they have and adapt X-linked gene dosage by X chromosome-upregulation. His current research focuses on early human embryo development, employing cutting-edge mammalian systems and interdisciplinary methods, including single-cell (multi)omics sequencing, advanced imaging, RNA FISH, computational approaches, CRISPR, pluripotent stem cell models and human embryos. His ultimate goal is to understand the fundamental mechanisms underlying the first weeks of human embryo development and their implications for disease and clinical applications.

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Ruben Perez-Carrasco

Ruben is a lecturer of theoretical systems biology in the department of Life Sciences at Imperial College London. The Perez-Carrasco group focuses on understanding the interplay between timing and precision in cell decision during development at genetic, cellular and tissue level. In order to do so, the group uses analytical and computational tools from stochastic dynamical systems and Bayesian inference. The group collaborates actively with other experimental groups bridging the gap between experimental data and the understanding of the general rules of life. As part of this interdisciplinary approach, the group is also focused in exploring novel dynamical functions encoded in gene regulatory networks by collaborating with synthetic biology labs, building and exploring the limits of artificial genetic circuits with target spatiotemporal patterns of gene expression.



Noemi Picco



Noemi is a lecturer in mathematics at Swansea University. Her research focusses on mathematical modelling of health and disease. She works at the interface between mathematics and biology to develop a range of theoretical and computational tools to describe the dynamical interactions occurring at different spatial and temporal scales. Her models include individual-based models coupled to partial differential equations, as well as population dynamics. Noemi is currently working on a number of applications, including the development of the cerebral cortex, the evolution of the vertebrate brain, the role of tumour ecology in the emergence of drug resistance, and early diagnosis of sepsis. She is also actively working on ways to integrate experimental data into mathematical models in order to quantitatively describe the processes of interest and make testable predictions.



Geoffrey Schiebinger



Geoffrey is an Assistant Professor in the Department of Mathematics, an Associate Member of the School of Biomedical Engineering at the University of British Columbia. Schiebinger's group develops mathematical foundations for biological data analysis, including single cell analysis and trajectory inference. He has recently proposed the "optimal transport hypothesis" as a powerful reformulation of Waddington's classical concept of a developmental landscape, and his group has leveraged this to establish the first rigorous theoretical guarantees for inferring developmental trajectories in the non-equilibrium setting. He is a recipient of the Maud Menten New Principal Investigator Prize in Genetics from CIHR, and a Career Award at the Scientific Interface from the Burroughs Wellcome Fund.



Linus Schumacher

Linus is a research group leader at the Centre for Regenerative Medicine, Institute for Regeneration and Repair, University of Edinburgh. Previously he was a postdoctoral researcher at Imperial College London and the University of Oxford, where he also obtained his DPhil, based at the Wolfson Centre for Mathematical Biology. For his undergraduate degree he read Natural Sciences at the University of Cambridge. He leads a research group modelling interactions between stem cells and the other cells that make up living tissue in development and regeneration.

Publications: <https://scholar.google.co.uk/citations?user=ZWEBq7EAAAJ&hl=en>



Takanori Takebe

Takanori is a Director of Commercial Innovation in Center for Stem Cell & Organoid Medicine (CuSTOM), and Endowed Chair and Associate Professor at Cincinnati Children's Hospital Medical Center. He is also a Professor at the Institute of Research at Tokyo Medical and Dental University (TMDU), and the founding director, Communication Design Center, Yokohama City University, and Principal Investigator at the Takeda-CIRa joint program. The Takebe Lab focused on patient-centered stem cell research, wherein he led a history of innovation for engineering complex hepato-biliary-pancreatic organoids from human stem cells for advancing the study of disease modeling, drug development, and transplantation. He was honored with the Robertson Investigator Award, from the New York Stem Cell Foundation, elected member of The American Society for Clinical Investigation (ASCI), and also on the board of directors for International Society for Stem Cell Research (ISSCR) and The Japanese Society for Regenerative Medicine (JSRM).



Alexandria Volkening

Alexandria Volkening is an Assistant Professor of Mathematics and (by courtesy) Biomedical Engineering at Purdue University. The Volkening group focuses on understanding how cells or other agents come together to create group-level dynamics, particularly in developmental-biology settings. Her research combines predictive, data-driven modeling (including agent-based and continuum perspectives) with novel approaches for quantifying previously qualitative biological data at large scale to better understand variability and plasticity in cellular self-organization.

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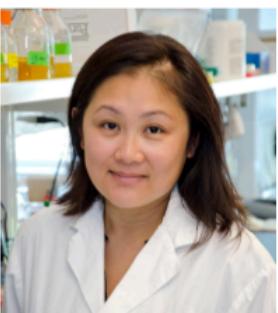
Knut Woltjen

Knut is an Associate Professor in the Department of Life Science Frontiers at the Center for iPS Cell Research and Application (CiRA), Kyoto University, Japan. As a post-doctoral fellow at the University of Toronto, Woltjen employed the *piggyBac* transposon to create the first footprint-free mouse and human induced pluripotent stem cell (iPS) cells. Woltjen's group maintains this theme by developing precision genome and epigenome editing methods in induced pluripotent stem cells to re-write and re-program the human genome. The goal of his research is to understand the underlying genetics of human health, disease, and evolution, and apply this knowledge to develop next-generation gene modified cell therapies.





Amy Wong



Amy is a Scientist in the Program of Developmental & Stem Cell Biology at the Hospital for Sick Children and an Assistant Professor in the Department of Laboratory Medicine and Pathobiology at the University of Toronto. She pioneered the first method to generate mature airway epithelia from human stem cells and is internationally recognized as a pioneer in using human stem cells to model lung development and disease. Her lab uses these iPSC-derived lung models to 1) understand the genetic networks and molecular factors regulating lung cell development and disease mechanisms; 2) test novel therapeutics for precision medicine; 3) create preclinical lung mimetics for disease modeling using "on-chip" platforms.

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Jun Wu



Jun is an assistant professor in the department of molecular biology at UT southwestern medical center. Dr. Wu's work has contributed to the development of novel culture systems and methods that enable the generation of new PSCs for basic and translational studies. Dr. Wu has expanded the spectrum of pluripotent states by capturing mouse PSCs with distinct molecular and phenotypic features from different developmental stages. And some of these culture conditions developed in mice enabled the generation of PSCs from many other mammalian species, including humans, non-human primates and ungulates. In addition, Dr. Wu has developed an efficient and versatile blastocyst complementation system for *in vivo* generation of functional tissues and organs from cultured PSCs, and several blastocyst models (blastoids) based on cultured stem cells. Dr. Wu has won several awards including UT southwestern endowed scholar, CPRIT scholar and NYSCF-Robertson Stem Cell Investigator award.

Trainee council biosketches



Mia Brunetti



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Mia Brunetti is a third-year doctoral student in Applied Mathematics at the University of Montréal, studying under Dr. Morgan Craig. Before that, she received a B.Sc. in Physiology and Mathematics from McGill University. Mia integrates her experimental and computational knowledge to create mathematical models of perturbed hematopoiesis in order to better understand leukemia development while guiding the optimization of its treatments. Mia's current projects examine novel clonal reduction strategies in acute myeloid leukemia, long-term dynamics of imatinib resistance in chronic myeloid leukemia, and the role of histone mutations on clonal hematopoiesis. In her free time, she enjoys painting, gardening, and going on hikes.



Harry Chun Man Cheng



Harry is a research technician in Dr. Nika Shakiba's lab. He completed his master's studies at McGill University. He previously focused on studying myosin X motility and muscle stem cell quiescence. His growing interest in how lineages diverge during differentiation led him to join the Shakiba lab. He is currently working to combine the experimental approach with the computational approach to build a simulator for Embryonic Stem Cells (ESCs) to reliably predict the cell fate trajectory of ESC-derived cells.

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Yeganeh Dorri Nokoorani

Yeganeh is a PhD student in Dr. Nika Shakiba's lab in the school of biomedical engineering at the University of British Columbia. She did her MSc in biomechanics at Sharif University of Technology. Her focus is on human pluripotent stem cells' (hPSCs) expansion and the genetically variants that emerge during this process. She tries to understand the mechanisms driving the emergence of these variants in the expansion process. Her project also aims for defining culture conditions in which the emergence of these variants is limited. Outside the lab, Yeganeh plays the Native American Flute, practices archery and watches movies.

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Matthieu Heitz

Matthieu is a Postdoctoral Fellow in the Mathematics department, at the University of British Columbia. He is working with Geoffrey Schiebinger on building mathematical models of cell development, based on the optimal transport theory. His background is computational, specifically in imaging sciences and computer graphics. He is interested in trajectory inference from time-series of single-cell omics and spatial omics data. Matthieu also works in close collaboration with experimentalists to design new models and technologies for the data they collect.

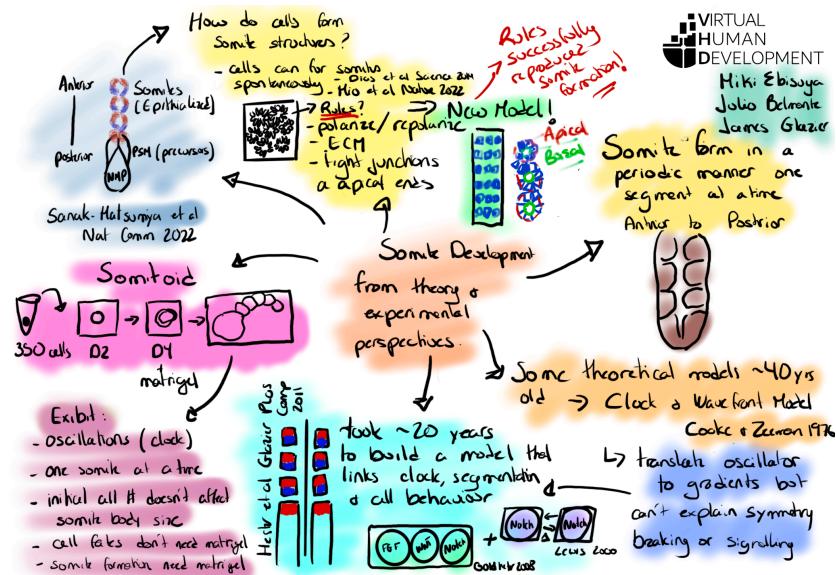
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Spotlight: Bridging theory and experiments (BriTE) virtual seminar series

Date: January 19, 2023

Speakers: Miki Ebisuya and James Glazier

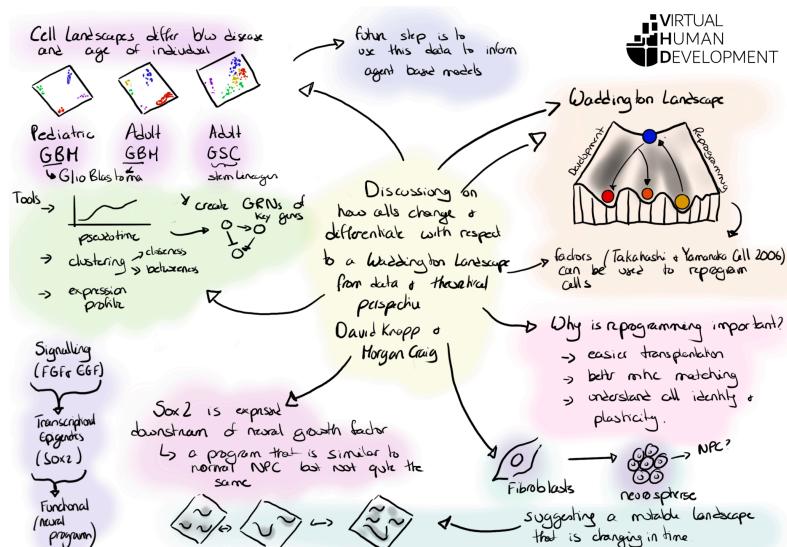
Theme: Somite development



Date: February 22, 2023

Speakers: Morgan Craig and David Knapp

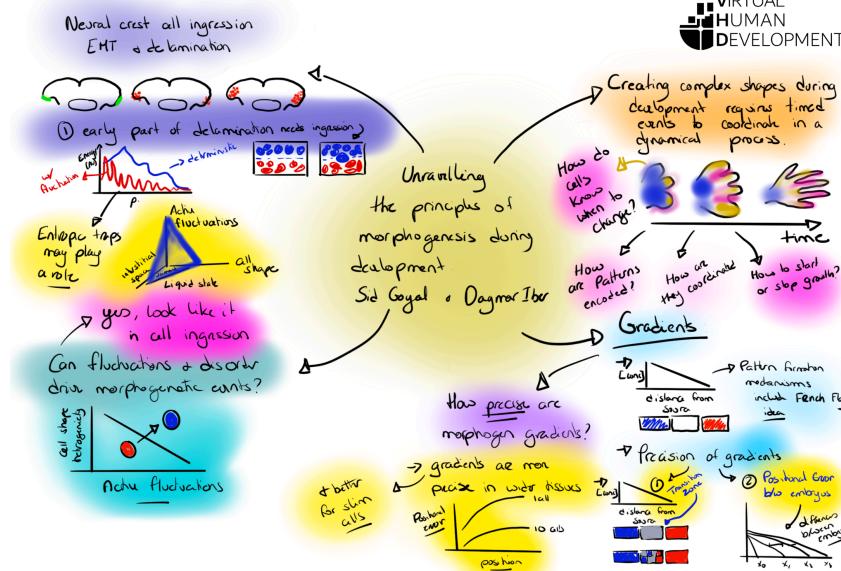
Theme: Waddington landscape



Date: March 20, 2023

Speakers: Sidhartha Goyal and Dagmar Iber

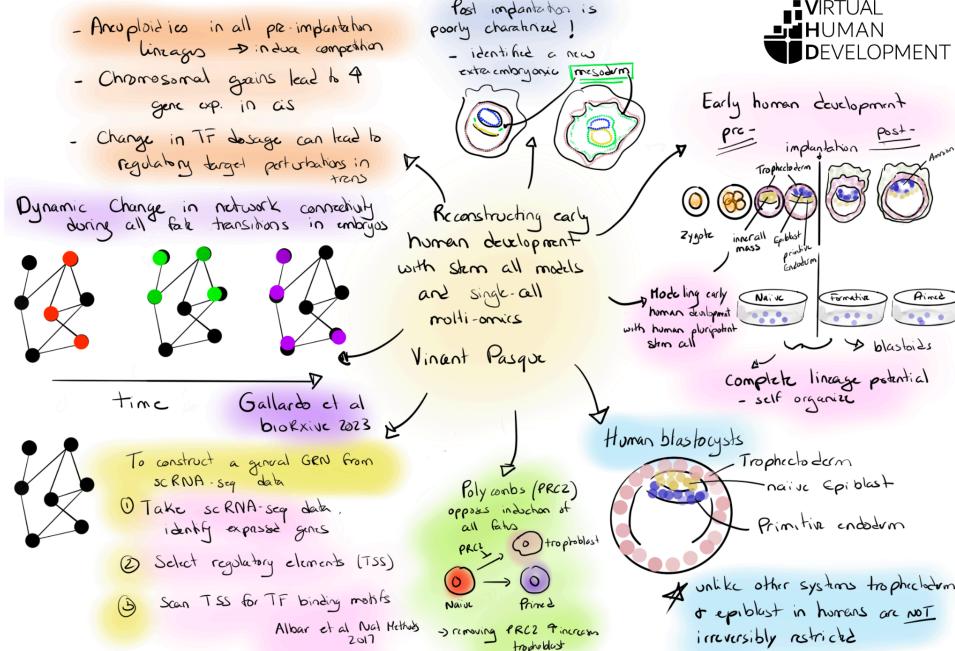
Theme: Morphogenesis



Date: April 17, 2023

Speakers: Maria Abou Chakra and Vincent Pasque

Theme: Early cell lineages of the developing embryo



Related projects with funding acquired

Examples of existing collaborative projects for which members have already acquired funding and which can synergize with efforts of the Virtual Human Development are highlighted below.

Project title	The evolutionary basis of cell competition in embryonic development
VHD members	Maria Abou Chakra Nika Shakiba Mo Ebrahimkhani
Short summary	Using evolutionary game theory, coupled to an in vitro model of human post-implantation development (<i>iDiscoid</i>) to explore the purpose and features of cell elimination in early embryonic development.

Project title	Programming clone composition to engineer developmental systems
VHD members	Nozomu Yachie Nika Shakiba
Short summary	Using CloneSelect DNA barcoding technology to track the contributions of individual clones to better develop designer organoids.

Project title	Deciphering cell competition during iPSC differentiation towards lung epithelia
VHD members	Nika Shakiba Amy Wong
Short summary	Using hPSC generated airway epithelial cell types to identify novel gene targets to selectively enhance cell fitness and enrich specific cell types for targeted cell-based therapies to treat airway diseases.

Project title	Examine and model the dynamic of amniotic cavity formation during embryogenesis
VHD members	Mo Ebrahimkhani Lutz Brusch Jörn Starruß Leah Keshet
Short summary	Using a model of post-implantation human embryo (<i>iDiscoid</i>) we will develop a computational model using parameters that can control location and timing of lumen and cavity formation.

Project title	A bioengineering platform to promote safe cell therapies
VHD members	Ivana Barbaric Nika Shakiba Sidhartha Goyal

Short summary	Using a combination of cell biology, bioengineering and mathematical modelling to suppress the appearance of genetically abnormal human pluripotent stem cells that may be unsafe to use in cell therapy
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Project title	Clonal dynamics of hematopoietic stem cells
VHD members	Morgan Craig Sidhartha Goyal
Short summary	Combining stochastic and deterministic mathematical models to understand clonal dynamics and production kinetics in hematopoietic stem cells during leukemia.

Project title	Building a human preimplantation embryo gene regulatory network model
VHD members	Vincent Pasque Maria Abou Chakra
Short summary	Building an <i>in silico</i> model of the human preimplantation gene regulatory network.

Project title	A multi-scale model of the developing human lung
VHD members	Nozomu Yachie Nika Shakiba Carl de Boer Geoffrey Schiebinger Maria Abou Chakra Daniel Aquilar-Hidalgo Amy Wong In collaboration with United Therapeutics , industry sponsor
Short summary	Building an <i>in silico</i> model of differentiation from a pluripotent to lung cell state.