



Sciences du Vivant - Environnement  
et Développement durable

**CONFÉRENCES  
JACQUES-MONOD**



CONFERENCE REPORT

**“Modeling Cell fate”**

**« *Modélisation du destin cellulaire* »**

**Roscoff, France, November 19-23, 2018**

President: **Laure Bally-Cuif**

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## Introduction

A series of Jacques Monod Conferences centered on Developmental Biology started in 2012 with a Conference on the **“Emergence and Evolution of Developmental patterns”**. The aim of this conference was to bring together established leaders in the fields of Cell, Developmental and Evolutionary Biology, with a perspective in systems biology and mathematical modeling. This CJM brought together three seemingly distinct groups of people, developmental biologists, evolutionary biologists, and physicists. The same three disciplines were brought together in 2015 to discuss the latest advances in developmental biology for a meeting **“Building, repairing and evolving biological tissues”** that was discussing the generation of tissue patterns and shape under normal physiology, as well as in tissue repair and regeneration. Based on the success of this second conference, this third conference was organized about **“Modeling Cell fate”** that pushed even further the multidisciplinary aspects and the introduction of more quantitative approaches and mathematical modelling of developmental processes.

The conference was organized along 5 themes:

- (1) Emerging properties of cell populations
- (2) Cell interactions sculpting tissues
- (3) Physical properties of cells
- (4) Cell lineages in embryos and tissues
- (5) Stochasticity of gene regulation in patterning

## Conference statistics

The program comprised the following presentations:

- 2 plenary lectures by outstanding individuals (1h each), by Geneviève Almouzni and Claudio Stern to open and close the meeting, respectively.
- 27 presentations by invited speakers (25 min + 5 min for questions)
- 5 short presentations selected from the abstracts (12 min + 3 min for questions)
- 10 5min-flash talks to present each of the two poster sessions; the presenters were also selected from the abstracts.

The flash talks were first initiated in 2015 and were designed to allow young scientists to gain experience in public speaking while advertising their poster. The flash talk slots were equally split between PhD students and post-docs.

6 invited/keynote speakers were from outside Europe,  
12 were from Europe outside France, and  
11 were from France.

3 selected speakers were from France and 2 were from Europe outside France.

For invited speakers, the female/male ratio was 15 women and 14 men.

For short talks, it was 3 women and 2 men

Each session was assigned a dedicated chair, chosen among applicants who had not been selected for an oral presentation.

There were two well-attended poster sessions, each lasting 2 hours. In addition, the poster room remained accessible until 22h for additional presentations and discussions. The program also left ample opportunity for informal discussions amongst the participants both at lunchtime and dinner/post-dinner time.

Because of the late season, it was not possible to the Ile de Batz. However, the participants had a free evening when dinner was not provided by the Station. This provided a nice platform for further informal discussions in smaller groups.

Finally, we took advantage of the lack of the visit of the Ile de Batz (Because of the late November season) to have a few talks on the Wednesday afternoon (the evening remained free and no dinner was served by the conference), as to be able to cancel the Friday morning session without decreasing the quality of the meeting. Indeed, the new schedule of Air France flights to CDG that are only in the morning, would not have allowed speakers to catch connecting flights to Europe of the Americas.

## **Scientific program**

The first evening was dedicated to a keynote lecture by Geneviève Almouzni who is the director of the Research part of the Institut Curie in Paris. She gave an overview of her work that elucidated how epigenetic processes contribute to developmental pathways and in particular how histone variants and their chaperones shape cell fate.

### ***Session 1. Emerging properties of cell populations***

Chair: Romain Levayer

In this session, several speakers described how physical processes shape cell fate. **Thomas Lecuit from IBDM in Marseille**, described how cell mechanics plays a critical role for tissue morphogenesis. **Alexander Aulehla from EMBL in Heidelberg** presented his work on the reconstitution of the segmentation clock *ex vivo* and the role of the various waves of signaling factors. **Alain Goriely from Oxford** described his physical modeling of the mechanics of cells and tissues. **Enrico Coen from Norwich**, focused his attention on plants and their particular reliance of mechanical forces to pattern their tissue and the whole plant. **Teva Vernoux from Lyon** who is also working on plants described how cell memories act for rhythmic organogenesis. **Andy Oates from Lausanne** described his work on biological clocks and in particular the segmentation clock that patterns the axis of vertebrates. **Thomas Gregor from the Institut Pasteur and Princeton**, described his quantitative deciphering of the gene regulatory networks that control the development of the early embryo. Finally, a short talk by **Christine Pujades from Barcelona** described forces that act in the development of the mammalian brain.

This session was completed by a set of excellent flash-talks by students and post-docs, on subjects related to poster session #1.

### ***Session 2. Cell interactions sculpting tissues***

Chair: Fisun Hamaratoglu

In this session, speakers discussed the emergent properties that arise when tissues coordinate their activities. **Bill Keyes from LGBMC in Illkirch** described his work on the molecular mechanisms regulating cellular senescence during embryonic development and during tissue regeneration and aging, but also during tumor formation. **Laura Johnston from Columbia** talked about cell competition and how cells compare their fitness during growth. **Jody Rosenblatt from U. of Utah** described how cells that gets extruded from epithelia in tumors become potentially metastatic after epithelial to mesenchymal transition. **Jean-Paul Vincent from the Crick Institute** and the former chair of this meeting discussed the various signaling pathways that shape the development of epithelium in the context of the *Drosophila* wing imaginal disc. **François Schweisguth from the Institut Pasteur** continued

the theme of *Drosophila* and how the Notch pathway patterns the sensory hairs of the dorsal notum. Finally, a short talk by **Vilaiwan Fernandes from University College London** presented her work as a young investigator on the glial signal that mediates neuronal specification in the context of the *Drosophila* visual system.

### **Session 3. Physical properties of cells**

Chair: Anne Schmidt

In this session, speakers described how physical forces exerted on cells can shape their function and morphogenesis. **Florence Besse from Nice**, talked about the role of RNA granules during neural development and what their potential function might be in controlling the translation or storing mRNAs. **Catherine Rabouille from Utrecht** was the first to discuss the role of nutrition and in particular amino-acid starvation in *Drosophila* that leads to the formation of stress granules. **Pat O'Farrell from UC San Francisco**, presented a fairly theoretical talk on the very early genomic events that take place during embryonic development. **Julien Vermot from the LGBC** had his lecture supported by an EMBO Young Investigator Lecture. He described the contribution of cell and tissue mechanics during vascular morphogenesis and in particular how hemodynamics controls the formation of these vessels. In the final talk, **Ewa Paluch from University College London** is a physicist who studies how a cross-talk between mechanics, including the shape of embryonic stem cells, controls their fate.

### **Session 4. Cell lineages in embryos and tissues**

Chair: Anne-Marie Pret

This session provided specific insights into the contribution of cell lineage in the formation of different organs, in particular the brain, but also in tumor formation that are often clonal. **Dominique Bergmann from Stanford** and a leader in the field of plant morphogenesis presented the development of stomata and how asymmetries can be generated during leaf development. A talk by **Jean Livet from the Institut de la Vision in Paris** described his work using sophisticated imaging approaches to study the clonal organization of the vertebrate central nervous system. **Magdalena Zernicka-Goetz from the University of Cambridge** had an emergency and could not give her talk on the very early events in mammalian embryonic development and the formation of the first asymmetries. **Allison Bardin from the Institut Curie** continued the theme of lineages using the *Drosophila* gut as a model system and their alteration by the Notch pathway. **Benjamin Simons from the University of Cambridge** is the sought-after specialist of modeling cell lineages, and in this case, he talked about lineages during spermatogenesis and the role of a niche in the maintenance of stem cells. **Claude Desplan from NYU**, the co-chair of this meeting, discussed the powerful model system represented by the highly deterministic lineage-based patterning of the *Drosophila* optic lobes, and how temporal and spatial patterning produce the huge neuronal diversity observed in this brain structure. **Michèle Crozatier from Toulouse** studied lineages during *Drosophila* hematopoiesis and how this is controlled by the niche. Finally, **Laure Bally-Cuif from the Institut Pasteur** and the chair of this meeting talked about adult neurogenesis in the context of the zebrafish brain and how several population of stem cells are maintained in the adult.

### **Session 5. Stochasticity of gene regulation in patterning**

Chair: Robert Kelsh

This session provided a general update on the stochastic mechanisms that are involved in development and in particular the effects of noisy transcription and its eventual cooptation to

generate novel patterns. **Frank Jülicher from MPI in Dresden** is a physicist who was able to define a critical point during the growth of tissue to attain the correct size and body symmetries. Continuing on her long dedication to studying the Notch pathway, **Sarah Bray from the University of Cambridge**, attempted to define a code in the response to the Notch pathway, a system that drew parallels with the earlier talk by Francois Schweisgut.

Decoding the Notch response theme of elimination of unfit cells, **Cédric Maurange from IBDM in Marseille**, focused on RNA-binding proteins known for their role in patterning the nervous system of flies and how they are re-utilized during tumor growth. **Ryoichiro Kageyama from Kyoto University** described his reconstituted system in which the Hes transcription factors than can produce cell-autonomous synchronized oscillations that are present in the somitic segmentation clock.

This session was completed by another set of excellent flash-talks by students and post-docs, on subjects related to poster session #2.

## **General comments**

There were 99 participants to the Conference, including an almost equal representation of Principal Investigators, post-docs and research associates/PhD students. Selected applicants originated from multiple different European Countries, USA, and Japan. The overall quality of the talks was outstanding, and each presentation was followed by a large number of questions that led to stimulating discussions, which often had to be interrupted to remain on schedule. All 5 oral sessions and 2 poster sessions were very well attended, to a large extent due to the geography of Roscoff as a venue. Its cozy and small size was integral to the very interactive atmosphere that prevailed during the meeting, fostering extensive informal scientific exchanges. The success of the conference could be judged from the request by most participants, during the final discussion session, that another meeting be held in 2021. The chairs and co-chairs received a significant number of messages conveying the happiness of the participants and the desire to return in three years. The growing participation to this meeting, the emphasis on systems-level study of development all justify the future organization of another version of this conference and its maintenance every 3 years beyond this. Claude Desplan, who was the vice-chair of this conference will chair the 2021 conference, pending approval by the CNRS. Allison Bardin from the Institut Curie was co-opted by consensus to be the co-chair of the 2021 conference and hopefully the chair of the 2024 incarnation.

## **Final program of the conference**

**Monday, November 19**

*Lundi 19 novembre*

**21:00-21:15**      **Opening and Welcome - *Accueil et annonces***

**21:15-22:15**      **Geneviève Almouzni (*Paris, France*) *Keynote I***

Chromatin plasticity and cell fate: histone variants and chaperones at work

*Plasticité chromatinienne et destin cellulaire : rôle des variants d'histones et des chaperones*

***Mardi 20 novembre***

Tuesday, November 20

## **Session I: Emerging properties of cell populations**

Propriétés émergentes des populations cellulaires

**Chairperson / Modérateur : Romain Levayer**

**08:45-09:15**     **Thomas Lecuit** (*Marseille, France*)

Control and self-organization of cell mechanics during tissue morphogenesis  
*Contrôle et auto-organisation de la mécanique cellulaire pendant la morphogenèse des tissus*

**09:15-09:45**     **Alexander Aulehla** (*Heidelberg, Germany*)

The role of collective signalling oscillations during embryonic patterning  
*Rôle des oscillations collectives de facteurs signalisateurs au cours du patterning embryonnaire*

**09:45-10:15**     **Alain Goriely** (*Oxford, United Kingdom*)

Understanding neuromechanics: from cells to tissue  
*Comprendre la neuromécanique : des cellules au tissu*

**10:15-10:45**     **Coffee break - Pause café**

**10:45-11:15**     **Enrico Coen** (*Norwich, United Kingdom*)

Resolving conflicts: the genetic control of plant morphogenesis  
*Résoudre les conflits : contrôle génétique de la morphogenèse des plantes*

**11:15-11:30**     **Teva Vernoux** (*Lyon, France*)

Tissue and cell memories are essential for rhythmic organogenesis in plants  
*Mémoires cellulaire et tissulaire sont essentielles à l'organogenèse rythmique chez les plantes*

**11:30-12:00**     **Andy Oates** (*Lausanne, Switzerland*)

On timers and clocks in development  
*Chronomètres et horloges au cours du développement*

**12:00-12:30**     **Flash talks:** *Nicolas Haupaix / Christine Ho / Keisuke Ishihara / Marco Kopic / Léo Valon*

**13:00-14:15**     **Lunch at the Conference Centre (Gulf Stream Hotel)**  
Déjeuner au Centre de Conférence (Hôtel Gulf Stream)

**14:30-16:30**     **POSTER SESSION I (CNRS-Hotel de France building)**  
**Communications par affiches (Bâtiment CNRS-Hôtel de France)**

**16:30-17:00**     **Thomas Gregor** (*Institut Pasteur, France and Princeton, USA*)

Optimal decoding of cellular identities in a genetic network  
*Décodage optimal des identités cellulaires dans un réseau génique*

**17:00-17:15**     **Cristina Pujades** (*Barcelona, Spain*)

Transduction of mechanical signals into specific cell decisions during brain morphogenesis  
*Transduction des signaux mécaniques en décisions cellulaires spécifiques pendant la morphogenèse du cerveau*

**17:15-17:45**     **Break - Pause**

**Session II: Cell interactions sculpting tissues**

Interactions cellulaires sculptant les tissus

**Chairperson / Modérateur : Fisun Hamaratoglu**

**17:45-18:15**     **Bill Keyes** (*Illkirch, France*)

Normal and pathological functions of cell senescence in development and regeneration *Fonctions normales et pathologiques de la sénescence au cours du développement et de la régénération*

**18:15-18:45**     **Laura Johnston** (*New York, USA*)

Tissue ecology: sensing and responding to differences in cellular fitness during growth  
*Ecologie tissulaire : sentir et répondre aux différences de « fitness » cellulaire pendant la croissance*

**18:45-19:15**     **Jody Rosenblatt** (*Salt Lake City, USA*)

How epithelial cell extrusion gets hijacked to instead drive EMT  
*Comment l'extrusion de cellules épithéliales peut être détournée pour conduire à une transition épithélio-mésenchymateuse*

**19:30-21:00**     **Dinner at the Conference Centre (Gulf Stream Hotel)**

*Dîner au Centre de Conférence (Hôtel Gulf Stream)*

Wednesday, November 21  
***Mercredi 21 novembre***

## **Session II (continued): Cell interactions sculpting tissues**

Interactions cellulaires sculptant les tissus

**Chairperson / Modérateur : Fisun Hamaratoglu**

**08:45-09:15**     **Jean-Paul Vincent** (*London, United Kingdom*)

Establishment of signalling landscapes in a developing epithelium  
*Contrôle spatial de la signalisation dans un épithélium en développement*

**09:15-09:45**     **François Schweisguth** (*Paris, France*)

Patterning of sensory organs in *Drosophila*  
*Patterning des organes sensoriels chez la drosophile*

**09:45-10:00**     **Vilaiwan Fernandes** (*London, United Kingdom*)

Glia relay differentiation cues to coordinate neuronal development  
*Les cellules gliales relayent des informations de différenciation pour coordonner le développement neuronal*

**10:00-10:30**     **Coffee break - Pause café**

## **Session III: Physical properties of cells**

Propriétés physiques des cellules

**Chairperson / Modérateur : Anne Schmidt**

**10:30-11:00**     **Florence Besse** (*Nice, France*)

Regulating neuronal RNP granules in space and time  
*Réguler les granules de ribonucléoprotéines dans l'espace et dans le temps*

**11:00-11:30 Catherine Rabouille** (*Utrecht, The Netherlands*)  
Stress assemblies in Drosophila by amino-acid starvation  
*Assemblages structuraux dus au stress par manque d'acides aminés chez la drosophile*

**11:30-12:00 Pat O'Farrell** (*San Francisco, USA*)  
Initial events in the differentiation of the genome  
*Premiers événements dans la différenciation du génome*

**12:00-12:30 Julien Vermot** (*Illkirch, France*) *The EMBO Young Investigator Lecture*  
Contribution of cell and tissue mechanics in response to hemodynamics during vascular morphogenesis  
*Contribution de la mécanique des cellules et tissus en réponse aux forces hémodynamiques pendant la morphogénèse vasculaire*

**13:00-14:15 Lunch at the Conference Centre (Gulf Stream Hotel)**  
*Déjeuner au Centre de Conférence (Hôtel Gulf Stream)*

**14:30-15:00 Ewa Paluch** (*London, United Kingdom*)  
Cross-talk between cell mechanics, shape and fate in embryonic stem cells  
*Interactions entre la mécanique, la forme et le devenir cellulaires dans les cellules souches embryonnaire*

## **Session IV: Cell lineages in embryos and tissues**

Lignages cellulaires dans l'embryon et les tissus

**Chairperson / Modérateur : Anne-Marie Pret**

**15:00-15:30 Dominique Bergmann** (*Stanford, USA*)  
Making a difference: asymmetries in plant cell and organ development  
*Faire la différence : asymétries lors du développement de la cellule et de l'organe chez les plantes*

**15:30-15:45 Jean Livet** (*Paris, France*)  
Analysis of the clonal architecture of the vertebrate central nervous system with improved combinatorial labeling and imaging approaches  
*Analyse de l'architecture clonale du système nerveux central chez les vertébrés à l'aide d'une combinaison optimisée de méthodes de marquage et d'imagerie*

**15:45-16:15 Magdalena Zernicka-Goetz** (*Cambridge, United Kingdom*)  
*This talk was cancelled due to an emergency for the speaker*

**16:15-16:45 Coffee break - Pause café**

**16:45-17:15 Allison Bardin** (*Paris, France*)  
Mutational alteration of stem cell lineages  
*Altérations par mutation dans les lignages souches*

**17:15-17:45 Benjamin Simons** (*Cambridge, UK*)  
Spermatogenesis: Stem cell maintenance in a facultative niche  
*Spermatogénèse : maintien des cellules souches dans une niche alternative*



**17:45-18:15**     **Claude Desplan** (*New York, USA*)  
The generation of neuronal diversity  
*Génération de la diversité neuronale*

**19:00-21:00**     **Free evening and dinner**  
*Dîner libre*

Thursday, November 22  
***Jeudi 22 novembre***

**Session IV (continued): Cell lineages in embryos and tissues**

Lignages cellulaires dans l'embryon et les tissus

**Chairperson / Modérateur : Anne-Marie Pret**

**08:45-09:15**     **Michèle Crozatier** (*Toulouse, France*)  
Control of *Drosophila* hematopoiesis: deciphering the role of the microenvironment  
*Contrôle de l'hématopoïèse chez la drosophile : rôle du micro-environnement*

**09:15-09:45**     **Laure Bally-Cuif** (*Paris, France*)  
Single cell and population mechanisms of adult neural stem cell maintenance  
*Maintien des cellules souches neurales adultes : contrôles à l'échelle de la cellule unique et de la population*

**Session V: Stochasticity of gene regulation in patterning**

Stochasticité de la régulation d'expression des gènes lors du patterning

**Chairperson / Modérateur : Robert Kelsh**

**09:45-10:15**     **Frank Jülicher** (*Dresden, Germany*)  
A critical point in tissue growth control  
*Un point critique dans le contrôle de la croissance tissulaire*

**10:15-10:45**     **Coffee break - Pause café**

**10:45-11:15**     **Sarah Bray** (*Cambridge, United Kingdom*)  
Decoding the Notch response  
*Décoder la réponse à Notch*

**11:15-11:30**     **Cédric Maurange** (*Marseille, France*)  
Early cooption of RNA-binding proteins induces hierarchical neural tumors in *Drosophila*  
*La co-option précoce de protéines de liaison à l'ARN induit une organisation hiérarchique des tumeurs neurales chez la drosophile*

**11:30-12:00**     **Ryoichiro Kageyama** (*Kyoto, Japan*)  
Mechanism of synchronized Hes7 oscillations in the somite segmentation clock  
*Mécanisme des oscillations synchrones de Hes7 dans l'horloge de segmentation des somites*

**12:00-12:30 Flash talks:**

*Marc Amoyel / Sara-Jane Dunn / Mette Handberg-Thorsager/Angie Molina-Delgado / Irepan Salvador-Martinez*

**13:00-14:15 Lunch at the Conference Centre (Gulf Stream Hotel)**

*Déjeuner au Centre de Conférence (Hôtel Gulf Stream)*

**14:30-16:30 POSTER SESSION II (CNRS-Hotel de France building)  
Communications par affiches (CNRS-Hotel de France)**

**6:30-17:00 Claire Chazaud (Clermont-Ferrand, France)**

Cell lineage differentiation in the blastocyst: the emergence of the pluripotent epiblast

*Différenciation des lignages cellulaires dans le blastocyste : émergence de l'épiblaste pluripotent*

**17:00-17:30 Nancy Papalopulu (Manchester, United Kingdom)**

A quantitative, dynamic and single cell analysis of cell state transitions and oscillatory gene expression at the tissue level

*Analyse quantitative, dynamique et en cellules uniques, à l'échelle tissulaire, des transitions d'état cellulaire et de l'expression génique oscillatoire*

**17:30-17:45 Break - Pause**

**17:45-18:45 Claudio Stern (London, United Kingdom) Keynote II, The EMBO Lecture**

Dissecting the molecular complexity of neural induction

*Disséquer la complexité moléculaire de l'induction neurale*

**18:45-19:00 Discussion about the next CJM**

**19:30-20:00 Drinks - Aperitif**

**20:00-... Banquet at the Conference Centre (Gulf Stream Hotel)**

*Banquet au Centre de Conférence (Hôtel Gulf Stream)*