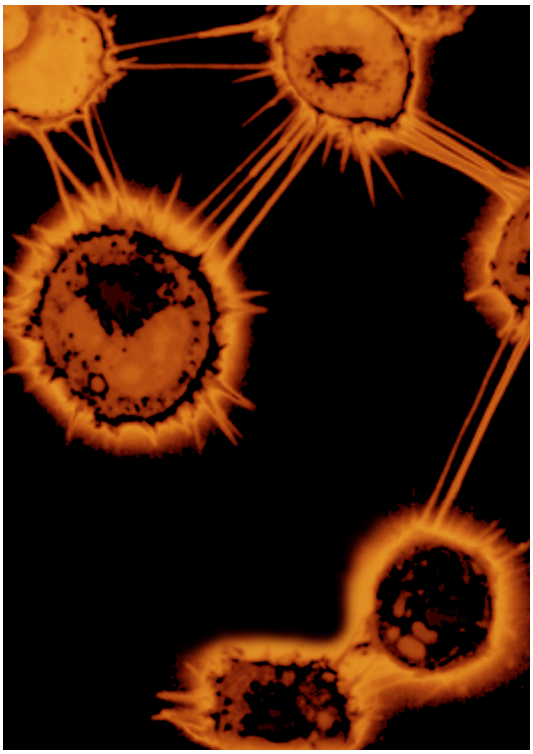
Institut Pasteur

institutCurie
Ensemble, prenons le cancer de vitesse.

Pasteur course

MOLECULAR BIOLOGY OF THE CELL



PROGRAM 2017-2018

JANUARY 8 – FEBRUARY 9, 2018

MOLECULAR BIOLOGY OF THE CELL

2017 - 2018

January, 8 - February, 9(*), 2018

(*) exams included

Directors of the course

Chiara ZURZOLO
Institut Pasteur
Paris, France

Roberto BRUZZONE
HKU-Pasteur Research Pole
The University of Hong Kong, Hong Kong

Philippe CHAVRIER
Institut Curie - Research Section
Paris, France

Location

Centre d'Enseignement de l'Institut Pasteur
Pavillon «Louis Martin»
28, rue du Docteur Roux
75724 Paris Cedex 15

Lectures: Room No 1
Practical Work: Room on the first floor

and

Amphithéâtre du Pôle de Biologie du Développement
Institut Curie
11, rue Pierre et Marie Curie
75005 Paris

Description of the course

The Molecular Biology of the Cell course is an intensive laboratory and lecture course of five weeks divided into weekly modules, each focusing on a cutting-edge aspect of cell biology. It is composed of lectures given by internationally renowned scientists, and of two practical sessions organized together with teams from the Curie and the Pasteur Institutes. The main topics of the course extend across the cell biology of infection, cancer, signaling, epigenetics and intracellular trafficking, emphasizing new experimental approaches. The availability of the core Imaging Platform at Institut Pasteur will introduce students to advanced techniques for the dynamic visualization of cells in health and disease.

Participants are selected from Master 2 students of the University of Paris 6, Paris 7 and Paris XI and foreign postgraduate students. The course is intended to be a platform of excellence in which students can meet and closely interact with worldwide top-level scientists to discuss, exchange ideas and establish valuable contacts in the perspective of establishing a network of young cell biologists at an early stage in their careers. Students will be able to understand the importance of basic research and of a broad interdisciplinary approach to improve human health. We also expect to provide orientations and mentoring to help course alumni in their future career.

The 2017 course is subdivided into four, week-long, modules. The first, lecture-only, provides a general introduction of cell organization and model organisms, with a focus on cell division, transport and motility. This is followed by two modules sections, extending into the fourth week, which comprise both lectures and practical workshops addressing current topics and experimental approaches to investigate vesicular transport/exocytosis and the mechanobiology of cell growth/size, respectively. Ample time will be devoted to the analysis of the experimental data obtained during the workshops, followed by dedicated sessions for oral presentation and discussion of the results, chaired by an external expert in the field. During the fourth week, students not enrolled in postgraduate programs of Paris universities will have a final exam in the form of an oral presentation to critically analyze a recent paper related to the topic of the practical workshops. Master students of the Paris universities will have an exam at the end of the fifth week, consisting in the preparation of a written research project (4-5 pages max.) based on the follow-up of a recently published article. Students will then discuss their project in the final oral presentation. The overall evaluation is based on the active participation to the course, the presentation of the practical work and the final exam.

Practicum 1

ANALYSIS OF THE ANTEROGRADE TRANSPORT OF TNF USING THE RUSH ASSAY

In mammalian cells, about one-third of the newly synthesized proteins are destined to be secreted. Conventional secretory proteins enter the biosynthetic pathway at the level of the endoplasmic reticulum (ER), and they are then transported to the Golgi apparatus. From there, the secretory proteins are delivered to their final destination compartments (e.g., plasma membrane, extracellular medium, lysosomes) using post-Golgi transport carriers. During their transit through the Golgi complex, the proteins encounter posttranslational modifications such as glycosylation or proteolytic cleavage.

The RUSH assay will be used to synchronize the transport of a cargo, namely TNF (Tumor Necrosis Factor), in the secretory pathway. The aim of the different experiments is to evaluate the effects of chemical compounds on the transport of TNF and on the integrity of the Golgi apparatus. We will use 2 techniques: end-point assay using fixed cells and immunostaining and biochemical analysis using endoglycosidase H digestion.

Practicum 2

MECHANICS IN BIOLOGY: FROM BACTERIA TO DEVELOPMENT

Many processes in biology can only be understood in terms of physical models. Famous examples that will be covered during this set of lectures and experiments comprise chemotaxis of bacteria and morphogenesis of both single cells and multi-cellular organisms. Morphogenesis is a problem where mechanical forces play an important role. We will thus put a major emphasis on this aspect. For multicellular organs and organisms, the interaction of cells via diffusing morphogens is equally important. The physics of diffusion is also what is underlying any understanding of chemotaxis of single-celled organisms such as *E. coli*. Within the 2nd practicum we will explore the processes of chemotaxis and morphogenesis in different model systems, ranging from bacteria via HeLa cells to organisms and brains.

During Days 1-2 we will explore the capacity of cells and organisms to effectively measure the concentration of nutrients in their environments to efficiently swim towards nutrient sources. After a theoretical account of both chemotactic search strategies and intracellular processing of the signals sensed, we will study the capacity of *E. coli* bacteria to sense chemical stimuli and to adjust their swimming patterns to the stimuli received. Interestingly, *E. coli* not only has to accurately measure small changes of extracellular nutrient concentrations to successfully approach a nutrient source, it also has to fight it's own rotational diffusion, which defers it from its desired path towards a nutrient source.

During Day 3 we will theoretically study the possible roles of mechanical forces for the shape of single-celled organisms and for multi-cellular organelles. In the experimental part we will deform the shape of *E. coli* bacteria by confining the growing cells into small micro chambers. We will then study how the cells recover from the bent conformation, i.e., how they straighten over time. We will then consider how mechanical forces can account for the behavior both in confinement and during straightening.

During Day 4-5 we will study the importance of mitotic spindle orientation for mammalian cells. Mitotic spindle orientation plays a central role for cell fate decisions, epithelial maintenance, and tissue morphogenesis. The architecture and adhesiveness of a cell microenvironment is a critical factor for the regulation of spindle orientation *in vivo*. In this course, we will use a combination of theory and experiments to provide a simple quantitative description of spindle orientation of adherent cells *in vitro*. For this aim, we will culture single HeLa cells on micro-patterns of defined geometry, dictating a specific shape and adhesion pattern to the cells. With these means, we will show that spindle orientation results from the action of cortical force generators, which interact with spindle microtubules and are activated by cortical cues.

During Day 6 we will study the dramatic and fast remodeling of tissue during the eary steps of organismal development. Those movements are critical during gastrulation, where an initially homogenous field of cells undergo movements leading to the separation of the endoderm, ectoderm and mesoderm. The cellular and physical causes of those movements are an intensive field of study. To illustrate some of the approaches used to analyze quantitatively tissue movement, the students will be split in two groups to perform live imaging of the gastrulation of two different embryos: the fruitfly *Drosophila melanogaster* and the zebrafish *Danio rerio*. Then, the quantitative analysis of tissue movement will be performed jointly using Particle Image Velocimetry.

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MOLECULAR BIOLOGY OF THE CELL 2017-2018

WEEK 1 January 8-12, 2018

Doctoral School module 1 "The Organization of the Cell"

Monday, January 8

9:00 - 9:30	Introduction & Presentation of the course	**Roberto BRUZZONE** (HKU-Pasteur Research Pole, Hong Kong) **Philippe CHAVRIER** (Institut Curie, Paris, France) **Chiara ZURZOLO** (Institut Pasteur, Paris, France)
9:30 - 10:00	Administrative issues by Register office & Presentation of the Education Center	**Sylvie MALOT**, Register office **Sylvie GARNERO**, Education center (Institut Pasteur, Paris, France)
10:00 - 10:30	Photos for badges (front desk, 25 rue du Dr Roux)	
10:30 - 11:30	Self-presentation of the Students (*5 min max, 2 slides each, background + project*)	
12:00 - 13:00	BCI departmental seminar (Amphi JACOB): **Spacetime at the cell scale: how do "clocks" and "rulers" crosstalk to control chromosome segregation during mitosis?**	**Helder MAIATO** (Institute for Molecular Cell Biology, Porto, Portugal)
14:00 - 16:00	**Membrane biology: Dynamics of lipid membranes and protein coats**	**Bruno ANTONNY** (IPMC, CNRS, Valbonne, France)
16:30 - 17:30	Self-presentation of the Students (*5 min max, 2 slides each, background + project*)	
17:30 - 18:30	Presentation of practical sessions and exam	
18:30 - 19:30	Welcome party (Cafétéria, ground floor, Teaching center)	

Tuesday, January 9 – Cell Division Structure

9:30 - 12:00	**How do chromosomes find their way during mitosis?**	**Helder MAIATO** (Institute for Molecular Cell Biology, Porto, Portugal)
13:30 - 16:00	**Cells' life under constraints**	**Matthieu PIEL** (Institut Curie, Paris, France)
16:30 -	Paper assignments	

Wednesday, January 10 – Cytoskeleton and cell motility

9:30 - 12:00	**Transport in neurons**	**Gipi SCHIAVO** (UCL, London, UK)
13:30 - 16:00	**Membrane and actin dynamics in the control of migratory and invasive strategies**	**Giorgio SCITA** (IFOM, Milano, EU)

Thursday, January 11 – Epigenetics

9:30 - 12:00	**Carcinoma-associated fibroblasts assist cancer cells invasion**	**Danijela VIGNJEVIC** (Institut Curie, Paris, France)
13:30 - 16:00	**Transcriptional regulation and epigenetic inheritance by small RNAs**	**Germano CECERE** (Institut Pasteur, Paris, France)

Friday, January 12 – Transport

9:30 - 12:00	**Epigenetic control of cell identity, memory and plasticity**	**Valerio ORLANDO** (University of Science and Technology, Kingdom of Saudi Arabia)
13:30 - 16:00	**Transport in cilia**	**Philippe BASTIN** (Institut Pasteur, Paris, France)

MOLECULAR BIOLOGY OF THE CELL 2017-2018

WEEK 2 **JANUARY 15-19, 2018**

DYNAMICS OF EXOCYTOSIS - Doctoral School module 2 "Membrane dynamics of endo/exocytosis"

PRACTICUM 1

ANALYSIS OF THE ANTEROGRADE TRANSPORT OF TNF USING THE RUSH ASSAY

under the direction of Franck PEREZ, Gaëlle BONCOMPAIN, Séverine DIVOUX and Guylène K'OUAS

Monday, January 15

9:00 - 11:30	**Decoding the Glycolipids Code**	**Giovanni d'ANGELO** (IBP-CN, Napoli, Italie)
12:00 - 13:00	BCI departmental seminar (Amphi JACOB): **Glycosphingolipid reprogramming drives neural differentiation**	**Giovanni d'ANGELO** (IBP-CN, Napoli, Italie)
14:00 - 14:30	Introduction to practicum 1	
14:30 - 18:30	*Practicum 1* - Day 1	

Tuesday, January 16

9:00 - 11:30	**Dynamics and Functions of the *Golgi Apparatus***	**Franck PEREZ** (Institut Curie, Paris, France)
11:45 - 12:30	*Practicum 1* - Day 2 – Addition of molecules	
14:00 - 18:30	*Practicum 1* - Day 2	

Wednesday, January 17

9:00 - 11:30	**Endocytosis and signaling (tentative topic)**	**Christophe LAMAZE** (Institut Curie, Paris, France)
11:30 - 12:15	*Practicum 1* - Day 3 – Addition of molecules	
13:30 - 18:30	*Practicum 1* - Day 3	
13:00 - 18:30	*Practicum 1* - Day 4	

Thursday, January 18

9:00 - 11:30	**Next generation approaches to study virus infection**	**Jason MERCER** (UCL, London, UK)

13:00 - 18:30 *Practicum 1* - Day 4

Friday, January 19

9:00 - 11:30	**Mechanics of membrane traffic info approaches**	**Roberto WEIGERT** (NIH, Bethesda, USA)

13:00 - 18:30 *Practicum 1* - Day 5

MOLECULAR BIOLOGY OF THE CELL 2017-2018

WEEK 3 JANUARY 22-26, 2018

DYNAMICS OF EXOCYTOSIS - Doctoral School module 2 "Membrane dynamics of endo/exocytosis"

PRACTICUM 1

ANALYSIS OF THE ANTEROGRADE TRANSPORT OF TNF USING THE RUSH ASSAY

under the direction of Franck PEREZ, Gaëlle BONCOMPAIN, Séverine DIVOUX and Guylène K'OUAS

Doctoral School module 3 "Mechanobiology of cells in space and time"

PRACTICUM 2

MECHANICS IN BIOLOGY: FROM BACTERIA TO DEVELOPMENT

under the direction of Sven van Teeffelen, Nicolas Dray and Jean-Baptiste Masson

Monday, January 22

9:30 - 11:00	**Trafficking and the Golgi apparatus**	**Sean MUNRO** (MRC-LMB, Cambridge, UK)
12:00 - 13:00	BCI departmental seminar (Amphi JACOB): **Capture of transport vesicles at the Golgi by golgin coiled-coil proteins**	**Sean MUNRO** (MRC-LMB, Cambridge, UK)
14:00 - 18:00	*Practicum 1* - Day 6 – Observation and analysis	

Tuesday, January 23

9:00 - 11:00	**How to search in complex environments at the micrometer scale**	**Jean-Baptiste MASSON** (Institut Pasteur, Paris, France)
14:00 - 17:00	Students' Presentation and Assessment of Practicum 1	

Wednesday, January 24

9:00 - 11:30	**Chemotaxis in bacteria**	**Tom SHIMIZU** (AMOLF, Amsterdam, The Netherlands)
13:30 - 18:30	*Practicum 2* - Day 1: Chemotaxis Run-and tumble motion and adaptation to chemotactic stimuli	

Thursday, January 25

9:00 - 12:00 **The Eukaryotic Cytoskeleton** — **Manuel THERY** (CEA – Hopital Saint-Louis, Paris, France)

13:00 - 17:00 *Practicum 2* - Day 2: Spindle organization during mitosis — **Daria BONAZZI** (Institut Pasteur)

Friday, January 26

9:00 - 12:00 **Mechanics of morphogenesis** — **Sven VAN TEEFFELEN** & **Roberto TORO** (Institut Pasteur, Paris, France)

13:00 - 18:30 *Practicum 2* - Day 3: Data analysis from Thursday and computational simulations with Cytosim (Nedelec lab)

MOLECULAR BIOLOGY OF THE CELL 2017-2018

WEEK 4 JANUARY 29-FEBRUARY 2, 2018

PRACTICUM 2

MECHANICS IN BIOLOGY: FROM BACTERIA TO DEVELOPMENT

under the direction of Sven van Teeffelen, Nicolas Dray and Jean-Baptiste Masson

Monday, January 29

9:00 - 11:30	**Mechanics of membrane traffic (membrane deformation/elasticity)**	**Aurélien ROUX** (Unige, Genève, Suisse)
12:00 - 13:00	BCI departmental seminar (Amphi JACOB): **Buckling of epithelia growing under spherical confinement**	**Aurélien ROUX** (Unige, Genève, Suisse)

14:00 - 18:00 *Practicum 2* - Day 4:
Mechanics of morphogenesis in bacteria.

Tuesday, January 30

9:00 - 12 :30	**From patterning to morphogenesis: the contribution of physics to developmental biology** **Quantitative analysis of collective behaviour during early development of Zebrafish and Drosophila**	**Romain LEVAYER** **Nicolas DRAY** **Thomas GREGOR** (Institut Pasteur, Paris, France)

14:00 - 18:00 *Practicum 2* - Day 5:
Cell migration and cell division in Drosophila and zebrafish

Wednesday, January 31

09:00-12:00 *Practicum 2* - Day 6:
Data analysis and Preparation of presentations

14:00 - 17:30 *Practicum 2* - Day 6:
Students' presentation and Assessment of Practicum 2

Thursday, February 1

9:00 - 10:00	**Career opportunities inside and outside academia**	**Mariana MESEL LEMOINE** (Institut Pasteur, Paris,France)

14:00 - 18:00 Exam external students

Friday, February 2

9:30 – 12:00	**The Cytoskeleton from a modeling perspective**	**François NEDELEC** (EMBL, Heidleberg, Allemagne)

12:00 - 14:00 Party

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MOLECULAR BIOLOGY OF THE CELL 2017-2018

WEEK 5 FEBRUARY 5-9, 2018

FINAL EXAM

Monday, February 5 to Tuesday, February 6

Project preparation. The written project has to be submitted to the Course Committee by Tuesday night.

Wednesday, February 7 to Thursday, February 8

Preparation of the oral exam

Friday, February 9

9:00 - 18:00 Final examination

DETAILED DESCRIPTION OF THE EXAMINATION

Oral exam on Friday 9 February, 2018 (mark on a 1-20 scale, coefficient 1):

Critical analysis of a scientific article and presentation of an imaginary 3-year research project as follow-up of the results of the article.
Presentation: 13 minutes; questions: 7 minutes; total duration: 20 minutes

Organization of the oral presentation:

- The presentation is open to the public
- Slides (Powerpoint or other supported formats)

The scientific articles will be given to students during the first week of the course. Each student will write a fictional project intended to be a follow-up of the article received and submit a 4/5 page document to the members of the jury no later than Tuesday 9th February at 20:00. This document should include:

- Summary of the article (max 1 page)
- Aims and description of the project (max 3 pages including figures if appropriate)
- References (max 1 page), using the style of a cell biology journal (e.g., JCB, JCS, MBC, Cell, NCB….)

DESCRIPTION DETAILEE DE L'EXAMEN

Examen oral le vendredi 9 février 2018 (note sur 20, coefficient 1) :

Présentation critique d'un article et discussion d'un projet fictif sur 3 ans découlant de ces résultats.
Présentation : 13 minutes ; questions du jury : 7 minute ; durée totale : 20 minutes.

Organisation de la présentation orale :

- Exposé public de chaque étudiant devant le jury
- Diapositives (logiciel Powerpoint ou autre format compatible)

Les articles scientifiques seront donnés aux étudiants pendant la première semaine de cours. Le projet fictif est présenté dans un document de 4/5 pages à remettre au jury au plus tard le mardi 9 février à 20h00, comprenant :

- Résumé de l'article (max 1 page)
- Objectifs et description du projet (max 3 pages, figures incluses)
- Bibliographie (max 1 page) selon le style d'un journal type JCB, JCS, MBC, Cell, NCB…

MOLECULAR BIOLOGY OF THE CELL COURSE

2017 - 2018

ADDRESS DETAILS

DIRECTORS OF THE COURSE

Chiara ZURZOLO
Membrane Trafficking & Pathogenesis Unit
Institut Pasteur
28, rue du Dr Roux
75724 Paris Cedex 15, France
Tel +33 - (0)1 45 68 82 77
chiara.zurzolo@pasteur.fr

Roberto BRUZZONE
HKU - Pasteur Research Pole
The University of Hong Kong
5 Sassoon Road
Pokfulam, Hong Kong
Tel +852 - 2831 5522
bruzzone@hku.hk

Philippe CHAVRIER
Institut Curie - Research Section
CNRS UMR 144
26, rue d'Ulm
75248 Paris Cedex 05, France
Tel +33 - (0)1 56 24 63 59
philippe.chavrier@curie.fr

ADMINISTRATIVE CONTACTS
INSTITUT PASTEUR

Teaching Center - 28 rue du Docteur Roux
Sylvie GARNERO
Building 09C – Pavillon Louis Martin – 1st floor
Tel: +33 (0) 1 40 61 38 04
sgarnero@pasteur.fr
cours@pasteur.fr

Register office – 28 rue du Docteur Roux
Sylvie MALOT or Céline CORBIN
Close to Centre Médical – Building 13
Salle Saint-Joseph de Cluny
Tel: +33 (0)1 40 61 33 62 (C. Corbin)
Tel: +33 (0) 45 68 81 41 (S. Malot)
Fax: 33 (0)1-45-68-84-40
enseignement@pasteur.fr