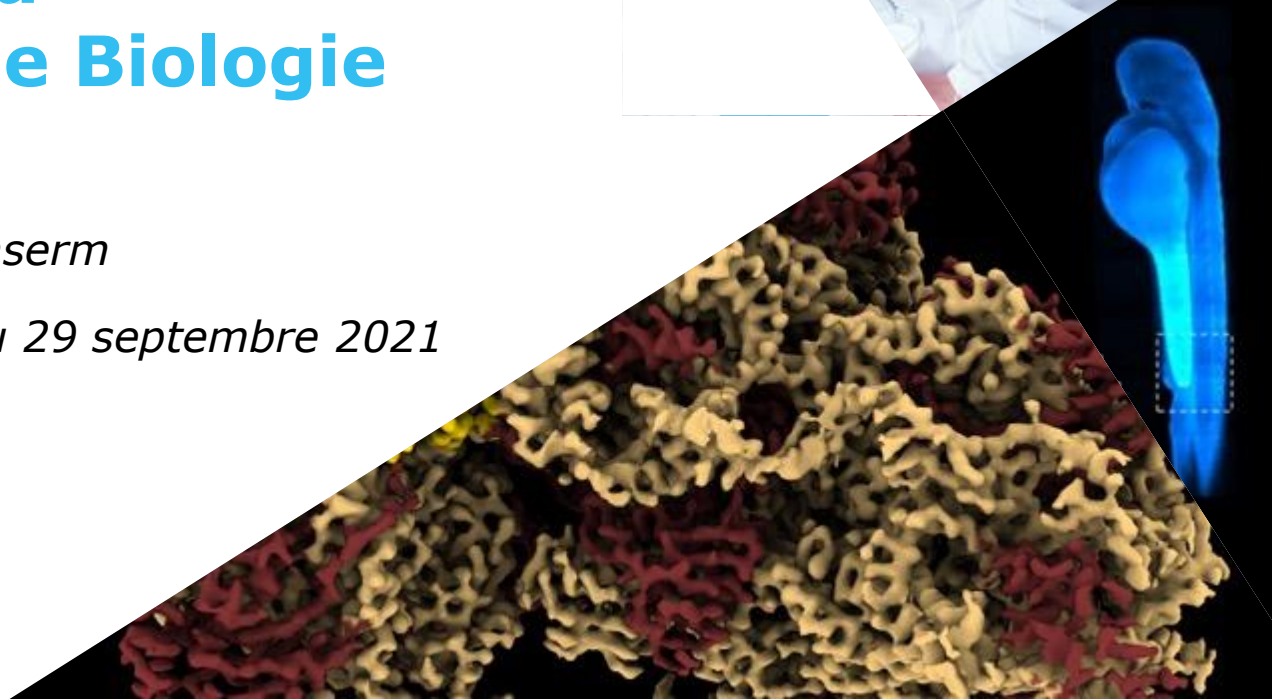


Présentation du Département de Biologie

*Responsable:
Jean-Louis Mergny, DR1 Inserm*

*Conseil d'administration du 29 septembre 2021
Pièce n°07*



Biology department Presentation

The *Département de Biologie* involves **two Units**:

- **LOB**: Laboratoire d'Optique & Biosciences
CNRS (INP) & Inserm
- **BIOC**: Laboratoire de Biologie Structurale de la Cellule
CNRS (INSB)

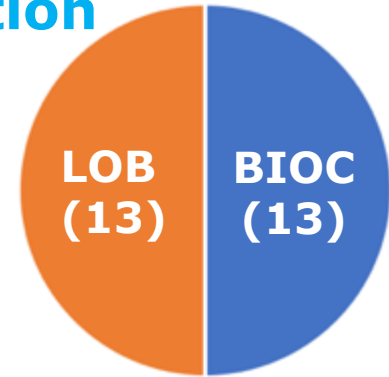
(One slide for each lab provided at the end of the presentation)

Total staff (*incl. students, post-docs, Tech staff*)

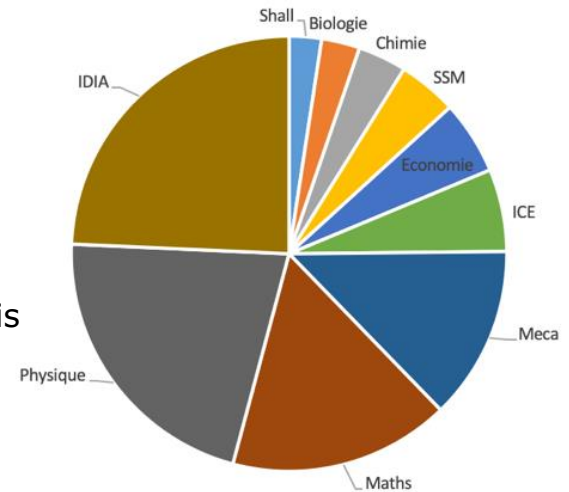
- LOB 73* (*also affiliated to Physics Department*)
- BIOC 40

* *incl. people in the Physics department*

One of the smallest départements within IP Paris
 $26/929 = 2.8\%$ of total Researchers

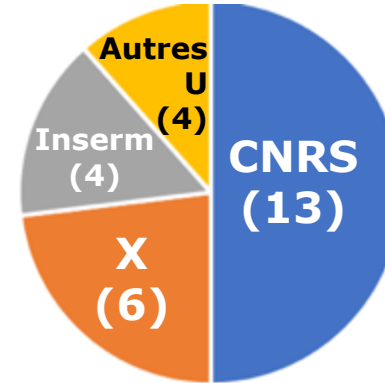
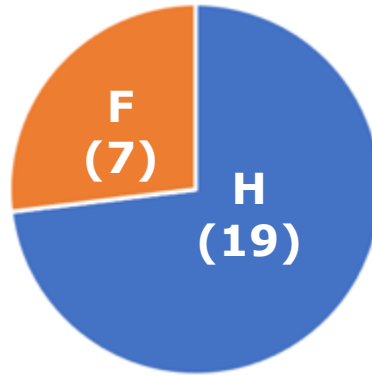


Biology as a primary affiliation: 26



Department composition

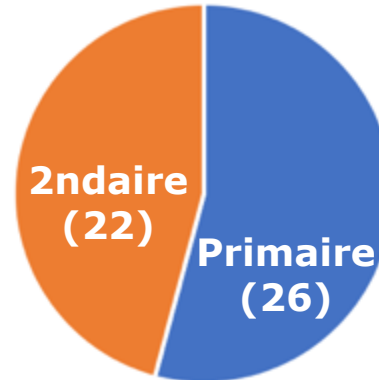
Primary affiliation: 26



Biology as a secondary affiliation: 22

(Researchers only – 4 IR not listed here)

- Physique (LOB) 10
- Informatique (LIX) 5
- Chimie (LSO) 4
- Mécanique (LadHyX) 3



(source: liste électorale Juillet 2021)

Small... But beautiful ?

Chosen articles in prestigious journals and awards from LOB / BIOC

Recent Publications in prestigious journals:

RESEARCH ARTICLE

PHOTOENZYMES

Mechanism and dynamics of fatty acid photodecarboxylase

D. Sorigué¹, K. Hadjidemetriou², S. Blangy¹, G. Gotthard³, A. Bonvalet⁴, N. Coquelle⁵, P. Samire^{1,6}, A. Aleksandrov⁴, L. Antonucci⁴, A. Benachir⁴, S. Boutet⁷, M. Byrdin², M. Cammarata^{8,†}, S. Carbajo⁷, S. Cuiné¹, R. B. Doak⁹, L. Foucar⁹, A. Gorel⁹, M. Grünbein⁹, E. Hartmann⁹, R. Hienerwadel¹, M. Hilpert⁹, M. Kloos^{9,†}, T. J. Lane⁷, B. Légeret¹, P. Legrand¹⁰, Y. Li-Beisson¹, S. L. Y. Moulin¹, D. Nurizzo³, G. Peltier¹, G. Schirò², R. L. Shoeman⁹, M. Sliwa¹¹, X. Solinas⁴, B. Zhuang^{4,6}, T. R. M. Barends⁹, J.-P. Colletier², M. Joffre⁴, A. Royant^{2,3}, C. Berthomieu^{1,6}, M. Weik^{2,6}, T. Domratheva^{9,12,6}, K. Brettel⁶, M. H. Vos^{4,6}, I. Schlichting^{9,6}, P. Arnoux^{1,6}, P. Müller⁶, F. Beisson^{1,6}

Alexis Gautreau, chercheur au BIOC



HSBP1 is the first assembly factor identified for the WASH complex



Success at competitive grants:

- ERC Synergy (E. Beaurepaire)
- Recent (2020 & 2021) ANR grants
- CNRS 80 Prime (2021 x 2)
- HFSP

« HOPE aims to shed new light on the function of the hippocampus and the role of its neuronal circuits through the design of a new, non-invasive and universal method to monitor the growth and construction of brain circuits located deep in the brain, from their neurogenesis to adulthood, under normal and pathological conditions. »

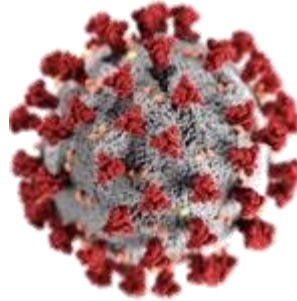
Fighting Covid-19

Implication of LOB and BIOC in research and outreach on Covid-19

Marc Graille, chercheur au BIOC



Vidéo Youtube consultée > 75,000 fois



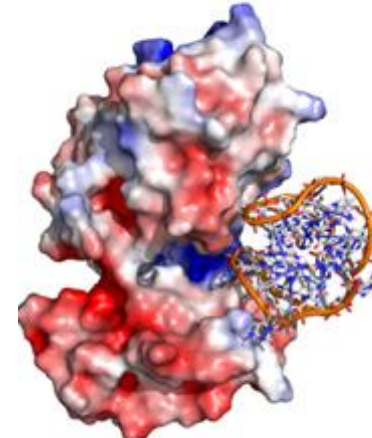
<https://www.polytechnique.edu/fr/content/vers-une-nouvelle-strategie-antivirale-contre-la-covid-19>

Published online 7 July 2021

Nucleic Acids Research, 2021, Vol. 49, No. 13 7695–7712
<https://doi.org/10.1093/nar/gkab571>

SARS-CoV-2 Nsp3 unique domain SUD interacts with guanine quadruplexes and G4-ligands inhibit this interaction

Marc Lavigne^{1,*}, Olivier Helynck², Pascal Rigolet³, Rofia Boudria-Soullah¹, Mireille Nowakowski⁴, Bruno Baron⁵, Sébastien Brûlé⁵, Sylviane Hoos⁵, Bertrand Raynal⁵, Lionel Guittat^{6,7}, Claire Beauvineau³, Stéphane Petres⁴, Anton Granzhan³, Jean Guillon⁸, Geneviève Pratiel⁹, Marie-Paule Teulade-Fichou³, Patrick England^{5,*}, Jean-Louis Mergny^{6,7,*} and Hélène Munier-Lehmann^{2,*}



Fanny MOUSSEAU*, Chao YU, Antigoni ALEXANDROU, Cédric BOUZIGUES

Laboratoire d'Optique et Biosciences, École Polytechnique, Institut Polytechnique de Paris,
INSERM, CNRS, 91128 Palaiseau, France

* fanny.mousseau@polytechnique.edu



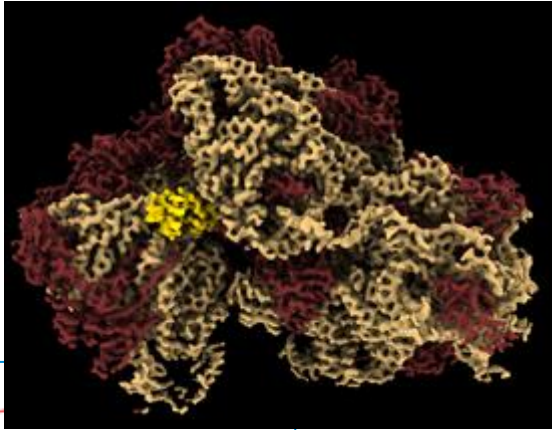
Pour détecter des biomolécules et pathogènes (protéines, virus, bactéries, ...) avec des sensibilités satisfaisantes, il est actuellement nécessaire d'utiliser des appareils de laboratoires coûteux. En combinant les remarquables propriétés optiques des ions lanthanides à un lecteur simple couplé à un smartphone, nous démontrons comment développer un système de détection portable, rapide et ultrasensible.

© École polytechnique - J.Barandé

Revolutions in Structural biology

The biology department is directly involved in, or benefits from, two recent major innovations in structural biology

Cryomicroscopy (« Cryo EM ») FEI Titan Themis (300kV)



AlphaFold (Prediction of protein structure) Artificial intelligence

Le Figaro, 30 Juillet 2021

Pouvoir prédire la structure d'une protéine offre un gain de temps considérable

THOMAS SIMONSON, DIRECTEUR DE RECHERCHE SPÉCIALISÉ EN BIOLOGIE DES PROTÉINES À L'ÉCOLE POLYTECHNIQUE (PALAISEAU)

10 SCIENCES

Le secret du pliage des protéines dévoilé

Une intelligence artificielle de Google arrive à prédire la structure 3D d'à peu près n'importe quelle molécule codée par le génome humain. Une avancée majeure qui ouvre un champ des possibles considérable.

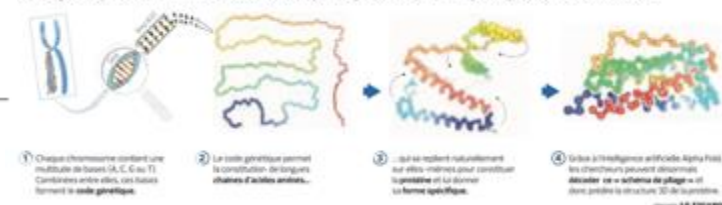


Illustration: S.B. PIRELLA

**SCIENTIFIC
REPORTS**
nature research

Check for updates

A physics-based energy function allows the computational redesign of a PDZ domain

Vaitea Opuu^{1,3}, Young Joo Sun^{2,3}, Titus Hou², Nicolas Panel¹, Ernesto J. Fuentes^{2,3} & Thomas Simonson^{2,3}

**COMMUNICATIONS
BIOLOGY**

ARTICLE

<https://doi.org/10.1038/s43203-020-0190-0>

OPEN

Cryo-EM study of an archaeal 30S initiation complex gives insights into evolution of translation initiation

Pierre-Damien Couroux^{1*}, Christine Lazennec-Schurdevin¹, Sophie Bourcier², Yves Mechulam¹ & Emmanuelle Schmitt^{1*}

Common themes / Keywords

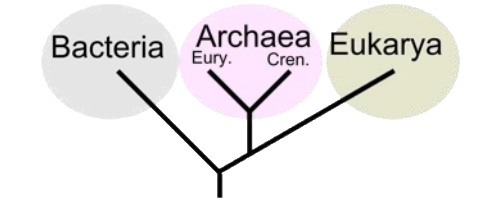
Relevant for LOB and/or BIOC

Structural Biology

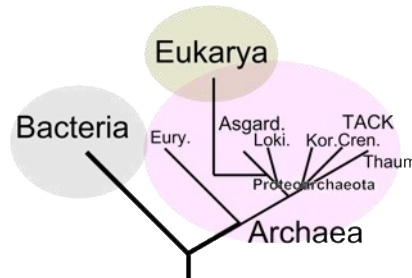
- Cryo-EM
- Crystallography
- Structural modeling
- Dynamics of biomolecules
- Unusual nucleic acid structures (G-quadruplexes)

Biochemistry

- Assembly of multiprotein complexes
- Nucleic Acids – Protein complexes
- Initiation of translation
- Microbial adaptation: Archaea & Bacteria



Carl Woese's three domain tree



two domain tree

Optics and spectroscopy

- Non linear optics
- Microscopy of tissues
- Nanoparticle imaging
- Protein relaxation

Cell Biology

- Cytoskeleton
- Cell migration
- Cell transformation

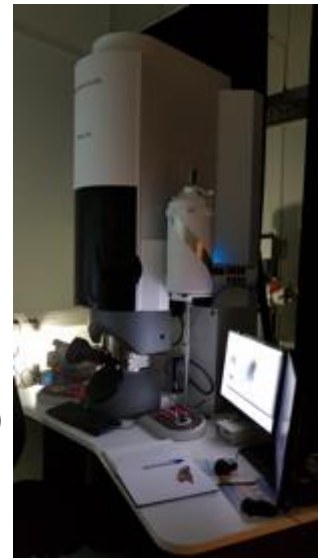
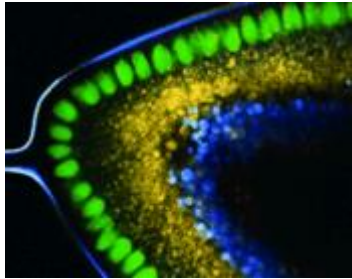
Developmental Biology

- Cell migration
- Zebrafish embryo

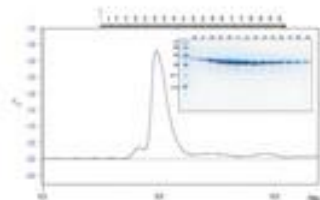
Facilities / Equipment

Of interest for the Biology Department

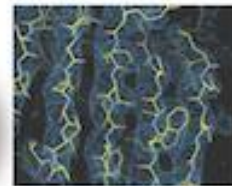
- **Structural biology:**
 - **Cryo EM** (Titan Themis, CIMEX facility)
 - X-ray Crystallography facilities
- **Optical imaging facility (Equipex Morphoscope)**
- **Biophysical platform** (CD, Abs, Fluo, Calorimetry...)
- **Protein expression & purification**
- **Zebrafish** facility
- Cell culture rooms (for prokaryotes & eukaryotes)



Microbiologie



Biochimie, Biophysique



Cristallographie aux rayons X

Strengths / Weaknesses / Opportunities / Threats

(Evaluation in progress)

Assets

- Facilitated **coordination**:
 - 2 labs located nearby
 - Nearly the same perimeter for X and IP Paris Biology
- Publications & Citations (>3,000 in 2020)
- Interdisciplinarity
- Attractivity for scientists (Visitors; CNRS / Inserm researchers)
- (some) Facilities: Imaging, CryoEM
- International character (collaborations, members)
- Implication in societal issues (Covid, Cancer, Environment)

Weakness & Threats

- Small size / **critical size** barely reached
- Need for a strong core in biology
- Single « *Chaire* » (with Servier)
- Heavy teaching load
- Visibility to students
- Not covering all usual facilities
- Growing administrative burden
- Limited means for the department

Opportunities

- Students' general interest in Biology (*of special interest to us : attract Bachelors / Propose a Phys-Chem-Bio track?*)
- iGEM (synthetic biology)
- Build strategic partnerships in France and abroad (e.g., Pasteur, Russia, China, Pharmas...)
- PIA4: STEP₂: *Science and Technology at Polytechnique Paris*
- Bioengineering (BME, & not only medical)
- Biocluster in Oncology « Paris Saclay Cancer Cluster » / local environment

Interdisciplinary center(s)

(BME; STEP2; Cluster Oncology Paris-Saclay)

The Biology département welcomes interdisciplinary initiatives, e.g. Biomedical engineering (BME); IP Paris Interdisciplinary Center for Quantitative and Engineering Science for Biology and Health

- Is implicated and benefits from BME (e.g., EUR BERTIP; Fondation Leduc: equipment; Bettencourt: Post docs)
- ... And ready to take a major role in STEP2 / WP1.1:

An excellent match (STEP2 – WP1: BOOSTING IP PARIS RESEARCH & INNOVATION CENTERS):

« Probe, engineer, and heal living systems (...) Multiscale characterization of living systems (...) Advanced optical imaging new molecular probes (...) basic mechanical principles in cell and developmental biology (...) 'omic' approaches, bioinformatics, machine learning, and predictive modelling (...) »

Assets

- Links with Inserm and CNRS INSB
- National partnerships & collaborations (Pasteur, Curie...)
- Bio-engineering (not exclusively biomedical engineering)
- Already familiar with interdisciplinarity (ex: LOB at the Physics – Biology interface)

Ready to host new (junior?) team(s)

- Necessity to reinforce Biology / maintain critical size and expertise
- Space potentially sufficient to host one new team / tenure track
- JLM is used to handle recruiting Group Leaders (international calls, SAB interviews...)

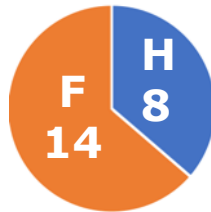
What the Biology department brings to IP Paris

International character

- Foreign staff, Foreign students:
7 ≠ nationalities present in LOB
- International collaborations:
bilateral partnerships (Russia, China, E.U.)

Gender balance

- Staff and PhD students
for ex, Students in LOB:
(2021-2022)



Academic reputation / Publication track

- Citations (> 3,000 / yr)
- ERC synergy

Implications in societal issues

- **Pathologies** (Cancer & transmittable diseases incl. Covid)
- **Origin of life** (e.g., discussion around the « tree of life » Archaea & eukaryotes)

**To build a MIT / EPFL « à la Française »
« Home brew » Biology needs to be strong**

Connections with NRO: not only CNRS

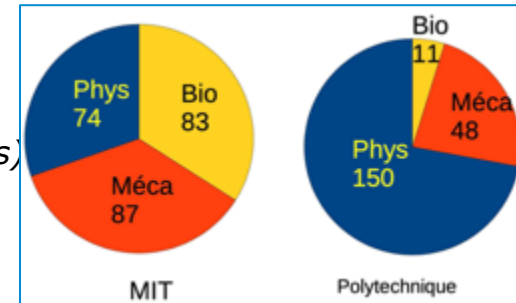
- Inserm: Health / Medical research
- « Free » supply of external researchers:
20/26: 77%

Ability to handle massive amounts of data

- Biology is a (massively) quantitative science
(ex: genomics – transcriptomics)

Interdisciplinarity

- Cross fertilization with other disciplines;
implication in several initiatives



Thank you for your attention



Bureau du Département de Biologie d'IP Paris

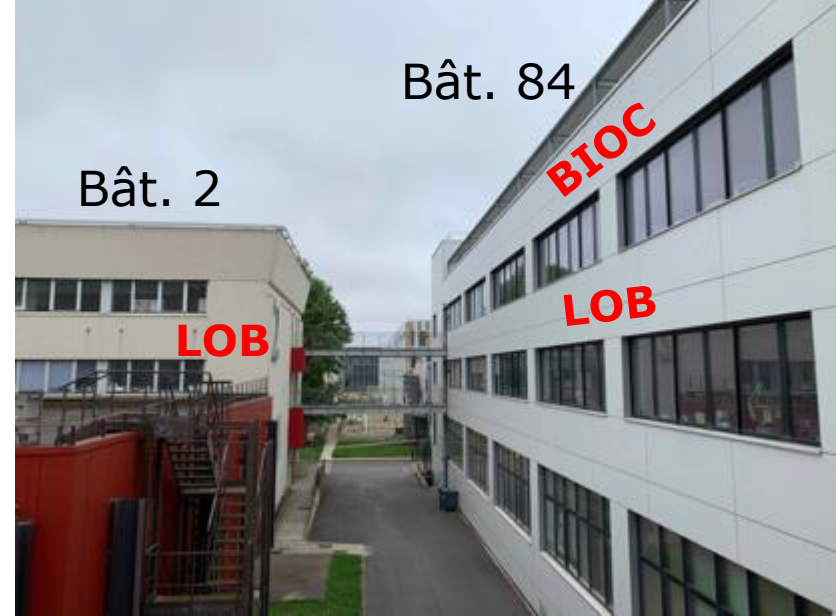
Membres de droit :

- Le responsable du département
- Le directeur du BIOCI
- Le directeur du LOB
- Le responsable du domaine de l'ED IP Paris qui relève du département :
- Le responsable du Master Biologie Santé :

Membres désignés :

1^{ère} réunion du bureau:
28 Septembre 2021

Location



BIOC:

- Bâtiment 84, R+2

LOB:

- Bâtiment 84, R+1
- Bâtiments 2/5 R+1

Short presentation of the BIOC

Joint research unit n°7654: CNRS (INSB), École Polytechnique

Expertise in:

- Structural biology
- Molecular and cell biology
- Simulations

Aim: Understand and engineer the cellular machinery.

Research programs:

- BIOC originally pioneered studies of the translation apparatus, which produces proteins from messenger RNA, applying biochemical and biophysical techniques like X-ray crystallography. Two groups continue this line of research, with cutting-edge tools such as high-resolution cryo-electron microscopy. They have revealed important details of the initiation and termination steps of translation and the functioning of the ribosome.
- Development of new imaging approaches to probe cellular activity within intact tissues (multiphoton multi-modal microscopy, *in vivo* imaging of animal models).
- Computer modeling and simulation to understand and engineer biomolecules. A significant effort is directed at developing new methods. Thus, the Proteus software package for protein design was developed and used to completely redesign a PDZ protein, solving the inverse folding problem.
- The Gautreau cell biology team focusses on the roles and regulations of branched actin networks in the cell. Several aspects are relevant for cancer biology, such as elucidating the effect of Arp2/3 inhibition in tumor cells with Rac1 mutations

.....

Short presentation of the LOB

Joint research unit n°7645: CNRS (INP), École Polytechnique, Inserm U1182

Expertise in:

- Molecular and cell biology
- Optics and femtosecond dynamics

Aims: Develop new concepts and tools to understand the functioning of biomolecules and their organization within cells and tissues.

Examples:

- Functional and structural dynamics of proteins and DNA (time-resolved spectroscopy, MD)
- Development of new imaging approaches to probe cellular activity within intact tissues (multiphoton multi-modal microscopy, in vivo imaging of animal models)
- Development of nano-particles for monitoring individual molecules

4 Teams (« pôles »)

- Molecular mechanisms of microbial adaptation
- Internal dynamics of biomolecules
- Nanoimaging for cell dynamics and quantitative biology
- Advanced microscopies and tissue physiology

