

Edito

This flyer gathers a selection of significant events that paved the activity of the Biochemistry and Plant Molecular Biology (B&PMP) institute during 2016-2017. These relate to the organization of conferences, the scientific production, the installation of new research groups and technological platforms, the training and public communication initiatives, and the advertisement of upcoming events in 2018.

We hope you will enjoy the reading.

The B&PMP staff

CONFERENCES



Chair of the scientific committee: Alain Gojon (INRA B&PMP)

The EMBO conference 'The nitrogen nutrition of plants - Nitrogen2016' was the third international symposium on the nitrogen nutrition of plants, following Nitrogen2013 in Puerto Varas (Chile), Nitrogen2010 in Inuyama-city (Japan) and the founder meeting Nitrogen2007 in Lancaster (UK).

At a time when improved nitrogen use efficiency by crops is clearly identified as a major issue for sustainable agriculture, the main objective of this conference was to review recent progress in the understanding of molecular, physiological and developmental processes involved in the nitrogen nutrition of plants.



In association with the Conference, the *Journal of Experimental Botany* has published a special issue 'Nitrogen Nutrition in Plants: Rapid Progress and New Challenges', gathering 14 review articles by the invited speakers of Nitrogen2016.



October 17-19th 2017 Montpellier SupAgro

Chair of the scientific committee: Stéphane Mari (INRA B&PMP)

The French Seed Biology Network brings together the French scientific community working on seed biology, their development, their adaptation to the environment and their food and non-food uses.

Five symposia of this network have already been held in Angers in 2007, Paris in 2009, Nantes in 2011, Dijon in 2013 and Clermont-Ferrand in 2015.

The sixth event took place in Montpellier from 17 to 19 October 2017. The objectives of this conference were to take stock of the research of French laboratories, to promote new multidisciplinary approaches and to respond to the emerging needs of society in the fields of biodiversity, production, food security, seed utilization and new quality criteria.

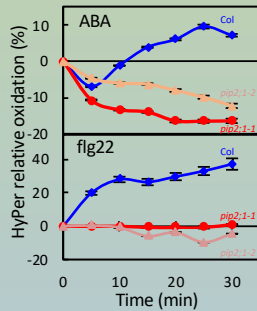
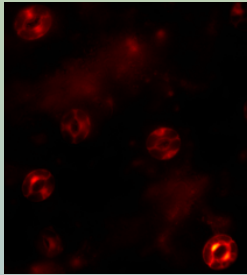


Montpellier hosted the Lateral Root Workshop jointly organized by Benjamin Péret and Laurent Laplace on the 26th and 27th of October 2017. This event is an annual meeting of collaborators interested in the fundamental mechanisms of lateral root development from the early stages of pre-initiation up to lateral root emergence and growth. The meeting gathered 64 participants from Europe as well as special guests from Japan (Hidehiro Fukaki and Tatsuaki Goh). Amongst the participants were Malcolm Bennett, Ben Scheres, Eva Benkova, Joop Vermeer... Talks were given by students and post-docs.

This project is supported by Agropolis Fondation under the reference ID 1700-003 through the « Investissements d'avenir » programme (Labex Agro:ANR-10-LABX-0001-01)

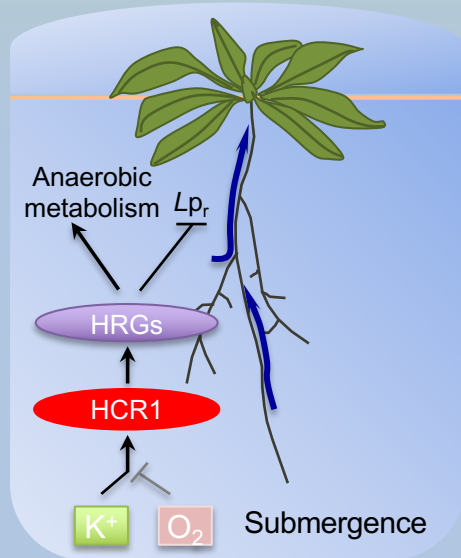
Scientific highlights

Rodrigues O, Reshetnyak G, Grondin A, Saijo Y, Leonhardt N, Maurel C, Verdoucq L (2017) [Aquaporins facilitate hydrogen peroxide entry into guard cells to mediate ABA- and pathogen-triggered stomatal closure](#). *P. Natl. Acad. Sci. USA*, 114(34):9200-9205



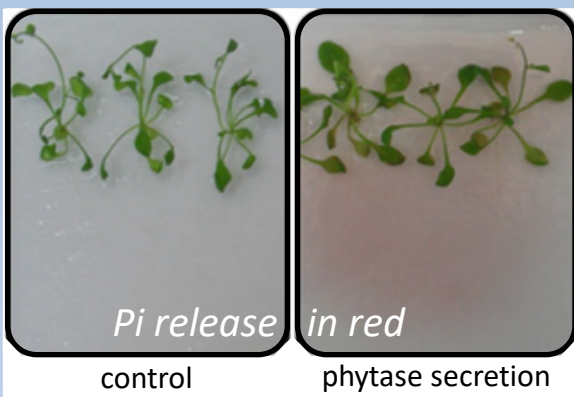
This work shows that phosphorylation of the AtPIP2;1 aquaporin by the OST1 protein kinase is necessary during stomatal closure induced by the stress hormone abscissic acid (ABA) or the bacterial elicitor flagellin (flg22). The use of HyPer, a genetic fluorescent probe sensitive to hydrogen peroxide (H_2O_2), revealed that this aquaporin plays a general role in signalling by facilitating the influx of H_2O_2 into guard cells.

Shahzad Z, Canut M, Tournaire-Roux C, Martinière A, Boursiac Y, Loudet O, Maurel C (2016) [A potassium-dependent oxygen sensing pathway regulates plant root hydraulics](#). *Cell*, 167(1):87-98.e14



A quantitative genetics approach revealed a mechanism that allows a plant to adjust its water status and growth according to different soil flooding conditions. The results of this study describe how roots sense and respond to soil oxygen and potassium levels jointly, so as to change their water uptake capacity. Aside from their scientific importance, these findings could make it possible to optimize crop flood tolerance

Belgaroui N, Berthomieu P, Rouached H, Hanin M (2016) [The secretion of the bacterial phytase PHY-US417 by Arabidopsis roots reveals its potential for increasing phosphate acquisition and biomass production during co-growth](#). *Plant Biotechnol. J.*, 14(9):1914-1924



Phytic acid (PA) is a major source of inorganic phosphate (Pi) in the soil. Plants are however unable to use PA for Pi nutrition and growth. Arabidopsis was engineered to secrete a bacterial phytase. Compared to the control, it showed normal growth and no hallmark of Pi deficiency when grown on phytic acid as sole P source. Interestingly, co-cultivation of the engineered plants with controls showed that the secreted phytases benefitted to the neighbouring control plants, which showed no sign of Pi deficiency and normal growth.

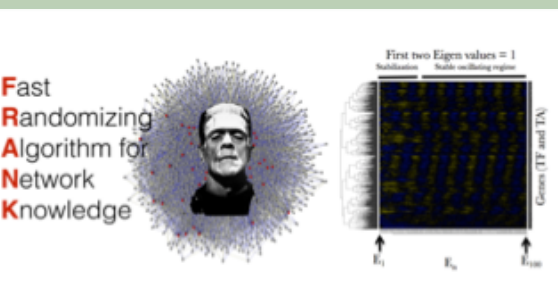
The work was done in collaboration with the Centre de Biotechnologie de Sfax in Tunisia.

HIGHLIGHTS 2016-20017

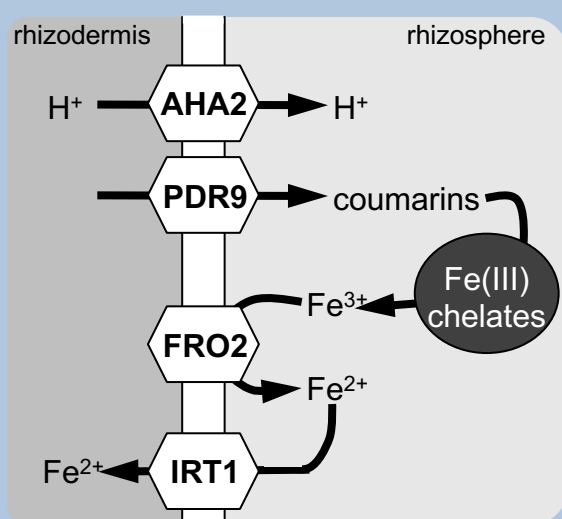
Scientific highlights

Carré C, Mas A, Krouk G (2017) [Reverse engineering highlights potential principles of large gene regulatory network design and learning](#). *NPI Syst. Biol. Appl.*, 3:17

This work by Carré *et al* is a collaboration with IMAG lab in Montpellier. It addresses central questions in biology, which are: how very large gene regulatory networks (GRNs) are organized, generate stable gene expression, and can be learnt using machine learning algorithms? In this work authors developed an algorithm (FRANK) able to simulate large GRNs. From these networks they simulate stable or oscillating gene expression and highlights some mathematical rules controlling such a collective behavior. Using this simulation tool, authors also demonstrate that it's likely possible to computationally learn GRNs from transcriptomic data and prior knowledge on the network. They particularly highlight the crucial importance of the prior knowledge structure in their capacity to learn large GRNs.

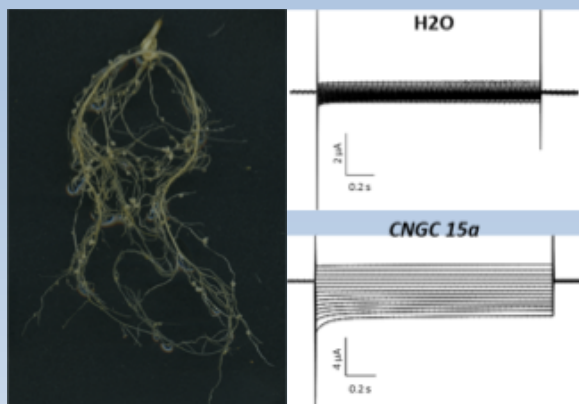


Fourcroy P*, Tissot N*, Gaymard F, Briat J-F, Dubos C (2016) [Facilitated Fe nutrition by phenolic compounds excreted by the Arabidopsis ABCG37/PDR9 transporter requires the IRT1 / FRO2 high affinity root Fe²⁺ transport system](#). *Mol.Plant.*, 9(3):485-488



Iron (Fe) is an essential micronutrient for plant productivity as well as the quality of their derived products. When Fe availability is scarce, non-graminaceous plants have evolved a reduction-based mechanism to mine Fe from the soil. It involves the reduction of Fe(III) chelates present in the soil by the FRO2 reductase and the transportation of the generated Fe²⁺ through the rhizodermis by the IRT1 transporter. This process being facilitated by the acidification of the rhizosphere by the AHA2 proton-ATPase. Recently, we and others have demonstrated that Fe nutrition is also facilitated by the synthesis and excretion, by the rhizodermis-specific PDR9 transporter, of coumarin compounds. Within this work, using the model plant *Arabidopsis thaliana*, we demonstrated that the IRT1/FRO2 high-affinity root Fe²⁺ transport system is necessary for the plant to assimilate the Fe remobilized by the coumarin compounds present in the root exudate.


Charpentier M, Sun J, Vaz Martins T, Radhakrishnan GV, Findlay K, Soumpourou E, Thouin J, Véry A-A, Sander D, Morris RJ, Oldroyd GED (2016) [Nuclear-localized cyclic nucleotide-gated channels mediate symbiotic calcium oscillations](#). *Science*, 352(6289):1102-1105



This work, led by John Innes Centre scientists (UK), in collaboration with B&PMP for electrophysiology, targets the early steps of signaling induced by nitrogen-fixing rhizobacteria in the legume plant *Medicago truncatula*. It evidences a complex between the K⁺-permeable DMI1 ("Does not Make Infections 1") nuclear channel and Ca²⁺-permeable cyclic nucleotide-gated channels (CNGC), and highlights the role of these channels in nuclear oscillations of Ca²⁺ and the establishment of symbiotic interactions.

Press Releases

Shahzad Z, Canut M, Tournaire-Roux C, Martinière A, Boursiac Y, Loudet O, Maurel C (2016) [A potassium-dependent oxygen sensing pathway regulates plant root hydraulics](#). *Cell*, 167(1):87-98.e14

How plant roots sense and react to soil flooding

While we already knew that plant roots were capable of sensing many individual soil characteristics (water, nutrients and oxygen availability), we did not have any understanding of how they integrated these signals in order to respond in an appropriate way. Researchers from CNRS and INRA have just discovered a mechanism that allows a plant to adjust its water status and growth according to different soil flooding conditions. The results of this study, published on 15 September 2016 in the journal *Cell*, describe how roots sense and respond to soil oxygen and potassium levels jointly, so as to change their water uptake capacity. Aside from their scientific importance, these findings could make it possible to optimize crop flood tolerance.

Dedicated session of the French Academy of Sciences

« The great French advances in biology presented by their authors »

How Roots Perceive and Respond to Flooding
presented by Zaigham SHAHZAD
and Christophe MAUREL



INSTITUT DE FRANCE
Académie des sciences

6 juin 2017

How Roots Perceive and Respond to Flooding

Zaigham SHAHZAD

Authors spotlight

How Roots Perceive and Respond to Flooding

Zaigham SHAHZAD (Zaigham.Shahzad@glasgow.ac.uk)
Christophe MAUREL (christophe.maurel@cnrs.fr)

Shahzad et al., *Cell*, 2016



Séance publique de l'Académie des Sciences – 6 Juin 2017

Finalists des volumes - 2016-2017

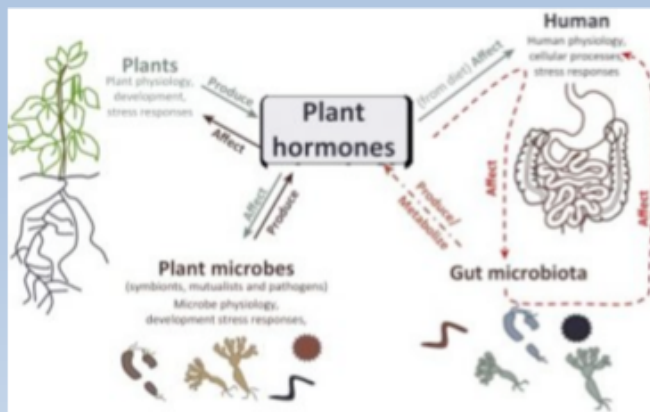


Emilie Chanclud & Benoît Lacombe (Sep 2017) [Plant hormones: key players in gut microbiota and human diseases?](#) *Trends Plant Sci.* 22(9):754-758

CellPress

How Humans and Their Gut Microbes May Respond to Plant Hormones

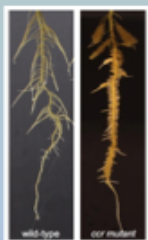
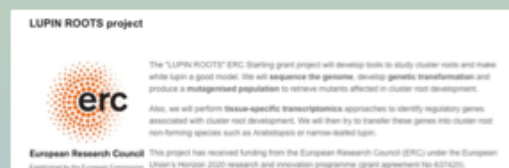
A bowl of salad contains more than vitamins and minerals. Plant matter also includes remnants of the hormones plants produce to control how they grow, age, and manage water intake. Recently, scientists have reported that our gut microbes and cells may respond to these hormones and even produce similar molecules of their own. In an opinion article published August 22 in the journal *Trends in Plant Science*, researchers in France explore how plant hormones may influence human health.



A new team funded by an ERC starting grant

White lupin : a new plant model in B&PMP !

A new team was created in 2015 upon arrival of Benjamin Péret (CNRS researcher) in July shortly after he obtained an ERC « Starting grant » project for a total amount of 2M€ (2015-20). This research project aims at studying the molecular mechanisms of cluster root development in white lupin (*Lupinus albus*). White lupin is the only cultivated species able to produce these amazing structures that are groups of dense lateral roots. They are metabolically highly active, able to efficiently remobilize and absorb nutrients from the soil, especially phosphate.



Since the start of the project in Sept 2015, several research axes have been initiated:

-Mutant identification. An EMS-mutagenized population was produced in the field (sub-contracted by seed producer Jouffray-Drillaud – 2015). Dedicated growth chambers were achieved in May 2016 (design and plan by Hugues Baudot) in order to screen several thousands of seedlings. Numerous mutants constitutively producing cluster roots were identified and their genetic analysis has started (Fanchon Divol and Fanny Garcia).

-Genome sequencing. The complete genome sequence was obtained at the end of 2017. It represents an invaluable tool to perform genetic and molecular studies. The 25 chromosome pairs were assembled with a final N50 of 17Mb. Structural and functional annotations were automatically generated (collaboration with Hélène Bérgès, CNRGV, Toulouse and Jérôme Gouzy, LIPM, Toulouse – Sub-contracting by 2 platforms Génotoul, Toulouse and Gentyane, Clermont-Ferrand). Re-sequencing of other commercial varieties is underway (Bárbara Hufnagel). Other approaches will include *in silico* and cytological studies of repeated elements (André Marquès – CONFAP Fellow from March 2018).

-Transcriptomics studies. Transcriptomic datasets have been produced by 2 complementary methods: spatial dissection of cluster roots and temporal sampling covering their development. RNAseq data production is underway (Bárbara Hufnagel) and their analysis will be performed internally (Bio-informatician position for Alexandre Soriano in 2018). We will generate gene regulatory networks through collaboration (Laurent Laplaze, IRD).

-Developmental analysis. We performed a detailed developmental description of cluster roots (Cécilia Gallardo) including using marker genes in transgenic roots transformed by the “*hairy root*” technique (Célia Casset).

-Developmental determinacy. We are also interested in rootlet development, since they display a determinate meristem (Patrick Doumas and Laurence Marquès), notably as part of a Projet Exploratoire (Labex Agro Nov 2017-18).

In 2016, several permanent members joined the team : Fanchon Divol (IR CNRS) in July then Patrick Doumas (CR INRA) and Laurence Marquès (MCF Univ Montpellier) in October. For more information, please contact us or visit our website www.plasticity.fr



Interactions with the public



B&PMP is participating every year in the 'Fête de la Science' national. The aim is to open the doors of the research institutions to welcome the public interested in learning more about research in France. Together with another research unit (UMR LEPSE), B&PMP welcomes during one day about 50 pre-graduate students to explain them the objectives and activities associated to our scientific projects. We show them how a set of complementary technologies is used into a coherent approach to clone a gene, discover the function of the protein it encodes, locate its expression in the plant, determine the conditions of this expression, and finally characterize the resulting physiological function and phenotype for the plant. On this occasion the students participate in seven workshops presented by the scientists and technician of both B&PMP and LEPSE.

How to feed 9 billions people by 2050 (7 october 2017) https://www.sciencesetavenir.fr/decouvrir/tele-cinema/sur-les-routes-de-la-science-au-vietnam-un-diner-aux-insectes-presque-parfait_112213

Because of global changes and increase in world population, nearly 9 billions people by 2050, agriculture is facing challenges for producing sufficient amounts of good quality food. Drought, soil salinization, flooding, pathogen attacks ... are among the most serious threats. What are the major research directions in agronomy to face these challenges? Developing crop root systems with a higher capacity for reaching water in the ground floor, or manipulating stress tolerance genes in crops, are examples among other. In this panel discussion, chaired by Doan Trung Luu (Researcher associate B&PMP), scientists were invited to popularize their research:

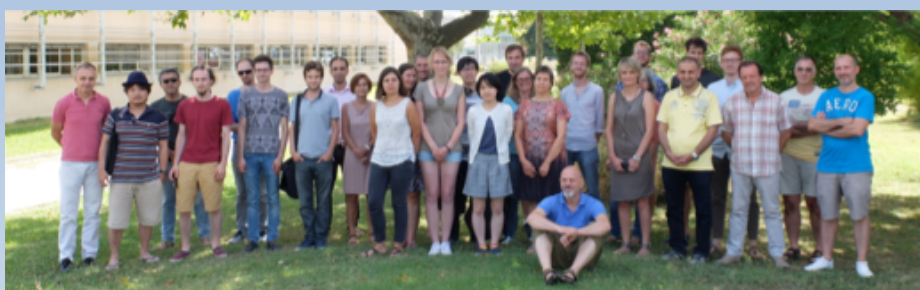
- Dr Philippe Nacry (B&PMP), member of the scientific committee of INRA, is an expert in plant biotechnology.
- Dr Nicolas Condom, CEO of Ecofilae, a consulting company, is promoting water reuse.
- and Dr Stéphane Person, Forest Goods Growing, is promoting insects as sources of proteins.

Training



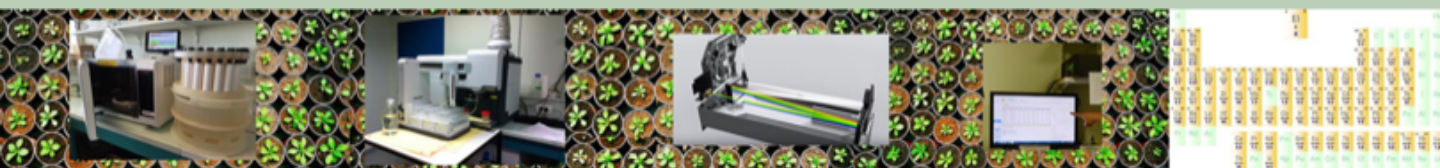
The biology of ion and water transport in plants involves specific concepts and methods that are generally not acquired during classical Master and PhD studies. The MISTRAL summer school organized every other year by B&PMP puts emphasis on such concepts and methods since 2012. It generally gathers 15-20 PhD students or post-docs (mostly from abroad) for two weeks of both theoretical and practical training in English, in particular within the various technological platforms of the institute. In addition, MISTRAL includes specific conferences given by 3-4 invited renowned international experts in the field.

More info on the Website of the 2016 session:
<http://www1.montpellier.inra.fr/ibip/mistral/>.



New facilities at B&PMP

Multi-Elemental Analyses Service (SAME)



[Stéphane Mari](#)

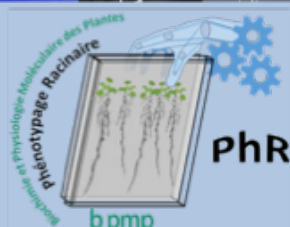
Scientific Manager

[Sandrine Chay](#)

Technical Manager

The Multi-Elemental Analyses Service (SAME), created officially in July 2016, is devoted to the atomic quantification from plant samples (roots, leaves, fruits, seeds, cellular fluids...) as well as from soil material. Basically, the samples (dry material) are digested by acidic hydrolysis that disrupts molecular structures to release their atomic content (phosphorus, calcium, magnesium, sodium, iron, zinc...). After this hydrolysis step, the chosen elements are quantified by atomic emission spectrometry. The service proposed by the platform includes the hydrolysis of the samples, the choice of elements and the quantification by spectrometry. The equipment is composed of a microwave with 2x24 reactors for the acidic digestions and a microwave-plasma atomic emission spectrometer (MP-AES, Agilent) equipped with an autosampler.

Root Phenotyping Platform (PhR)



[Philippe Nacry](#)

Scientific Manager

The Root Phenotyping Platform, created in 2017, is hosted by the « Biochemistry and Plant Molecular Physiology » department. It is dedicated to kinetic and non-destructive analysis of seedling Root System Architecture of many species including *Arabidopsis*, rice, tomato, rapeseed, and *Medicago* grown *in vitro*. The main objective of the platform is to develop approaches, tools and methods to characterize the impact of different growth environments on root growth and development. This includes osmotic stresses, nutrient deficiency or excess or biotic interactions alone or in combination. These analyses provide the basis for further genetic and molecular physiology approaches

Seedling are grown *in vitro* on 120x120mm (Small plates: SP) or 245x245mm (Large plates: LP) Petri dishes. The phenotyping facility includes a self-contained imaging unit that can handle up to 72 LP and 200 SP at once with imaging frequency ranging from 2 to 24 hours.

The imaging automat is located in a dedicated growth chamber allowing temperature, hygrometry, photoperiod, light intensity being adjusted according to user's requirements.

It is equipped with a 16Mpixel linear camera, a telecentric objective and collimated LED backlight for images at 10µm resolution with high contrast (even for thin and almost translucent *Arabidopsis* roots).

Collected images are stored on long term on a secure data storage system.

Images are analyzed through semi-automated or fully automated pipelines integrated in the Open Alea Lab suite (<https://team.inria.fr/virtualplants/software/>). The Root Phenotyping Platform is backed to B&PMP research programs but is open to the scientific community through local, national and international collaborations.

Coming in 2018....



12TH CONGRESS OF THE INTERNATIONAL PLANT MOLECULAR BIOLOGY

5-10 AUGUST 2018 | MONTPELLIER FRANCE

ORGANIZING COMMITTEE



Benoit Lacombe
CNRS, BPMP



Michel Leducq
Université Montpellier, IAP RICE 2



Alain Ghesquière
IRG, DIADE



Jean-Benoit Morel
INRA, BPPI



Laurent Tomagosa
Montpellier SupAgro, AGAP



Emmanuel Guiderdoni
CNRS, AGAP



Claire Corange-Faliss
CNRS, BPMP



Sophie Loran
CNRS, IPME

The IPMB congress is a triennial meeting gathering 1500-2000 plant molecular biologists from all over the world since 1984. The IPMB2015 was held in Brazil (Iguazu) and was preceded by IPMB2012 in Korea (Jeju Island) and IPMB2009 in USA (St Louis). Each of the previous meetings demonstrates the importance to develop multidisciplinary approaches to face climate changes and population increase. IPMB2018 will follow up with an attractive scientific program highlighting major impact recent discoveries from basic molecular biology to crop biotechnology. Combination of plenary and parallel sessions will demonstrate the importance of plant molecular biology to fulfill the need for the development of an ecologically intensive farming.

The congress will take place in a conference center offering all facilities in old downtown Montpellier. Nestled between the countryside, the sea and the mountains, Montpellier is the capital of the biggest wine area in the world.

<https://www.ipmb2018.org/>



1st international Plant Systems Biology meeting
September 10-14, 2018 in Roscoff (FR)

Scientific Committee:

Gabriel Krouk (Chair) [\[web page\]](#)
Pascal Falter-Braun (Co-Chair) [\[web page\]](#)
Siobhan Brady [\[web page\]](#)
Gloria Coruzzi [\[web page\]](#)
Rodrigo Gutierrez [\[web page\]](#)

Committee for promotion of IPSB student engagement.

Miriam Gifford [\[web page\]](#)
Ruth Bastow [\[web page\]](#)

Local organizer Committee:

Nathalie Babic (CNRS)
Gabriel Krouk (CNRS)
Wojciech Szponarski (INRA)



Gabriel Krouk (Chair)
(CNRS, B&PMP)



Pascal Falter-Braun (Co-Chair)



Gloria Coruzzi



Rodrigo Gutierrez



Siobhan Brady



System Biology aim is to use mathematical modeling procedures together with computer science to study biological objects as a whole trying to explore their emerging properties. Many plant biology labs around the world are taking these new avenues of research and are even developing landmark datasets and analysis, bridging biology, modeling and computer science.

The IPSB2018 Jacques Monod conference (1st international Plant Systems Biology [IPSB] meeting) is meant to consolidate the plant biology community around this emerging field that represents an important shift in plant biology studies.

<https://sites.google.com/site/iplantsystemsbiol/home>

<https://twitter.com/hashtag/IPSB2018?src=hash>