

NEWS FROM CRH

October 2020



CENTRE OF THE REGION HANÁ
FOR BIOTECHNOLOGICAL AND
AGRICULTURAL RESEARCH



INTERVIEW

Recently, you and your colleagues have been collecting the fruit of your long-term research labor in several areas. One of them is an article in *Nature Communications*, where you, together with partners from the Czech Republic, Austria and Sweden, brought new knowledge that changes the perception of the effect of plant hormones cytokinins on cells. How important is this accomplishment to you?

I appreciate it very much and I thank all colleagues who contributed to this success. I am especially proud to have shown that CRH can do multidisciplinary research at a very high level. Modern science is based on this principle. It would not be possible to achieve breakthrough results without it.

Not only interdisciplinarity is important, but also the cooperation of various institutions at home and abroad.

Yes, researchers from CRH, Laboratory of Growth Regulators, Regional Center of Advanced Technologies and Materials and institutes from Austria and Sweden participated in this project. Achieving the results would not be possible without the use of advanced microscopic methods developed and used in CRH and especially without cooperation with Eva Benková from the Institute of Science and Technology (IST) in Austria, with whom we have collaborated on the topic since 2013. The paper is a great accomplishment and satisfaction mainly for the main author Karolina Kubiasová, who participated in microscopic observations in CRH and IST as part of her doctoral thesis.

It is certainly interesting for scientists if their work contributes to the elimination of a commonly used principle. What dogma was rebutted this time?

Since 2000, when cytokinin receptors were discovered in plants, views on where they are signaled in the cell have changed. The original idea predicted the extracellular perception of cytokinins by cell surface receptors. This was replaced by the belief supported by experimental data that the receptors are located primarily within cells. However, there were indications that functional receptors could also be present on their surface. We have succeeded in proving that this is indeed the case and that the cytokinin receptors, which are necessary for the initiation of molecular-biological processes in the plant, are also found in the plasma membrane, i.e. on the cell surface.

In the professional community you are also known in connection with phenotyping, you are the coordinator of the Czech Plant Phenotyping Network (CzPPN). How is your group doing in this area?

LUKÁŠ SPÍCHAL

Head of Phenotyping
research program



“I am especially proud to have shown that CRH can do multidisciplinary research at a very high level.”

I think that in recent years we have managed to find a firm place in the field of automated plant phenotyping and we have been able to find our own domain in which we are perceived as pioneers. We have developed a number of original procedures that enable large-scale screening of libraries of substances, large collections of genotypes and biostimulants. CzPPN is also visible in the world due to the effective

cooperation of academia with private sector; a company Photon Systems Instruments, world leader in the development of phenotyping devices, is also a member of the network. We hope that our group will be able to join the Roadmap of

Czech Research Infrastructures within the CzPPN and thus become a functional and Czech-supported connection with European EMPHASIS infrastructure.

A team under your leadership has developed a robotic system called Cinderella, which is designed to automatically prepare samples for plant research. Automation is necessary in science, are you considering further projects in this area?

Yes, in our team we are developing “low-cost” equipment for automated plant phenotyping. It brings about new challenges, but also valuable experience. In our group, we are moving from “interdisciplinarity” to “multidisciplinarity” and we fully enjoy the connection between basic and applied research. We learn what experimental development means in practice, and also how long the journey from prototype to commercial use can be. I really enjoy watching team members reach their potential sometimes in a completely different area. It is very inspiring. Our equipment is primarily intended to facilitate our own work, but we believe that they can have commercial potential and we are open to cooperation leading to market application.

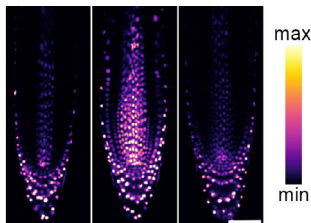
SCIENCE AND RESEARCH

CHANGE IN VIEW OF PLANT HORMONES EFFECT

Researchers from CRH and other Czech research institutions, in collaboration with colleagues from Austria, Sweden and the United Kingdom, have taken a crucial step in understanding the effects of plant hormones cytokinins in plants. They have shown that cytokinin receptors, which are essential for initiating molecular-biological processes in the plant, are also found on the cell surface. The results were published in *Nature Communications*.

“We were the first to document that cytokinin receptors actually occur on the surface of some cell types. It was also possible to decipher the circumstances under which this happens and the pathways in which the receptors move from inside the cell to its surface and vice versa. The age-old dogma that these receptors need to be searched only inside cells has therefore been rebutted,” said one of the corresponding authors Lukáš Spíchal from CRH.

Cytokinins are among the key hormones that are absolutely essential for plant life. Czech scientists have a



long tradition in their study and are among the world's best in this field. This time the researchers from CRH “tracked” the cytokinins in collaboration with foreign colleagues using two different methods. They worked with the roots and isolated root cells of a model plant of *Arabidopsis thaliana*. Obtained results significantly change the ideas about the mechanisms of action of cytokinins.

Reaching conclusions would not be possible without the use of advanced microscopic methods developed and used in CRH and the Austrian Institute of Science and Technology. “Detecting receptors and their fluorescent ligands in living cells is very difficult, but by using super-resolution methods in microscopy, we are gradually approaching this challenging goal. The selection of the correct method of biological sample preparation also plays an important role,” explained Olga Šamajová from CRH.

Further research should clarify whether and how differences in receptor placement help the plant to “tune” the action of cytokinins in plants, including the root system. “The role of these hormones in root development is still not clear, and our results suggest that there are a number of regulatory mechanisms yet to be mapped. A closer understanding of regulatory role of cytokinins may also be useful for development of a new generation of compounds derived from these hormones used in agriculture,” explained Ondřej Novák from the Laboratory of Growth Regulators.

Kubiasová K., Montesinos J.C., Šamajová O., Nisler J., Mik V., Semerádová H., Plíhalová L., Novák O., Marhavý P., Cavallari N., Zalabák D., Berka K., Doležal K., Galuszka P., Šamaj J., Strnad M., Benková E., Plíhal O., Spíchal L. (2020) Cytokinin fluorochrome reveals multiple sites of cytokinin perception at plasma membrane and endoplasmic reticulum. *Nat. Commun.* 11:4285. IF = 12.1

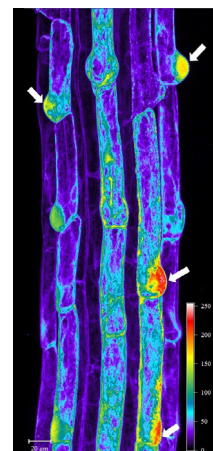
NEW INFORMATION ON ANNEXIN 1 PROTEIN

The localization of Annexin 1 protein was studied by researchers from CRH in collaboration with colleagues from the Max Planck Institute in Dresden and the University of Bonn. The study, which was the first to observe a given protein in living plants during its development, was published by *Frontiers in Plant Science* and can be considered as a starting point for further research into this protein.

Annexin 1 protein is found in all eukaryotic organisms. The range of its activities is very diverse, but in the case of plants it has not been much explored. The researchers monitored Annexin 1 protein associated with the green fluorescent protein in *Arabidopsis thaliana* at various stages of plant development using advanced microscopic techniques. Most of them at the disposal of the Department of Cell Biology of the CRH, but colleagues from the Max Planck Institute in Dresden also contributed.

“Thanks to the possibility of using lattice light sheet fluorescence microscopy, we were able to prove that the protein is located near the nucleus in a certain type of root cells. During root development, we could observe how this protein dynamically moves along with the nucleus. Another benefit lies in the fact that we managed to prove that this protein also participates in cell division,” said the main author of the work, Michaela Tichá, who obtained the published results during her doctoral studies.

Tichá M., Richter H., Ovečka M., Maghelli N., Hrbáčková M., Dvořák P., Šamaj J., Šamajová O. (2020). Advanced Microscopy Reveals Complex Developmental and Subcellular Localization Patterns of ANNEXIN 1 in *Arabidopsis*. *Front. Plant Sci.* 11:1153. IF = 4.4

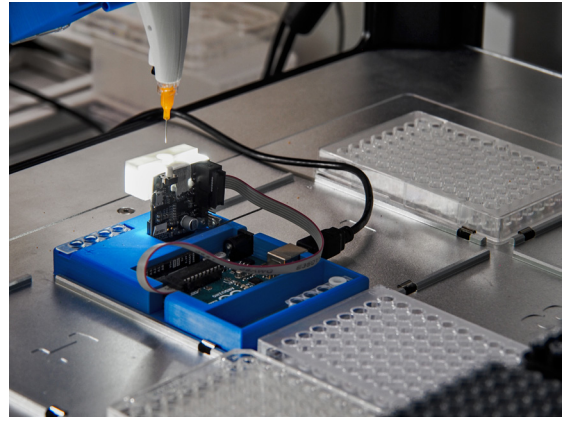


FOCUSED ON PRACTICE CINDERELLA HELPS PREPARE SAMPLES

CRH researchers, in collaboration with Stäubli Systems and the Science and Technology Park (VTP) of UP, have developed a robotic system called Cinderella, which is designed to automatically prepare samples for research of plant behavior depending on the environment. Automated equipment can significantly speed up the preparation of experiments.

The device combines automated transfer and control of seeds with the preparation of necessary gels and liquids that contain fertilizers or test substances. “Cinderella will create a complex sample, which used to be prepared by hand by laboratory technicians. It enables preparation more precisely, in large quantities, faster and, if necessary, even in continuous operation. In addition, the entire device is placed in a box with air filtration and a UV lamp, which ensures the sterility of the environment,” explained Pavel Mazura, a molecular biologist and the principal investigator of the Proof-of-Concept (PoC) project from TACR GAMA program.

CRH is the national coordinator for plant phenotyping within the Czech Plant Phenotyping Network (CzPPN). According to CzPPN coordinator Lukáš Spíchal, the new facility can significantly streamline the entire research



process in this field. “We are able to analyze plant growth in automatic mode using non-invasive sensors, in really large quantities. The critical point in the preparation of plants is the transfer of seeds, which brings about high demands on manual work of laboratory technicians. The robot will eliminate this, and the laboratory technician will therefore be able to engage in other activities,” explained Spíchal.

Although Cinderella is intended for laboratories performing plant phenotyping, it may be used to transfer other small objects. Its use is therefore more diverse, not only in research. CRH and VTP are now looking for a commercial partner to use the device alone or as part of a larger facility. Cooperation with Stäubli Systems, which provided a key robotic arm for testing free of charge, was also very important for the project.

VEGETUP INCREASES THE YIELD OF FRUIT VEGETABLES



VegetUP, developed by CRH scientists for watering in hydroponic cultivation, increases the yield of fruit vegetables by five to ten percent. During its preparation, the researchers built on many years of study of plant hormones - cytokinins.

“The product increases the production of fruit vegetables and at the same time delays aging of plants, so they can bear fruit more evenly throughout their vegetation. It also helps plants manage temperature excursions,” said one of the authors Radoslav Koprna from CRH. Along with him, other colleagues from the Department of Chemical Biology of CRH and the Laboratory of Growth Regulators, which is a joint workplace of the Faculty of Science of UP and the Institute of Experimental Botany of the ASCR, also took part in the development of the substance.

VegetUp has been included in the database of fertilizers and auxiliaries for hydroponic cultivation, i.e. cultivation without soil, which has been booming in recent years. As only a very small amount of solution is needed, CRH staff are able to prepare it potential buyers themselves. “While in other substances it is necessary to use micromolar amounts, in this case it is only nanomolar amount in large volumes of water. The recommended dilution is in units of milliliters to tens of thousands of liters of water. Those interested can turn to us, but we have also started to address large growers ourselves. I have not heard of any similar substance on the market,” added Koprna.

ON THE WAY TO CATRIN

SCIENTIFIC COUNCIL OF CRH DEVOTED TO CATRIN



The jubilee 20th meeting of the Scientific Board of CRH, which took place on September 16, had a somewhat unconventional program. Among other things, the scientific centers entering CATRIN university institute, which, based on the decision of the Academic Senate of Palacký University, will start its activities on October 1, presented themselves.

CATRIN REACTOR OFFERED TOPICS FROM CANNABIS TO NANOMATERIALS

The participants of CATRIN Reactor talked about magnetic nanostructures, the use of nanomaterials in medicine, advanced microscopic methods, cannabis as a medicinal plant and industrial crop, the development of new drugs or the diagnosis of viruses, including the new coronavirus and many other topics. It was attended by scientists from all three university centers, which will link their research at the new university institute. The aim of the meeting was to share knowledge and experience of individual research groups and to find space for mutual cooperation.

At the meeting, about twenty scientists from the Regional Center for Advanced Technologies and Materials, CRH and the Institute of Molecular and Translational Medicine presented their research. For example, for Petr Tarkowski of CRH, the meeting was important for several reasons. "Firstly, during discussions with colleagues from IMTM and RCPTM, I was reassured that we are able and willing to implement activities that I have been thinking about for

"This year, CRH has completed a successful stage of its development and is on the verge of entering a new one, as part of CATRIN. I am glad that we were able to celebrate our anniversary at the occasion of founding CATRIN and that we were joined by representatives of the Regional Center for Advanced Technologies and Materials and the Institute of Molecular and Translational Medicine. Presentation of research programs of all three research centers confirmed their excellent scientific level and outlined the possibilities for further development and deepening of mutual cooperation. In a relatively short time since its establishment, all three centers have achieved a number of outstanding results and have become internationally respected institutions," said Jaroslav Doležel, scientific director of CRH and head of the Olomouc branch of the Institute of Experimental Botany of ASCR.

The University Institute - Czech Institute for Research and Advanced Technologies (CATRIN) integrates three university research centers. Together, they will look for opportunities to tackle global issues using, among other things, approaches of biomedicine, biotechnology and new materials.

a long time, such as testing the biological activity of plant extracts or using nanomaterials to maintain microbial quality of medical cannabis. Secondly, I obtained more detailed information not only about the research areas of colleagues from other two research centers, but also about the available methods and devices for joint use. Last but not least, this meeting made me think about possible cooperation in the field of phytoremediation," said Tarkowski.



BRIEFLY

Participants of a September debate entitled Climate change: What will we breathe, eat and drink? organized at the University of Ostrava by several universities under the Partner network of universities for social responsibility project called for the changes in agriculture, better land management, stronger support for the transfer of knowledge into practice and political decisions or for the reduction of bureaucracy. Palacký University, which also participated in the organization, sent plant geneticist Aleš Pečinka from the Institute of Experimental Botany of the ASCR, which is part of CRH. Among other things, he talked about methods of targeted genome editing, which can help provide enough food for the world's population without further burdening the environment. A record of the debate is available at [Universitas website](#).

The fall stage of the documentary film festival about food Earth on a plate took place in Fort Science on September 15. The event was organized by the following institutions In Mind, the research program Food for the Future Strategy AV21, the Institute of Experimental Botany of ASCR and Fort Science.

The program of the summer horticultural and flower exhibition Flora Olomouc was again joined by scientists

from the Olomouc branch of the Crop Research Institute, which is a part of CRH. In Pavilion H in the Plant Research Laboratory, they presented an interactive exhibition Seed Production. "Our exhibition was dedicated to seeds and monocotyledons of vegetables and medicinal, aromatic and culinary plants. We focused our attention on the seed production of various types of these crops, more precisely on the post-harvest treatment of seeds, which includes, for example, various methods of manual and mechanized cleaning, sorting, post-harvest ripening or sanding and their germination. Workers introduced concepts such as dormancy, stratification, scarification and others. Visitors will be able to try out many of the presented processes," said Kateřina Směkalová from Crop Research Institute.

All three partner institutions forming CRH received an excellent "mark" within the evaluation of research organizations by the Council for Research, Development and Innovation (RVVI) according to the 2017 Methodology. Palacký University Olomouc, the Institute of Experimental Botany of the Academy of Sciences of the Czech Republic and the Crop Research Institute after two years of evaluation are in the highest of the four ranking groups of research institutions in the Czech Republic. The quality of their selected results on a national scale determined their inclusion.

CONGRATULATIONS

IVO FRÉBORT HAS BECOME A VICE PRESIDENT OF EFB

CRH Director Ivo Frébort has become the new Vice President of European Federation of Biotechnology (EFB). He will also lead the newly established Plants, Agriculture and Food Division.

"I very much appreciate being elected a Vice President of EFB. It has come as the result of our research center's long-term cooperation with this organization. I am really pleased to be able to contribute to the fulfillment of the main goal of EFB, which is to promote and support the development of biotechnology in Europe," said Frébort. CRH, led by him, has been a member of EFB since 2011. It also works closely with the Asian Biotechnology Federation.

Professor Frébort, along with other vice presidents, will work closely with the new EFB President Jeff A. Cole, Professor Emeritus of Microbiology at the University of



Birmingham, who is also a member of CRH Scientific Board. He will replace Swedish microbiologist Mathias Uhlén, who has led the non-profit organization since 2015.

NEW ORGANIZATIONAL STRUCTURE OF EFB

The management of the European Federation of Biotechnology (EFB) strives for more effective management and better coordination of activities by changing its organizational structure. Ivo Frébort, CRH Director and an Executive Board member of EFB, also participated in the change. He was one of the initiators of the new Plants, Agriculture and Food Division, which he will lead. The existing sections have been replaced by seven divisions, with the Biopharmaceutical and Medical Biotechnology division also being a novelty.

As the head of Plants, Agriculture and Food Division, Professor Frébort plans to organize conferences, summer schools and popularization events in this area. “Under the auspices of the division, we will continue to organize the international conference Plant Biotechnology: Green for Good, which takes place every two years in Olomouc. Other events will be organized mainly by partners from Germany and Switzerland. I also consider it very important

that the major biotechnology companies Syngenta and Novozymes will participate in the activities of this division. At the beginning of October, our division sponsored one of the program components of the European Forum for Industrial Biotechnology and Bioeconomy (EFIB), where delegates learned up-to-date information on the current state and other perspectives of the biotechnology-based industry,” adds the biochemist, who is a supporter of the regulation of existing European legislation on GMOs.

EFB has 80 members from institutions across Europe and over 25,000 expert members. It promotes the safe, sustainable and beneficial use of basic research and innovation in the biological sciences, while providing space for interdisciplinary and international cooperation. Czech Republic has strengthened its position in the institution thanks to the activities of CRH. Ivo Frébort has been elected a Vice President, and Michaela Holecová has become an Executive Board member of EFB.

ANOTHER CALL FOR CHANGE IN EU LEGISLATION ON GMOS

European scientists are again calling for a change in European legislation on GMOs, which they say is essential for the further development of sustainable agriculture, ensuring sufficient food for a growing population and protecting the environment. The statement has been issued by the European Initiative for Sustainable Agriculture through Genome Editing (EU-SAGE) on the second anniversary of a controversial ruling by the EU Court of Justice that plants obtained using modern genome editing methods are genetically modified organisms (GMOs). Management of CRH as well as the EFB have joined the initiative.

The ruling of EU Court of Justice from July 25, 2018 means that even plants obtained via methods of precision breeding using genome editing by CRISPR are genetically modified organisms (GMOs). “This means that even crops with the smallest genome modifications, which can occur spontaneously in nature, are subject to restrictive European regulations, which practically prohibit these



modifications,” warns Jaroslav Doležel, scientific director of CRH and head of the Olomouc Institute of Experimental Botany of the Academy of Sciences.

European scientists are therefore recommending to the European Council, the European Parliament and the European Commission a revision of the existing GMO directives, as they run counter to current scientific knowledge on plant genome editing. The complete article is available here: https://www.eu-sage.eu/sites/default/files/2020-07/Open%20Statement%20EU-SAGE%20July%202020_EN.pdf



Centre of the Region Haná for Biotechnological and Agricultural Research

CRH brings together research groups from Palacký University and Olomouc worksites of Institute of Experimental Botany, AS CR, and Crop Research Institute. CRH is a Regional Branch Office of EFB.

Šlechtitelů 241/27
783 71, Olomouc – Holice

Tel: +420 585 634 979

Email: crh@upol.cz

Web: www.cr-hana.eu

Facebook: www.facebook.com/Centrumregionuhana/

Twitter: www.twitter.com/crh_olomouc

Published by:
Centre of the Region Haná for
Biotechnological and Agricultural
Research 2020

Editor: Martina Šaradínová

Photo:
Vědeckotechnický park UP, CRH
archive

Graphic design:
Ondřej Růžička