proteinspotlight
> ONE MONTH, ONE PROTEIN <

Issue 116, March 2010

www.proteinspotlight.org

A complicated affair

Vivienne Baillie Gerritsen

There is no life without communication. A heart will not beat, an eye will not see, a flower will not bloom, unless cells are exchanging information continuously. Such information comes both from the outside environment – such as light and temperature, for instance – and the inside environment – such as calcium, hormones or pressure, for example. Take a plant. A given leaf does not grow into its shape or size without the help of multiple upstream messages which have been processed, understood and performed accordingly. Thus giving the rose its petal, the cactus its needles and the fir tree its cone. A very intriguing question is how does a plant know when to tell a leaf to stop growing? In other words: how does a plant know when to tell cells to stop multiplying and expanding? Thus giving the leaf its final – and characteristic – form? The protein kinase ERECTA may provide an answer. ERECTA, or ER, seems to have a central role in relaying multiple messages to multiple pathways involved in plant development and architecture.

from the series “CC – unlimited power”
by Robert Slingsby, 2009

Courtesy of the artist

Long before the world wide web and text messages, Nature had devised intricate forms of exchange so that a population of cells – which can easily exceed a million – is organised into specific parts, which take on specific roles. A liver, a foot, a stem, a fin. Without the relay of such knowledge, a cell would not know that it has to become a neuron and migrate to the brain, or grow into the beginnings of a bud and blossom in the Spring. Thousands of cues – either external to the cell, or internal – are transmitted unremittingly and processed by way of specific biological pathways.

But what is it that grabs the cues in the first place? The answer is: receptors. Cells' membranes are riddled with them – as are their internal organelles. Receptors recognise – and are recognised – by all sorts of ligands which will bind specifically to them, thus triggering off a signal which will be relayed, spinning biological pathways into life, or indeed, keeping them alive. ER is one such receptor.

ER belongs to the large family of LRR (Leucine Rich Repeat) receptor-like kinase proteins, which are known to participate in signal transduction. This particular protein kinase, ER, has been extensively studied in the model plant organism *Arabidopsis thaliana.* It is dispersed throughout the plant – save in its roots – and has proved to have not only one role, but many, in plant development as well as pathogenic resistance.

ER is a transmembrane protein and probably acts as a signal transducer. The extracellular segment of ER is typically made up of LRRs which form the receptor that is recognised by a ligand – whose nature is unknown to date. Such ligands then activate the cytoplasmic part of ER, i.e. the kinase which, in turn, phosphorylates a target molecule. Whose nature is also unknown.

The theory is that these target molecules may then act upon certain genes involved in plant cell division, differentiation and coordination. The ultimate outcome being the size and shape of an organ, such as a fruit for instance.

Receptor-like kinases, like ER, are therefore constantly coping with external and internal messages in order to sculpt a bud or delineate a leaf. What is more, besides the role of ER in the proper development of a plant, it also seems to be involved in the response to light, the increase in photosynthetic activity and transpiration efficiency. More surprisingly, though, ER could also have a role in pathogenic resistance to bacteria and fungi. One example is bacterial wilt caused by *Ralstonia solanacearum*. The existence of ER seems to check the progression of the disease. How? It has been suggested that, on recognising *R.solanacearum, A.thaliana* – by way of ER – may change the development program in such a way that the altered architecture of the plant makes it difficult for the bacteria to infect it. An intriguing concept.

Certainly ER does seem to be at the heart of plant development, be it at the level of cell division, cell growth or cell coordination. As a result, it must be found upstream from many biological pathways. And what scientists would also like to know is what the downstream targets are. Indeed, getting to know the LRR receptor-like kinase ER better would not only help understand how signal transduction occurs but would be of great service in the fight against diseases such as bacterial wilt, for example – one of the most widespread plant afflictions. Like an adolescent, ER is receiving and transmitting messages unremittingly. The only difference is that we still don't know who sends the messages, nor for whom they are destined. Communication has never been a straightforward affair.

Cross-references to UniProt

LRR receptor-like protein kinase ERECTA, *Arabisopsis thaliana* (mouse-ear cress) : Q42371

References

1. Ingram G.C., Waites R.
   Keeping it together: coordinating plant growth
   Current Opinion in Plant Biology 9:12-20(2006)
   PMID: 16326130

2. Lease K.A., Lau N.Y., Schuster R.A., Torii K.U., Walker J.C.
   Receptor serine/threonine protein kinases in signalling: analysis of the erecta receptor-like kinase of Arabidopsis thaliana
   The New Phytologist 151:133-143(2001)

3. Zanten M., Snoek L.B., Proveniers M.C.G, Peeters A.J.M
   The many functions of ERECTA
   Trends in Plant Science 14:214-218(2009)
   PMID: 19303350

4. Torii K.U., Mitsukawa N., Oosumi T., Matsuura Y., Yokoyama R., Whittier R.F., Komeda Y.
   The Arabidopsis ERECTA gene encodes a putative receptor protein kinase with extracellular leucine-rich repeats
   The Plant Cell 8:735-746(1996)
   PMID: 8624444