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## Recognizing pathogens, and recognizing errors

August 19, 2015 by Mary Williams

*This week's Research in Focus article has two take-home messages. The first is about how an important plant pathogen is recognized by its host: specifically, the role of a newly-identified tyrosine-sulfated bacterial protein. The second is about the process of science and the foundation of trust on which it rests: specifically, how to proceed when an error is recognized.*

### Discovery of the activator for rice immune receptor XA21

*Xanthomonas oryzae* pathovar *oryzae* (also known as Xoo) is a bacterial pathogen of rice. By studying

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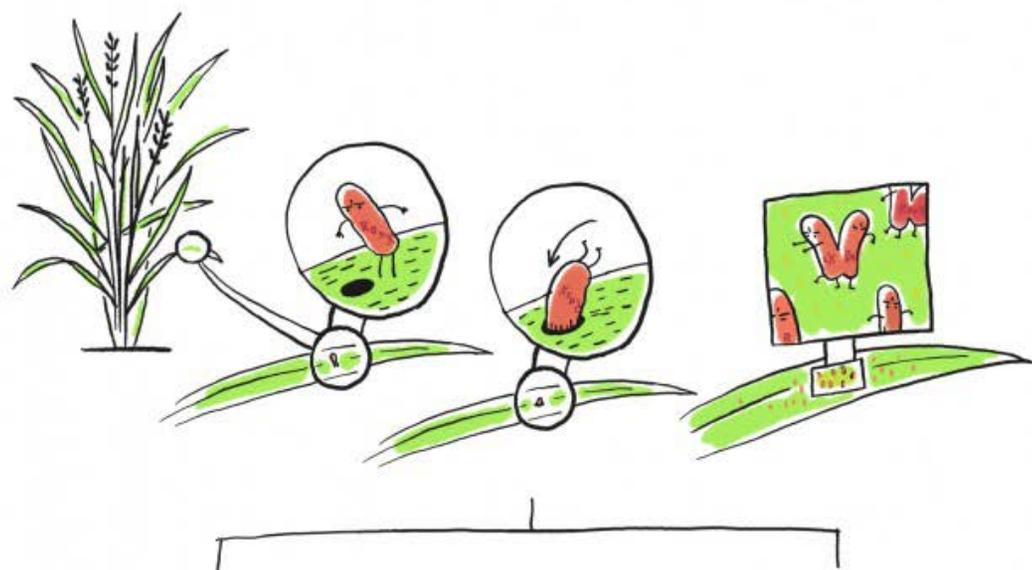
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rice strains resistant to *Xoo*, members of Pamela Ronald's lab mapped resistance to XA21, a leucine-rich repeat receptor kinase (Song et al, 1995 ). Until recently, the question of what this receptor recognizes to initiate resistance was uncertain. The lab thought they had the answer in 2009, but later found that there were errors in their studies, leaving the receptor's activator an open question (Lee et al., 2013 ).

In a new paper by Pruitt et al., ( 2015 ), a small bacterial protein known as RaxX was shown to be necessary and sufficient for recognition by XA21. One of the interesting things about RaxX is that it is recognized only when one of the tyrosine residues is sulfated; bacterial strains that fail to produce RaxX or that cannot sulfate it, as well as some strains isolated from rice-growing areas in India that carry a variant RaxX allele, are able to avoid detection by XA21.

Bacterial tyrosine-sulfated proteins were unknown until recently, and this is the first identification of a bacterial protein with this modification. Interestingly, tyrosine-sulfated proteins are produced in plants, including some with roles in defense (see Mosher et al., 2013 ). As yet the biological function of RaxX is not known. Does it confer some benefit to *Xoo* (in the absence of its detection by the receptor XA21), perhaps mimicking the properties of an endogenous plant protein?

By identifying the protein recognized by XA21, this research opens up possibilities for engineering receptors with broader recognition capabilities and for extending resistance to *Xanthomonas* pathogens of crops beyond rice.



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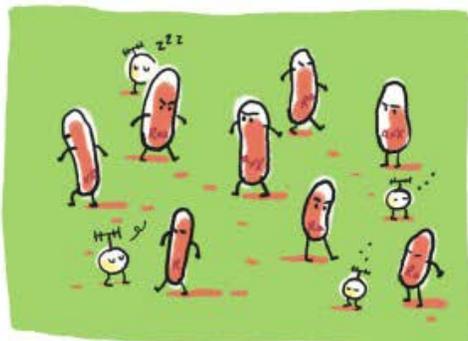
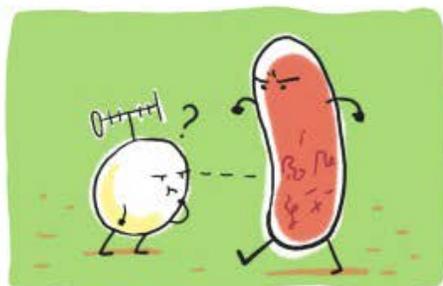
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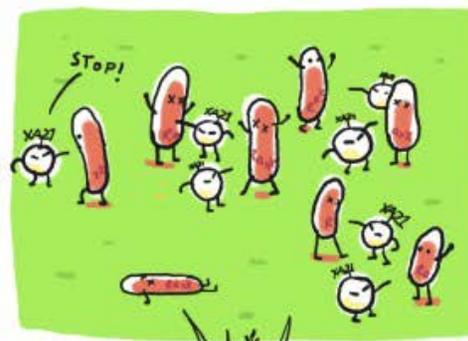
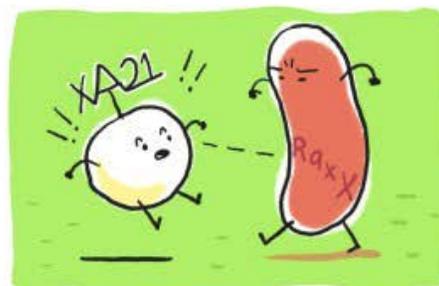
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## SUSCEPTIBLE PLANT



## RESISTANT PLANT



In susceptible plants, *Xanthomonas oryzae* pv *oryzae* evades detection and causes disease. Resistance occurs when plants carrying the immune receptor XA21 recognize the bacterial RaxX protein; immune responses are initiated and the plant remains healthy. Illustration by Maurice Vink CC BY 4.0.

### Lessons about the process of science

In the guide to responsible conduct in research, the National Academy's Committee on Science, Engineering and Public Policy states that "*The scientific enterprise is built on a foundation of trust*" (2009). Two of the core responsibilities of a research scientist are to **report results factually** and to **report mistakes when they are identified**. The steps taken by the Ronald lab after they realized that their 2009 publication contained errors provides an exemplar for how these responsibilities should be carried out in practice. First-person accounts from the researchers about the process they undertook can be found in Schwessinger et al., (2015), Ronald (2013), and Retraction Watch (2015). I urge everyone to

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read these accounts and the NAS guide, and to remember that the collective privilege of seeking knowledge comes with the collective personal responsibility of research integrity.

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