In fending off diseases, plants and animals are much the same, research shows

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In earlier research, the authors used rice and mice to identify the first immune receptors in plants and in animals.

(PhysOrg.com) -- It may have been 1 billion years since plants and animals branched apart on the evolutionary tree but down through the ages they have developed strikingly similar mechanisms for detecting microbial invasions and resisting diseases.

This revelation was arrived at over a period of 15 years by teams of researchers from seemingly disparate fields who have used classical genetic studies to unravel the mysteries of disease resistance in plants

and animals, according to a historical overview that will appear in the Nov. 19 issue of the journal *Science*.

The report, written by Pamela Ronald, a UC Davis plant pathologist, and Bruce Beutler, an immunologist and mammalian geneticist at The Scripps Research Institute, describes how researchers have used common approaches to tease apart the secrets of immunity in species ranging from fruit flies to rice. It also forecasts where future research will lead.

"Increasingly, researchers will be intent on harnessing knowledge of host sensors to advance plant and animal health," said Ronald, who was a co-recipient of the 2008 U.S. Department of Agriculture's National Research Initiative Discovery Award for work on the genetic basis of flood tolerance in rice.

"Some of the resistance mechanisms that researchers will discover will likely serve as new drug targets to control deadly bacteria for which there are currently no effective treatments," she said.

At the heart of this research saga are receptors -- protein molecules usually found on cell membranes -- that recognize and bind to specific molecules on invading organisms, signaling the plant or animal in which the receptor resides to mount an immune response and fend off microbial infection and disease.

Beutler and Ronald have played key roles in this chapter of scientific discovery. In 1995, Ronald identified the first such receptor -- a rice gene known as known as Xa21 -- and in 1998, Beutler identified the gene for the first immune receptor in mammals -- a mouse gene known as TLR4.

Despite having gone their separate ways at least a billion years ago, plants and animals have developed remarkably similar mechanisms for detecting the molecular signatures of infectious organisms. Credit: Image courtesy of Tree of Life Web Project

Their overview in Science includes illustrated descriptions of the disease-resistance or immunity pathways in the mouse, Drosophila fruit fly, rice and a common research plant known as Arabidopsis. These represent the immune defense systems of vertebrates, insects, monocotyledons (grass-like plants) and dicotyledons (plants like beans that have two seed leaves.)

The researchers note that plant biologists led the way in discovering receptors that sense and respond to infection. The 1980s brought about an intense hunt for the genes that control production of the receptor proteins, followed by an "avalanche" of newly discovered receptor genes and mechanisms in the 1990s.

Another milestone included discovery in 2000 of the immune receptor in Arabidopsis known as FLS2 -- which demonstrated that a plant receptor could bind to a molecule that is present in many different microbial

invaders.

The review also discuses how plant and animal immune responses have evolved through the years and which mechanisms have remained the same.

While the past 15 years have been rich in significant discoveries related to plant and animal immunity, Beutler and Ronald are quick to point out that researchers have just scratched the surface.

"If you think of evolution as a tree and existing plant and animal species as the leaves on the tips of the tree's branches, it is clear that we have examined only a few of those leaves and have only a fragmentary impression of what immune mechanisms exist now and were present in the distant past," said Beutler, an elected member of the U.S. National Academy of Sciences.

He and Ronald predict that, as results from new gene sequencing projects become available, scientists will likely find that some plant and animal species emphasize specific resistance mechanisms while having little use for others.

For example, the researchers point out that the Drosophila's immune system depends on only one immunologically active receptor, known as the Toll receptor, to sense invasion by fungi and gram-positive bacteria. In contrast, Arabidopsis has dozens of sensors to protect against microbial infections and rice has hundreds.

Ronald and Beutler project that many surprises will be uncovered by future research as it probes the disease-resistance mechanisms of other species.

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