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## T Cell Fundamentals: Understanding the Basics of Immunology

By Jim Oldfield  
*June 18, 2007*

T cells, a type of white blood cell, work within the immune system to prevent disease—cancer and infection—by attacking foreign cells and viruses. But they are also the vehicle for autoimmune diseases, including Type 1 diabetes and rheumatoid arthritis, in which T cells fail to recognize healthy cells and instead destroy them. Ironically, although one of their normal functions is to patrol for and kill cancer cells, T cells themselves can undergo cancerous transformations to become lymphomas or leukemias. The immune system must therefore maintain a fine and specific balance, mounting robust defenses against harmful elements, while recognizing and sparing the roughly 100 trillion cells that comprise the system's "host," the human body. When this balance is lost, we get sick.

Immunology researchers study the molecular and cellular processes that underpin immunity and what happens when immunity fails. Immunology is a rapidly evolving and promising research field, because scientists are now within reach of genetically manipulating immunity based on a thorough understanding of those basic processes. Dr. Michele Anderson, a scientist in molecular and cellular biology at Sunnybrook Research Institute, is one such researcher.

Since the mid-1990s, her focus has been on a gene first known as HEB. HEB's specialty is transcription—turning on other genes. Scientists studying immunity established an early and important niche for HEB in regulating T cell development. HEBAIt had been HEB's silent partner since HEB was recognized as a T cell player (and likely for millions of years before), but that changed forever in 1997, when Anderson spotted HEBAIt during a genomic-scale screening for genes active in the early stages of T cell development.

At first she thought HEBAIt was a new but uninteresting gene, because part of it looked identical to HEB, but then she noticed that its other half was different—a unique series of amino acids nobody had ever seen before—and that was the end of the silent partnership. When she named it HEBAIt, HEB became known, with perhaps unkind irony, as HEBCan.

"It was a kind of eureka moment—very exciting," says Anderson.

There is no consensus on how the HEBs felt about this development, but it has undoubtedly raised the profile of their extended family of basic helix-loop-helix transcription factors, which have been toiling in the gene transcription business for countless generations.

The consequences of the discovery have grown ever since, as Anderson and other scientists have produced evidence that HEBAIt and HEBCan influence a wide range of immune responses. They are essential to the development of healthy T cells, and may play a role when T cell development goes awry. Abnormal T cell development can result in immunodeficiency—the loss of the ability to combat infection. Immunodeficiency occurs in acquired immune deficiency syndrome, or AIDS, when the T cells become the target of



Dr. Michele Anderson in the Sunnybrook research lab. - Photo by Doug Nicholson

occurs in acquired immune deficiency syndrome, or AIDS, when the T cells become the target of

an invasive pathogen. Immunodeficiency can also result from disruptions in T cell development that lead to the production of nonfunctional cancerous T cells, which grow so rapidly that they displace normal blood cells.

The ability of HEBAIt to increase the rate of growth in developing T cells suggests that its dysregulation could have similar consequences. (Anderson's lab also found that HEBAIt may be associated with a total loss of growth control in B cells, producing B cell leukemia, the most common childhood cancer.) To examine the roles of HEBAIt and HEBCan in T cells, the Canadian Institutes of Health Research awarded Anderson \$592,125 over five years in February 2007, despite an extremely low—15%—funding rate.

While HEBAIt and HEBCan were unavailable for comment, scientists are looking forward to the day when their remaining secrets are revealed, unleashing their potential to help expose the nefarious workings of cancer. To put it mildly, cancer has been a pernicious and fickle player in the gene transcription business, and developing effective treatments will require detailed knowledge of how regulators of gene expression like HEBAIt and HEBCan function during T cell development. Says Anderson, "The immune system is a fascinating biological system, and although the gene therapy field is slow, it's going to get there, eventually."

**The Canada Foundation for Innovation, Ontario Innovation Trust, the University of Toronto, the Leukemia Research Foundation and the Canadian Institutes of Health Research funded Anderson's work.**

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