

Preface

Researchers have used a variety of techniques over the past century to gain fundamental insights in the field of immunology and, as technology has advanced, so too has the ability of researchers to delve deeper into the biological mechanics of immunity. The immune system is exceedingly complex and must patrol the entire body to protect us from foreign invaders. This requires the immune system to be highly mobile and adaptable - able to respond to diverse microbial challenges while maintaining the ability to distinguish self from a foreign invader. This latter feature is of great importance because the immune system is equipped with toxic mediators, and a failure in self/non-self discrimination can result in serious diseases. Fortunately, in most cases, the immune system operates within the framework of its elegant design and protects us from diverse microbial challenges without initiating disease.

Because the immune system is not confined to a single tissue, a comprehensive understanding of immunity requires that research be conducted at the molecular, cellular, and systems level. Immune cells often find customized solutions to handling microbial insults that depend on the tissue(s) in which the pathogen is found. Removal of immune cells from their natural environment is one common means by which immunity is studied; however, this approach comes with the caveat that immune cells interact uniquely with the microenvironments and tissue architecture they encounter. Because no two tissues are alike, immune cells will often adapt and respond based on the unique microenvironment in which they reside. Given this fact, it is of great importance to consider cellular context when deciphering the mysteries of the immune system. Lessons learned in one tissue may not necessarily apply to the entire body.

Understanding the contextual side of immunity necessitates study of immune cells *in vivo*. However, those that pursue *in vivo* research immediately encounter the obstacle of how best to study immune cells in their natural environments. This obstacle is not a trivial one, as it is far easier to remove cells from their natural environments and study them *ex vivo* or *in vitro*. Fortunately, scientists in other disciplines have come to the rescue with exciting advances in imaging techniques. These advances have enabled immunologists to quite literally “see” how immune cells respond to diverse challenges. Using static imaging approaches, researchers have captured snapshots in time, which are then pieced together with

corroborating datasets to assemble a sequence of events. More recently, researchers have instituted an exciting upgrade, transitioning from static to dynamic imaging techniques such as two-photon laser scanning microscopy. These dynamic approaches are advantageous because researchers can use them to study immune cells in their natural environments in real time. Thus, it is no longer necessary to extrapolate from in vitro observations how immune cells operate in vivo. Immune cells operating in states of health and disease can now be filmed and studied afterwards in great detail.

The field of visualizing immunity has moved rapidly over recent years and has carved out an important niche within the broader discipline of immunology. This issue was assembled to pay tribute to those who have gleaned fundamental insights in immunology using imaging approaches. The reviews within span a breadth of knowledge that covers certain technical, molecular, cellular, and systems aspects of visualizing immunity. The issue begins with what should be considered when assembling a custom imaging platform and then progresses to the mechanics of T cell interactions and activation. From there, the issue moves on to lymphocyte motility/migration, B lymphocyte activation, and finally to visualizations of some challenges that immune cells face (e.g., pathogens and tumors). We felt that these topics have a natural flow in the order presented and allow the reader to “see” the development of immune responses at all levels. The visualizations within are aesthetically pleasing, and it is gratifying to know that many novel insights have been extracted from such stunning imagery. Now that the field has been set ablaze with enthusiasm, it is certain that exciting new immunological discoveries lie just around the corner. This issue is merely a snapshot in time for a field that should grow exponentially in the years to come.

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