Introduction
The gradual evolution of the immune system has allowed it to respond to various pathogens by different effector mechanisms. The potential range of immune responses that can be mounted against a given antigen is extensive and is characterised by the type of antigen and the cells of the immune system involved. Broadly classified, there are two types of immune cells that are involved, (a) cells such as macrophages, neutrophils, eosinophils, which form the major component of the innate immune system and which respond without using clonotypic receptors and (b) cells that respond by using clonotypic receptors (T and B cells) and which make up the adaptive immune system.

The functions of the immune system, however, are mediated by complex interactions between the innate and adaptive immune system. Cells such as macrophages, dendritic cells and activated B cells constitute the class of professional antigen presenting cells (APCs). These cells present the antigen in the form of short peptides in association with the surface MHC class molecules and are recognised by the clonotypic T cell receptor (TCR) present on the surface of the mature T cells. Mature T cells express either CD4 or CD8 coreceptors. CD4 T cells recognise peptides presented by MHC class II molecules on the surface of APCs whereas CD8 T cells respond to the antigenic peptides presented by MHC class I molecules. However, B cells respond to antigen alone and undergo differentiation upon B cell receptor (BCR) engagement and produce antigen specific antibodies.

Generation of the ligand for the TCR, the peptide-MHC complex, on the surface of APC is a complex event involving a series of steps. Broadly, these events include internalisation of
exogenous proteins via endocytosis or phagocytosis, degradation of proteins to peptide fragments, binding of peptides to intracellular MHC class I/II molecules, and transport of these complexes to the plasma membrane for presentation to lymphocytes. Despite the identification of various endocytic sub-cellular organelles and proteases involved, the exact pathways for the major bulk of antigen processing and presentation are still controversial.

Once a T cell recognises the peptide-MHC complex, there are a number of interactions between the T cell and the APC. The response of an antigen specific naïve T cell upon its recognition of the peptide-MHC complex is initiated by oligomerisation of TCR, coreceptor and costimulatory molecules at the interface in specialised membrane microdomains, rafts, facing the APCs, which results in effective TCR mediated signaling cascades and culminate in one or several outcomes of T cell activation such as proliferation, effector stage generation, secretion of various cytokines, activation induced cell death (AICD), generation of immune memory and anergy. However, the importance of membrane compartmentation for the recognition of peptide-MHC complexes needs more comprehensive understanding to explain the early events in T cell activation.

These complex sets of interactions and signal transduction through the TCR are translated to a functional fate of the T cell. Differentiation of a CD4 T cell results in the generation of a Th1 or Th2 T cell effectors. A Th1 response regulates the cell-mediated immunity and is effective in the elimination of intracellular pathogens, and Th2 response regulates humoral immunity and is critical for the clearance of extracellular pathogens. Th1 response is characterised by the production of cytokines such as IL-2, IFN-γ and TNF-β whereas in a
Th2 response IL-4, IL-5, IL-6, IL-10 and IL-13 are the cytokines that are produced. A Th1 response results in a strong delayed-type hypersensitivity reaction whereas a Th2 response results in an allergic response.

Another outcome of T cell activation is generation of memory T cells as well as AICD of effector cells. Immunological memory is defined as faster, greater response upon re-exposure to the same antigen. Memory T cells are characterised by an altered pattern of expression of cell surface molecules such as CD44, CD45 and its isoforms, CD62L and CD69. Post activation, a differentiated effector T cell undergoes programmed cell death or AICD. It is still unclear how the balance between memory and AICD is controlled in a T cell response.

Given the several outcomes of T cell activation and the central role of T cells in an adaptive immune response, the decisions taken by a T cell are critical for the host. These choices emanate from the initial cognate and non-cognate interactions between a T cell and APC, therefore, the functional life of a T cell is stringently dependent on the process of T cell-APC interaction. In this context, I have tried to address some of the issues related to T cell functions using a variety of approaches.

In one approach I have used a previously established system wherein maleylation of proteins is used for specific delivery of protein antigens to different APCs via scavenger receptors (SRs). SRs are a group of receptors that are expressed on the cells of monocytic lineage and bind to various polyanionic ligands. It has been earlier shown that maleylated
proteins are more immunogenic than the native proteins since they enhance T cell response \textit{in vivo}. Comparative analysis of the cytokine profile of native protein primed T cells and maleyl protein primed T cells has shown that immunisation with maleyl proteins skews the CD4 T cell response to Th1 type even if immunisation with the native protein results in Th2 cytokine phenotype. Using this system, I have attempted to address the role of various factors that regulate the cytokine commitment of CD4 T cells.

In another approach methyl-\textbeta-cyclodextrin, a cyclic heptasaccharide, which chelates cholesterol, an important component of membrane microdomains, from the plasma membrane thereby disrupting the microdomain organisation, has been used to examine early events of T cell activation.

Finally, I have used an experimental system involving the drug pentoxifylline (PF), which has been previously shown to result in better induction of T cell memory. Using this approach, the effect of increase in intracellular cAMP and its downstream signaling pathways have been examined in generation of immunological memory and survival of activated T cells.