Nature Reviews Immunology | AOP, published online 19 September 2008; doi:10.1038/nri2420

INNATE IMMUNITY

Swarms defend against parasites

Neutrophils have an important role in the immune response against pathogens, but the mechanism by which they mediate their protective effect is poorly understood. A recent study in *Immunity* shows that during infection neutrophils migrate to the lymph nodes, where they form dynamic clusters, referred to as swarms, that have an important role in the defence against intracellular parasites.

To examine neutrophil trafficking to the lymph nodes, the authors used mice in which neutrophils expressed green fluorescent protein, infected them with the intracellular parasite *Toxoplasma gondii* and examined tissue sections of the lymph nodes by fluorescence microscopy. They observed that neutrophils rapidly migrated to the lymph nodes after infection, and this was dependent on their expression of the adaptor protein MyD88 (myeloid differentiation primary-response gene 88). Moreover, infiltrating neutrophils were found to form swarms, and these coincided with the location of the parasites in the lymph nodes.

The authors then investigated the dynamics of neutrophil swarm formation using two-photon-laser-scanning microscopy of intact draining lymph nodes. They observed that neutrophils formed two types of swarm following infection with *T. gondii*: transient swarms, which were smaller and dissolved quickly, and persistent swarms, which were larger (owing to continuous neutrophil migration and merging with nearby swarms) and persisted for the duration of the imaging period. Based on this, the authors propose that, once a swarm reaches a certain size, the signal generated from the neutrophils overpowers the signal of neighbouring swarms, generating a stable swarm centre. Neutrophils were also found to migrate towards these swarms in a directed manner and in streams, which indicates that there might be communication between the cells.

The authors went on to examine how the swarms were assembled following infection and observed that they could be initiated by the cooperative action of neutrophils and parasite egress from infected cells of the lymph node. More specifically, small clusters were initially formed by a few 'pioneer' neutrophils, and these clusters induced the migration of other cells into the swarm.

As neutrophils are known to degrade tissues through the secretion of enzymes, the authors then examined whether the appearance of swarms corresponded with the destruction of infected cells in the lymph nodes. Indeed, they observed that the continuous layer of $CD169^+$ macrophages that is normally found in the subcapsular sinus of the lymph node was disrupted following infection with *T. gondii*, with gaps in this area corresponding to the location of neutrophil swarms. This suggests that, following parasite infection, neutrophil swarms disrupt the structure of the lymph node by removing subcapsular-sinus macrophages.

Taken together, these data indicate that signals released by parasites during their egress from infected cells and by pioneer neutrophils result in the formation of dynamic swarms, which remove infected macrophages in the subcapsular sinus of the lymph node.

Rachel David

ORIGINAL RESEARCH PAPER Chtanova, T. *et al.* Dynamics of neutrophil migration in lymph nodes during infection. *Immunity* 19 August 2008 (doi:10.1016/j.immuni.2008.07.012)