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Reprogramming macrophages to combat cancer by engineering polymer surface properties

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Abstract

Two pathways for activating macrophages exist. One of these pathways is known as the classically activated M1 pathway, which is achieved through exposure to lipopolysaccharide. M1 macrophages are part of the type 1 T helper (Th1) response and are known as pro-inflammatory cells.[1] The other pathway is reached through interleukin-4 and is known as the alternatively activated M2 pathway. M2 macrophages produce pro-angiogenic factors.[2] Being able to control the polarization of these cells is very attractive for both drug delivery and tissue engineering applications. One such application lies in tumor associated macrophages (TAMs), which promote tumor growth through the release of angiogenic molecules. Our goal is to use polymeric drug delivery systems to reprogram TAMs such that the produce pro-inflammatory molecules, which will kill neoplastic cells.These polymers will be eventually used to delivery anti-cancer therapeutics to the tumor. Our approach has been to examine polymer functional groups and their effect on macrophage polarization.

In assessing the ability of polymers to reverse the polarization of macrophages, we examined secretion of several markers of both the Th1 and Th2 responses. For the M1 macrophages, these included tumor necrosis factor-α, monocyte chemotactic protein-1, and reactive nitrogen intermediates. Arginase and interleukin-10 were monitored as markers of M2 macrophages. Macrophages were activated in both polarizations and were incubated with polymers modified with different functional groups. Several functional groups were identified as being able to reprogram M2 macrophages – the polarization of TAMs – to produce increased amounts of molecules associated with M1 macrophages.

1. Gordon, S. Alternative activation of macrophages. *Nature reviews Immunology***3**, 23–35 (2003).

2. Schmid, M. C. & Varner, J. A. Myeloid cells in the tumor microenvironment: modulation of tumor angiogenesis and tumor inflammation. *Journal of oncology***2010**, 201026 (2010).

Biography

Kaitlin M. Bratlie is an Assistant Professor of Materials Science& Engineering and of Chemical & Biological Engineering at Iowa State University. She was an NRSA NIH postdoctoral fellow in the David H. Koch Institute for Integrative Cancer Research at MIT. Her research interests are focused on understanding how biomaterial properties influence biocompatibility through optical imaging techniques. She has published 20 papers.