Biological Applications of Carbon Nanotubes

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**Description:**
Adoptive T cell transfer, involving the ex vivo expansion of T lymphocytes, is a viable therapeutic approach for both infectious diseases and cancer, with demonstrated efficacy in treating melanoma, Epstein-Barr virus, and HIV-related infections. However, T cell transfer by clonal expansion is not clinically feasible as it does not consistently generate therapeutic quantities of T cells. Efforts to develop a reproducible “off-the-shelf” means of stimulating and expanding T cells in vitro have focused on bead-based systems. This novel approach involves single walled carbon nanotubes (SWNT) coupled to anti-CD3 antibodies, a known stimulant for T-cell proliferation. SWNTs have a much higher surface area to volume ratio than previous artificial antigen-presenting cells (aAPCs), which facilitates the high density clusters of T cell antigen receptors that are critical for T-cell activation. Anti-CD3 antibodies adsorbed onto SWNT bundles activate T-cells at antibody concentrations at least an order of magnitude less than antibody alone. Furthermore, similar activation is not achieved with other high surface area materials such as activated carbon, polystyrene nanoparticles, and buckyballs. This novel method thus utilizes the unique properties of SWNTs for enhanced stimuli presentation.

**Field of Application:** Adoptive immunotherapy of cancer or infections, including melanoma, Epstein-Barr virus, and HIV-related infections. Broader applications include a modular vaccine systems based on CNT adjuvants. Viruses and pathogens that elicit or subvert immune responses are essentially small nanoparticles with the ability to interact with cells of the immune system in a variety of ways; with their unique ability to activate T-cells, SWNTs can serve as building blocks in the construction of a library of vaccine systems that can be tested for efficacy for any particular antigen.

**Advantages:** Aforementioned applications involve manipulation of biology outside the body or administration of the CNTs through routes which present no substantial regulatory requirements (e.g., oral administration). The research should therefore easily translate into clinical settings. Also, levels of T-cell stimulation can be modulated by varying the concentration of SWNTs, which show promise as the first “tunable” adjuvant that can be engineered to optimize the magnitude and direction of an immune response.

**Stage of Development:** CNT Labware demos available

**Publications:**

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