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(54) **COMPOSITIONS AND METHODS TO MODULATE CELL ACTIVITY**

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(58) **Field of Classification Search**

CPC A61K 9/16; A61K 9/1611

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,435,762 B2 5/2013 Sternson et al.
8,957,036 B2 2/2015 Cascio et al.

(Continued)

OTHER PUBLICATIONS

Huang et al, "Remote Control of Ion Channels and Neurons Through Magnetic-Field Heating of Nanoparticles", Nature Nanotechnology, Aug. 2010, vol. 5, No. 8, pp. 602-606.*

(Continued)

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(57) **ABSTRACT**

The present invention provides methods and compositions for the remote control of cell function based on the use of radiofrequency waves to excite nanoparticles targeted to specific cell types. The nanoparticles may be applied to the target cell extracellularly and/or expressed intracellularly. The cell type of interest expresses a temperature sensitive channel wherein excitation of the nanoparticles results in a localized temperature increase that is transduced into a cellular response. Such cellular responses may include, for example, increases in gene expression resulting in production of one or more physiologically active proteins. The expression of such proteins can be used to treat a variety of different inherited or acquired diseases or disorders in a subject. Accordingly, the invention provides a generic approach for treatment of any disease associated with a protein deficiency.

16 Claims, 56 Drawing Sheets