[0010] In yet another aspect, the nanoparticle has a pMHC density as defined herein of from about 0.4 pMHC/100 nm^2 to about 1.3 pMHC/100 nm^2, or alternatively from about 0.5 pMHC/100 nm^2 to about 0.9 pMHC/100 nm^2, or alternatively from about 0.6 pMHC/100 nm^2 to about 0.8 pMHC/100 nm^2, and further wherein the nanoparticle core has a diameter from about from about 25 nm to about 60 nm, or from about 25 nm to about 50 nm, or from about 20 nm to about 40 nm, or from about 15 nm to about 50 nn, or from about 15 nm to about 40 nm, or from about 15 nm to about 35 nm, or from about 15 nm to about 30 nm, or from about 15 nm to about 25 nm, or alternatively about 15 nm, or about 20 nm, or about 25 nm, or about 30 nm, or about 35 nm, or about 40 nm.

[0011] In some aspects, the nanoparticle core further comprises a plurality of co-stimulatory molecules, co-stimulatory antibodies, inhibitory receptor-blocking antibodies, and/or a plurality of cytokines coupled to the nanoparticle core.

[0012] Thus, certain aspects of the disclosure relate to a complex comprising, or alternatively consisting essentially of, or yet further consisting of, nanoparticle cores coupled to a plurality of pMHC complexes, wherein the nanoparticles cores optionally further comprise, or further consist thereof, or alternatively further consist essentially of one or more co-stimulatory molecules and/or one or more cytokines coupled to the nanoparticle core. For these compositions containing a plurality of the complexes, the pMHC complexes on each nanoparticle core are the same or different from each other; and/or the MHC of the pMHC complexes on each nanoparticle core are the same or different from each other; and/or the cytokines on each nanoparticle core are the same or different from each other; and/or the costimulatory molecules on each nanoparticle core are the same or different from each other; and/or the diameters of the nanoparticle cores are the same or different from each other; and/or the valency of the pMHC complexes on each nanoparticle core are the same or different from each other; and/or the density of the pMHC complexes on each nanoparticle core are the same or different from each other; and/or the valency of the co-stimulatory molecules on each nanoparticle core are the same or different from each other; and/or the valency of the cytokines on each nanoparticle core are the same or different from each other.

[0012a] In another aspect, provided herein is a complex comprising a nanoparticle core coupled to a plurality of antigen-MHC class II complexes (pMHCIIs), the nanoparticle core comprising iron or an iron oxide and having a diameter which is from about 5 nm to about 25 nm, wherein the antigen is an autoimmune disease relevant antigen and wherein the number

of coupled pMHCIIs per nanoparticle surface area is from about 0.4 pMHC/100 nm^2 to about 5 pMHC/100 nm^2, wherein the pMHCIIs are coupled to a maleimide functionalized end of a polyethylene glycol (PEG) linker that is less than about 5 kilodaltons in molecular weight, wherein a non-maleimide functionalized end of the polyethylene glycol (PEG) linker is coupled to the nanoparticle core, and the non-maleimide functionalized end comprises an alkoxy, an alkyl, alkyl-amide-alkyl, alkyl-ester-alkyl, alkyl-amide, alkyl-acid, or alkyl-ester, wherein the complex differentiates an activated T cell or a memory T cell into an IL-10 producing TR1 cell.

[0012b] In another aspect, provided herein is a pharmaceutical composition comprising the complex described herein and a biocompatible excipient.

[0013] In certain aspects, provided herein are compositions comprising a plurality of the complexes provided herein. In some embodiments, the compositions further comprise a carrier, optionally a pharmaceutical carrier. In some embodiments, the compositions provided herein may optionally comprise one or more nanoparticle cores coupled to one or

What is claimed is:

1. A complex comprising a nanoparticle core coupled to a plurality of antigen-MHC class II complexes (pMHCIIs), the nanoparticle core comprising iron or an iron oxide and having a diameter which is from about 5 nm to about 25 nm, wherein the antigen is an autoimmune disease relevant antigen and wherein the number of coupled pMHCIIs per nanoparticle surface area is from about 0.4 pMHC/100 nm^2 to about 5 pMHC/100 nm^2, wherein the pMHCIIs are coupled to a maleimide functionalized end of a polyethylene glycol (PEG) linker that is less than about 5 kilodaltons in molecular weight, wherein a non-maleimide functionalized end of the polyethylene glycol (PEG) linker is coupled to the nanoparticle core, and the non-maleimide functionalized end comprises an alkoxy, an alkyl, alkyl-amide-alkyl, alkyl-ester-alkyl, alkyl-amide, alkyl-acid, or alkyl-ester, wherein the complex differentiates an activated T cell or a memory T cell into an IL-10 producing TR1 cell.

2. The complex of claim 1, wherein the number of coupled pMHCIIs per nanoparticle surface area is from about 0.4 pMHCII/100 nm^2 to about 1.3 pMHCII/100 nm^2.

3. The complex of claim 1, wherein the number of coupled pMHCIIs per nanoparticle surface area is from about 0.5 pMHCII/100 nm^2 to about 0.9 pMHCII/100 nm^2.

4. The complex of claim 1, wherein the diameter is from about 15 nm to about 25 nm.

5. The complex of claim 1, wherein the pMHCIIs are covalently coupled to the nanoparticle core, via the formation of a carbon-sulfur bond between the thiol (-SH) group of a cysteine residue added to the carboxyl terminus of the pMHCIIs and maleimide.

6. The complex of claim 1, wherein the IL-10 producing TR1 cell expresses CD49b.

7. A pharmaceutical composition comprising the complex of claim 1 and a biocompatible excipient.

8. The complex of claim 1, wherein the non-maleimide functionalized end comprises an alkoxy or an alkyl.

9. The complex of claim 8, wherein the non-maleimide functionalized end comprises an alkoxy.

10. The complex of claim 9, wherein the alkoxy comprises C_1 to C_3 alkyl.

11. The complex of claim 8, wherein the non-maleimide functionalized end comprises an alkyl.