

analysis was performed. Significant ($p < 0.05$) decrease in surviving fractions with increased incubation time was observed (FIGS. 17A-17B). For example, DU-145 clones (FIG. 17A) treated for 24 h or 48 h showed surviving fractions of 0.19 ± 0.062 and 0.075 ± 0.03 respectively, as compared to the untreated controls with a surviving fraction of 1.0. Similarly, PC-3 cells (FIG. 17B) treated with paclitaxel-loaded nanoparticles for 24 h or 48 h showed surviving fractions of 0.26 ± 0.01 and 0.14 ± 0.02 respectively. Furthermore, the data showed decreases in both the number and size of colonies in both cell lines exposed to Ptx-GGbPEG nanoparticles.

In vivo Studies Using Athymic Nude Mice Bearing Human Xenograft Prostate Cancer Tumor:

To evaluate the in vivo efficacy of Ptx-GGbPEG-Apt copolymeric nanoparticles, PC-3 cells were injected subcutaneously in the flanks of athymic nude mice as described above. When palpable tumors ($\sim 150 \text{ mm}^3$) were obtained, comparative efficacy studies were performed by dividing animals into five groups ($n=4$) in a way to minimize weight and tumor size differences among the groups and the following regimens were administered by a single injection via the tail vein: (i) saline; (ii) GGbPEG nanoparticles without drug; (iii)

Histological Analysis of Tumor:

Histological staining of the excised tumors was performed and the slides were evaluated by an independent pathologist. Histological examination of tumors by H & E staining at day 60 post treatment showed that saline and GGbPEG treated tumor cells had well-defined cell borders and hyperchromatic nuclei (FIG. 19, designated "A" and "B" respectively). In addition, the cytoplasm of these cells was vesicular and eosinophilic, with evidence of mitoses. On the other hand, tumors treated with Ptx (FIG. 19, designated "C"), Ptx-GGbPEG (FIG. 19, designated "D"), or Ptx-GGbPEG-Apt (FIG. 19, designated "E"), were extensively necrotic, characterized by loss of nuclear staining and cellular details. These data suggested that in the treated groups, the remaining tumor mass at day 60 post treatment consisted largely of dead or dying tumor cells.

While the specification has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to, variations of, and equivalents to these embodiments. Accordingly, the scope of the present invention should be assessed as that of the appended claims and any equivalents thereto.

SEQUENCE LISTING

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56

Ptx solution, 40 mg/kg; (iv) Ptx-GGbPEG nanoparticles, 40 mg/kg; or (v) Ptx-GGbPEG-Apt, 40 mg/kg. The tumor size and body weight were then monitored for 60 days.

The results (FIG. 18) showed that a single intravenous administration of Ptx-GGbPEG-Apt bioconjugates was significantly more efficacious in tumor reduction as compared with nontargeted nanoparticles and controls. One reason for this enhanced efficacy may be that the targeted particles were designed to bind to the PSMA proteins on prostate cancer cells, thus possibly delaying clearance from the site of the tumor. For each control group of saline, GGbPEG, and Ptx, the treatment does not show any significant long-term efficacy, and the mean tumor sizes at the end of the study for the groups were 194.1 mm^3 , 187.9 mm^3 , and 166.2 mm^3 , respectively. None of the animals of the saline and GGbPEG groups exhibited tumor regression. The difference in the final mean tumor size or survival time for the Ptx-treated group compared with the saline and GGbPEG groups was not statistically significant. The Ptx-GGbPEG-Apt-treated group demonstrated the most efficacy with a final mean tumor volume of 96.2 mm^3 , significantly ($p < 0.05$) smaller than all the other groups. All mice in the Ptx-GGbPEG-Apt group survived the 60 day study duration. In addition, the Ptx-GGbPEG group was more efficacious than the Ptx, GGbPEG and saline control groups, but significantly less efficacious when compared with the Ptx-GGbPEG-Apt group as shown in FIG. 18.

What is claimed is:

1. A composition comprising a reaction product of gellan gum covalently bonded to polyethylene glycol, wherein the reaction product comprises gellan gum-b-PEG-COOH with an amide bond linkage between the gellan gum and polyethylene glycol.

2. The composition of claim 1, wherein the reaction product comprises nanoparticles of gellan gum covalently bonded to polyethylene glycol.

3. The composition of claim 2, wherein the nanoparticles have an average particle size ranging from about 50 nm to about 1000 nm.

4. The composition of claim 2, further comprising a biologically active substance complexed with the nanoparticles.

5. The composition of claim 4, wherein the biologically active substance comprises an anti-carcinogenic compound, a protein or a small molecule.

6. The composition of claim 2, further comprising a bifunctional ligand covalently bonded to the nanoparticles, said bifunctional ligand comprising (i) a first functional group capable of covalently bonding to a moiety on the nanoparticle and (ii) another moiety thereon that provides an affinity for a material.

7. The composition of claim 6, further comprising a biologically active substance complexed with the nanoparticles.

8. A method of delivering a drug to a patient, said method comprising: