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Review article

Gold nanoparticle-mediated bubbles in cancer nanotechnology

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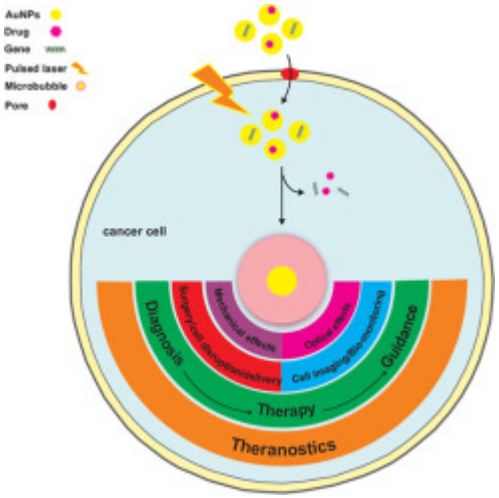
Abstract

Microbubbles (MBs) have been extensively investigated in the field of biomedicine for the past few decades. Ultrasound and laser are the most frequently used sources of energy to produce MBs. Traditional acoustic methods induce MBs with poor localized areas of action. A high energy level is required to generate MBs through the focused continuous laser, which can be harmful to healthy

tissues. As an alternative, plasmonic light-responsive nanoparticles, such as gold nanoparticles (AuNPs), are preferably used with continuous laser to decrease the energy threshold and reduce the bubbles area of action. It is also well-known that the utilization of the pulsed lasers instead of the continuous lasers decreases the needed AuNPs doses as well as laser power threshold. When well-confined bubbles are generated in biological environments, they play their own unique mechanical and optical roles. The collapse of a bubble can mechanically affect its surrounding area. Such a capability can be used for cargo delivery to cancer cells and cell surgery, destruction, and transfection. Moreover, the excellent ability of light scattering makes the bubbles suitable for cancer imaging. This review firstly provides an overview of the fundamental aspects of AuNPs-mediated bubbles and then their emerging applications in the field of cancer nanotechnology will be reviewed. Although the pre-clinical studies on the AuNP-mediated bubbles have shown promising data, it seems that this technique would not be applicable to every kind of cancer. The clinical application of this technique may basically be limited to the good accessible lesions like the superficial, intracavity and intraluminal tumors. The other essential challenges against the clinical translation of AuNP-mediated bubbles are also discussed.

Graphical abstract

Potential applications of gold nanoparticle-mediated bubbles in cancer nanotechnology.



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Keywords

Cancer; Nanotechnology; Gold nanoparticles; Bubble; Theranostics

Abbreviations

Ab, Antibody; ALG, Sodium alginate; AuNP, Gold (Au) nanoparticle; AuNRs, Gold (Au) nanorods; AuNSs, Gold (Au) nanoshells; A431 cell, Epidermoid carcinoma cell line; A549 cell, Lung adenocarcinoma cell; BT-474 cell, Human breast carcinoma cell (HER2-positive cells); BSA, Bovine serum albumin; Caco-2 cell, Epithelial colorectal adenocarcinoma cells; $CD8^+$ lymphocytes, cytotoxic T lymphocytes; Cs, Chitosan; CT, Computed tomography; Cy7, Cyanine 7; C225, Anti-EGFR Antibody; Doxil, Liposome-encapsulated doxorubicin; EGFR, Epidermal growth factor receptor; FBS, Fetal bovine serum; FITC-dextran, Fluorescein isothiocyanate–dextran; Hep-2C cell, EGF-positive carcinoma cell; HEK293T cell, Immortalized human embryonic kidney cells; HAuNS, Hollow Gold (Au) nanoshells; HNSCC cell, Head and neck squamous cell carcinoma; HN31 cell, Head and neck squamous cell; HeLa cell, Immortalized human cervical cancer cells; H1299 cell, Human non-small cell lung carcinoma cell; IgG, Immunoglobulin G; i.v., Intravenous; LITT, Laser-induced thermal therapy; mAb, Monoclonal antibody; MPNS, Magneto-plasmonic nanoshells; MDA-MB-231, Human breast adenocarcinoma cell; MRI, Magnetic resonance imaging; NI, Not import; NIR, Near-infrared; Panitumumab, Anti-epidermal growth factor receptor antibody; NPs, Nanoparticles; NOM9 cell, Immortalized normal human oral kerot-inocyte cell; OVCAR-3 cell, Ovarian carcinoma cell line; PB, Plasmonic bubble; PNBs, Plasmonic nano bubbles; PNPs, Plasmonics Nanoparticles; PEG, Polyethylene glycol; PVP-MPNS, Polyvinylpyrrolidone-stabilized magneto-plasmonic nanoshells; pDNA, Plasmid DNA; PTT, Photothermal therapy; RGCs, Retinal ganglion cells; RPE cell, Human retinal pigment epithelium cell; siRNA, Small interfering RNA; SP, Surface plasmon; SNA, Spherical Nucleic Acid; ZMTH3 cell, Adherent canine pleomorphic adenoma cell

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