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Current trends in theranostic nanomedicines

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ABSTRACT

Nanomedicine plays a vital role in targeting therapeutics to the desired site of action. Over the years, several nanomedicines, like monoclonal antibodies (Rituximab, Brentuximab Vedotin, Alemtuzumab, etc.), nanostructured lipid carriers, conjugated polymeric nanoparticles, solid lipid nanoparticles, liposomes, polymeric micelles, quantum dots, dendrimers, protein-based nanoparticles, carbon nanotubes, and inorganic nanoparticles (e.g., mesoporous silica nanoparticles, iron oxide nanoparticles, gold nanoparticles, calcium phosphate nanoparticles) have gained wide attention in treatment and diagnosis of diseases. In recent years, nanomedicines have been widely adopted for their imaging potential. In this context, nanomedicines are being amalgamated to a single nanomedicine (also termed nanotheranostics) for diagnosis and drug therapy. However, very few nanotheranostics succeeded in reaching the clinic. Therefore, a collective effort from doctors, pharmaceutical scientists, nanomaterial engineers, and clinicians is required to introduce the future generation of nanotheranostics into the market. In this review, authors have cross-talked about the emerging theranostic modalities (e.g., monoclonal antibodies, dendrimers, polymeric & lipid nanoparticles, and inorganic nanoparticles) for precise diagnosis and therapy of the disease.

1. Introduction

Patient-centered care has always been on higher priority. However, the use of all the current treatment options for treating various deadly diseases is restricted due to the inter-individual variation in drug responses, which significantly influence the activity of drugs at only selective stages of the disease. To overcome these issues, the combination of diagnosis and drug therapy can be a superior therapeutic option, which offers an improved prognosis and patient-specific effect. This concept explored an incredible platform named "theranostics". John Funkhouser is the pioneer of theranostics, which means the combination of diagnosis and therapy. The prime objectives of the theranostic approach are to diagnose the disease accurately and efficiently to deliver the "right" drug based on the initial prognosis at the "right" dose [1]. Presently, there are several areas where theranostics are being employed (Fig. 1).

Nanotheranostics or theranostic nanomedicines are the advanced forms of theranostics made for sensitive diagnosis, precise targeting, efficient and controlled delivery of the nanomaterials. The term nano is derived from the Latin word "*nanus*", which means dwarf. International system (SI) of units uses nano as a prefix for 10^{-9} parts of a meter. Nanomaterials are usually defined as materials having a dimension between 1 and 100 nm. Most organizations such as the International Organization for Standardization (ISO), ASTM International, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), ETC group, and Swiss Re group stated the upper limit of nanomaterials as 100 nm. However, the soil association and Defra stated the upper limit as 200 nm, Chatham House and Friends of Earth stated the upper limit as 300 nm, Swiss federal office of public health stated the upper limit as 500 nm, and House of Lords Science Committee stated the upper limit as 1000 nm [2]. Thus, the size of the nanomaterials used for theranostic purpose range from 1 to 1000 nm [3]. Nanomaterials are referred to as nanovesicles, nanoparticles (NPs), nanotemplates, nanofibers, nanotubes, nanorods, nanowires, etc., based on their appearance

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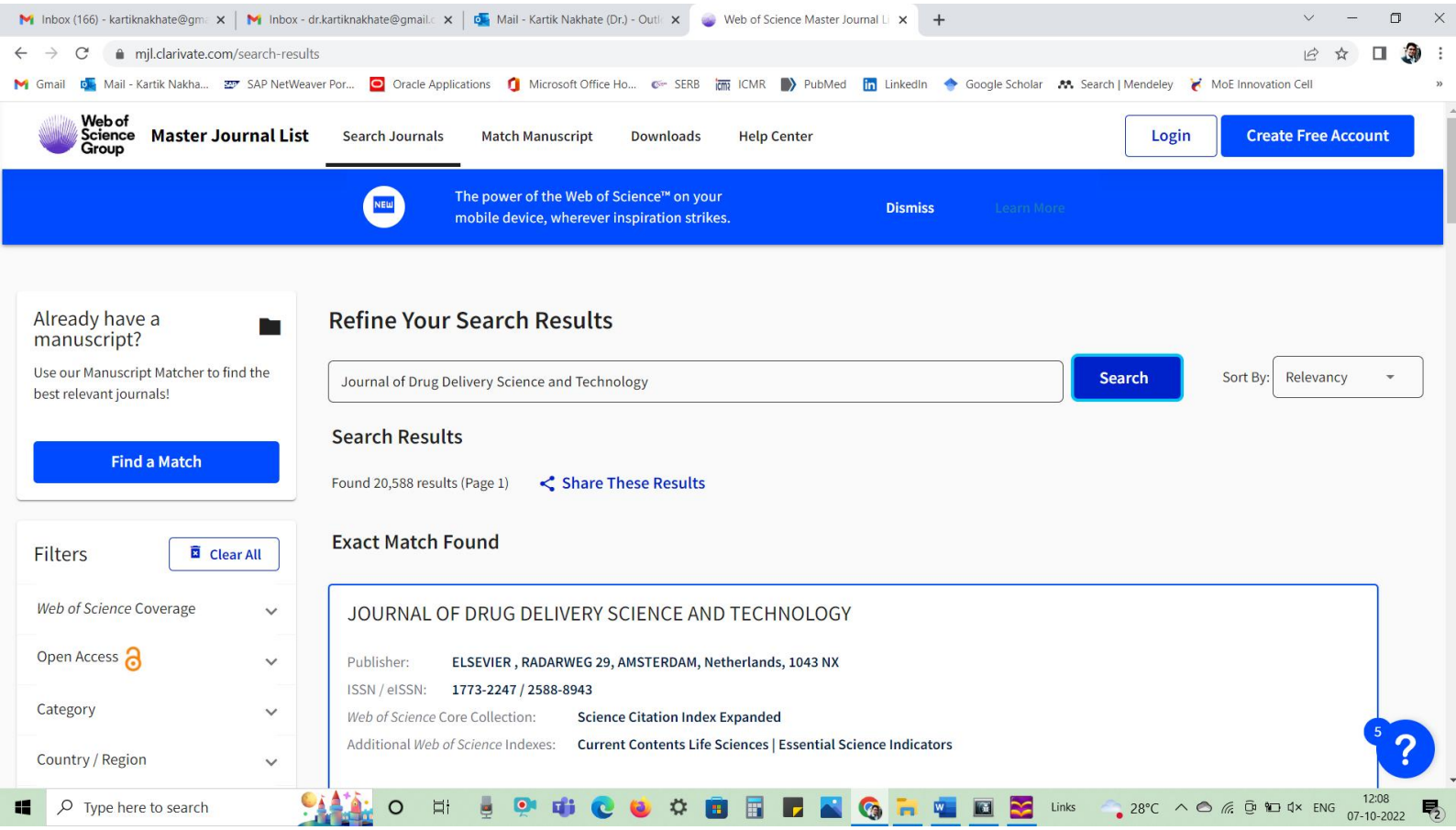
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