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Extended Abstract

Hyphenated Mass Spectrometric Techniques for Smart Materials Architecture: Theranostic Applications

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Abstract:

Rapid early detection is crucial for transboundary/emerging/ zoonotic disease outbreak prevention. Several international organizations such as WHO, OIE, FAO and EPA called upon the development of rapid, sensitive, low cost, and easy to use early diagnosis of pathogens as "rapid field tests" or "point of care diagnostics". Molecular recognition plays an important role in biological systems and is observed in between receptor-ligand, antigen-antibody, DNA-protein, sugar-lectin, RNA-ribosome, substrate-enzyme, etc. (The lock and the key theory, Pauling, 1940). My investigations show that the characteristics of the functional biomimetic system of "molecular architecture" for certain biological organisms and systems should be designed by computational approach. Molecular imprinted polymers (MIPs) have been applied as artificial antibodies, catalysts, sensors, drug assay tools, and affinity separations. Targets including epitopes or haptens, which are the major antigenic determinants of microorganisms like bacteria or viruses, lead to innovations in disease theragnosis. MALDI-TOF MS bio typing was highly successful in rapid identification of Brucella cultures through dendrodrogram analysis, despite the high phenotypic and genotypic similarity among members of the genus Brucella. From the species perspective, B. suis and B. ovis were more related to B. melitensis than to B. abortus, which had a separate cluster. Strain-specific mass spectral peaks were observed among almost all strains examined Tandem mass spectrometric experiments reveal individual polymer end groups; in contrast, the 1-D MS spectrum provides insight about the sum of chain end substituents present in the oligomer, which may also contain partial or complete monomer unit(s). Additionally, MS can be employed to analyze copolymer sequences and to differentiate polymer architectures. Hyphenated mass spectrometric techniques are machines driving these innovations to successful marketable products based on patents. Computational chemistry tools will aid this developmental approach upon conformational decisions of diagnostic biomarkers/ biomimetic smart polymers.

Introduction:

Smart materials have gained increasing attention within the medical specialty analysis fields due to their adjustable physical and/or chemical properties in response to deliberately imparted external stimuli or to environmental changes. For these reasons, their introduction in nanomedicine has opened unprecedented prospects of manipulation of biological entities at cellular and even sub-cellular level. during this situation, the intrinsic properties of nanoparticles or nanotextured materials square measure exploited, providing active devices capable of diagnostic, therapeutic or maybe theranostic functions. once physical cues like lightweight irradiation, ultrasounds, or magnetic attraction fields square measure applied to a wise nanostructure, associate degree energy transduction happens and results into the activation of a certain cellular practicality. Moreover, an acceptable modification of the nanoparticle surface (e.g., with the help of a cell substance or of a organism antibody) will improve the effectivity of this activation, by targeting specific cell populations or maybe specific intracellular organelles. This approach, which may be outlined as a brand new paradigm in nanomedicine, finds many applications together with cancer medical care, drug delivery, tissue engineering, and even applied science. during this mini-review, we'll target those nanomaterials that, in our opinion, square measure the foremost promising in terms of clinical translation, with explicit attention to nanoparticles that act as "nano-transducers," letting a far off manipulation of biological activities, and therefore providing a "smart" interface between biological and non-biological environments. the chance to finely and remotely manipulate cell behavior in deep tissues is of maximum importance in medication for restoring physiological cell activities once the onset of a pathological condition. moreover, the remote of cell activities in vivo permits the elucidation of mechanisms at the bottom of various diseases and also the development of novel therapeutic ways. A consolidated technique for the fine modulation of the activity of specific cell varieties is diagrammatic by optogenetics, that consists within the genetic sensitization of targeted cells to lightweight through a promoter-driven expression of sensitive proteins. instead, a brand new generation of sensible nanomaterial-based approaches for the remote of cell behavior has recently been planned. sensible nanomaterials are often externally/wirelessly activated by completely different energy sources [e.g., near-infrared (NIR) radiations, radiofrequency stimulations, magnetic fields, ultrasounds, etc.] that square measure able to penetrate biological tissues with efficiency and non-invasively. Nanostructure activation in deep tissues triggers specific behaviors or tunes organic chemistry pathways concerned in numerous cell activities, like differentiation morphological maturation and secretion unleash. These energy-driven nanoparticle-mediated approaches square measure able to overcome the scarce tissue penetration by visible radiation and also the use of viruses to genetically modify target cells, that square measure the most drawbacks presently limiting clinical applications of optogenetics. electricity nanomaterials square measure a category of nanostructures able to generate a voltage on their surface once exposed to a mechanical stimulation, as an example by suggests that of ultrasounds, US. This voltage has been used for the stimulation of electrically excitable cells, like neurons Royo-Gascon Hoop Lee and bone cells. Our cluster incontestable for the primary time that the acute US-driven piezo-stimulation of atomic number 56 titanate nanoparticles (BTNPs) associated to cytomembrane was able to considerably increase the intracellular atomic number 20 concentration in neural cells. the mix people and non-piezoelectric BTNPs wasn't able to elicit a major neural response, therefore confirming that the mechanism was mediate by piezoelectric effect and not by different broad phenomena. Another wide-spread approach for remote cell activation is diagrammatic by nanoparticle-assisted heat stimulation by short-duration temperature increments during a physiological rangeA native increment of temperature are

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often obtained by exploiting completely different energy transduction approaches, like the photothermal and also the magnetothermal ones. Photothermal stimulation consists within the transduction of gauge boson energy into heat and might be remotely triggered with NIR radiation together with several plasmonic nanomaterials, like gold nanoshells, gold nanorods. However, the mechanisms of photothermal stimulation on advanced neural networks ought to be any investigated. Indeed, a recent work documented associate degree smothered neural network activity of hippocampal primary culture treated with gold nanorods upon NIR irradiation. Remote photothermal nerve activation was with success used for causing leg contraction in frogs once treatment with carbon nanohorns and NIR irradiation. equally to neural cells, muscle cells are often stirred up by heat: during this concern, our cluster has recently incontestable that associate degree acute NIR irradiation of gold nanoshell-containing cultures is ready to induce myotube contraction, whereas a chronic one urged to push mitochondriogenesis. instead to photothermal stimulation, magnetothermal transduction are often exploited for cell heating/stimulation. during this case, magnetic nanoparticles dissipate heat once bear associate degree alternate force field. during a recent work, this approach was exploited for remote deep stimulation of the ventral tegmental space (VTA) through the gap of a transfected heat-sensitive receptor TRPV1 in mice. the resultant increase of neural activity was conjointly ascertained within the brain areas receiving excitative projections from VTA. apparently, the retention amount of the magnetic nanoparticles within the VTA was longer than a month, therefore letting chronic magnetothermal VTA stimulations. This antineoplastic activity was even redoubled once the MSN pores were loaded with cancer drug as a growth drug model. during this approach, CeO2-based nanoparticles accomplished at constant time intracellular compartment targeting, antitumoral activity, and drug delivery functions.