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Relevance of Nanomedicine to Veterinary Science: An Insight

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ABSTRACT

Nanotechnology is no more being a concept or theory of the new world, but has turned into a new enabling technology over the years, with tremendous potential to revolutionize agriculture and livestock. Nanotechnology has the potential to solve many more puzzles related to animal health, production, reproduction, good hygienic practices during rearing and maintaining of food animals, the possible applications of the technology is almost incredible in relation to livestock. It can provide new tools for molecular and cellular biology, biotechnology, veterinary physiology, animal genetics, reproduction etc. which will allow researchers to handle biological materials such as DNA, proteins or cells in minute quantities usually nano-liters or pico-liters. Nanotechnology tools like microfluidics, nanomaterials, bioanalytical nanosensors, etc. Existing research has clearly demonstrated the feasibility of introducing nanoshells and nanotubes into animal systems to seek out and destroy targeted cells. Nanoparticles smaller than one micron have been used to deliver drugs and genes into cells. Thus in this contribution will provide a glimpse of the probable future of nanomedicine in veterinary science and keep veterinarians abreast of the emerging technology. It is reasonable to presume over the next couple of decades that nanobiotechnology industries and unique developments will revolutionise animal health and medicine. In spite of all benefits and opportunities which use of nanotechnology offers, it is still in the early stages of its development and not applied throughout the world. Also, there are little concerns about impact of nanoparticles on animal health and environment.

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INTRODUCTION

Nano is a Latin word which means 'Dwarf' and the thought of nanotechnology was first time given by Nobel laureature physics Richard Fenman in the south California in 1952 [1]. In real sense term nanotechnology was approximately 1-100 nanometer range, to provide a popularized by Eric Drexlerin 1980s. Nanotechnology is a technology of experimenting and manipulating with particles, called nanoparticles that are demonstrated in the scale of nanometers by the exploitation of the concept of nanotechnology one can manufacture the structures materials, decades and machines by using nanoparticles with programmed precision [2]. It is considered as a potential technology to revolutionize veterinary medicine, animal health and other areas of animal production [3].

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By the use of emerging technology one can alter the form of production, processing, packaging and even mode of products ultimate use. Nanotechnology may also be useful to develop nanoscale materials, controlled delivery systems, contaminant detection and to form nano devices for molecular and cellular biology [4]. The term nanotechnology refers to the ability to measure, manipulate and organize matter at the nanoscale level. The scale classically refers to matter in the size range of 1-100 nm, but it is often extended to include materials below 1 µm in size [5]. Advances in nanotechnology have led to the development of new nanomaterials whose physiochemical properties differ from those of their larger counterparts due to their higher surface-tovolume ratio. Thus making them excellent candidates for

biomedical applications, given the range of biological processes that occur at nanometer scale [6].

Our understanding of the principles that rule the nanoscale world will be of great impact on veterinary research leading to new discoveries never before imagined. Veterinary nanotechnology has the potential to improve diagnosis and treatment delivery systems, provide new tools for molecular and cellular breeding, animal history from birth to a consumer's table, animal nutrition scenarios ranging from the nutrient uptake and utilization, modification of animal waste as expelled from the animal, pathogen detection, and many more [5]. The main purposes of this essay are to trigger the interest in the field of nanotechnology and to provide a glance of the potential important targets for nanotechnology in the field of veterinary medicine.

Nanotechnology Applications in Medicine and Pharmacology

At nanoscale, the physical, chemical and biological properties of materials are quite different from those of the corresponding bulk materials. Nanomaterials have special properties like greater penetrability, reactivity, surface area, and quantum properties due to their size. The use of less material together with more efficient reactions when working with nanomaterials helps in evolving nanotools capable of functioning more proficiently while dealing with the nanostructures. Nanotechnology is an exciting and rapidly emerging technology that is permeating to different disciplines including molecular and cellular biology that has revolutionized the science and engineering with great benefits to the society [6]. The concept of nanomedicine can be effectively applied in various areas of veterinary medicine. Smart treatment delivery systems are envisioned for animal systems such as drugs, nutrients, probiotics, nutraceuticals and implantable cell bioreactors [7]. Integrated sensing, monitoring and controlling system could also detect the presence of disease and notify the farmer and veterinarian to activate a targeted treatment delivery system. The technology can have a role in vaccine delivery substantially improving adjuvant properties and enhancing immunogenicity [8].

The use of nanocarriers is one of the most important aspects of nanomedicine, which in recent years has been marked by a considerable increase in the number of studies which describe improvements in traditional pharmacological bases used, especially in human therapeutics [9].

Possibilities of Application in Veterinary Science

Veterinary health care is a highly visible and growing concern not only for farmers, breeders and passionate owners, but also for our government. Veterinary nanotechnology has the potential to improve diagnosis and treatment delivery systems, provide new tools for molecular and cellular breeding, identity preservation of animal history from birth to a consumer's table, the security of animal food products, major impact on animal nutrition scenarios ranging from the diet to nutrient uptake and utilization, modification of animal waste as expelled from the animal, pathogen detection, and many more [7]. Nanotechnology is currently employed in the treatment of African animal trypanosomosis [10]. Foot-and-mouth disease virus (FMDV) is a major threat because of failure to establish effective control on the disease. To address this, Greenwood *et al.,* (2008) investigated the possibilities of using inert nano-beads that targets antigen and stimulates dendritic cells (DCs) to induce immune responses against FMDV-specific synthetic peptides in sheep, while single peptides induced responses in most sheep, multiple combinations could effectively induce cell-mediated immune (CMI) and Humoral immunity (HI) [11]. So, the probable implementation of this novel technology in veterinary medicine will not be a mere thought.

Nanoparticles as precise drug delivery systems

One of the areas of veterinary medicine that would benefit most from the nanotechnology research is the field of pharmacology. Such creations would not only protect our patients from viral or bacterial infections, but also accelerate wound healing and can alleviate pain. Also these new compounds could carry drugs and genes in a more targeted manner. These systems will have an impact on the rate of absorption, distribution, metabolism, and excretion of drugs or other substances in the body thus allowing us to control the drug dynamics [12].

Nanoparticles in diagnosis and treatment

Biochips can be used for early disease detection in animals. A Biochip (or microarray) is a device typically made of hundreds or thousands of short strands of artificial DNA deposited precisely on a silicon circuit. Biochips can also be used to trace the source of food and feeds to detect the presence of animal products from different species as a means to locate the source of pathogens a response to public health threats such as avian flu and mad cow disease. In addition to DNA biochips, there are other variations that detect minute quantities of proteins and chemicals in a sample, making them useful for detecting biowarfare agents or disease. Using biochips, biological samples such as blood, tissue and semen can be instantaneously analysed and manipulated. Bioanalytical nanosensors are devices or systems that measure or detect a chemical with the use of a biological material or tissue. These will enable us with detection of very small amounts of a chemical contaminant, virus or bacteria in agriculture and livestock system. Nanoshells are a new type of optically tunable nanoparticle composed of a dielectric (for example, silica) core coated with an ultra-thin metallic (for example, gold) layer. Nanoshells can be injected into the animal's bloodstream with targeted agents applied to the nanoshells to seek out and attach to the surface receptors of cancer cells. Illumination of the body with infrared light raises the cell temperature to about 55°C, which 'burns' and kills the tumour [13]. Others have been experimenting with 'smart' super paramagnetic nanoparticles, which when injected in the bloodstream target tumour receptor cells. These

nanoparticles are made from iron oxides that when subjected to a magnetic field enhances the ability of the nanoparticles to locate tumour cells. At the site of the tumour the nanoparticles emit an attached drug to kill the cancer cells. Other form of nanomaterial is Quantum dots which are nanometre-scale crystals that were originally developed for optoelectronic applications [14]. Quantum dots may be injected into the bloodstream of animals and they may detect cells that are malfunctioning. Because quantum dots respond to light it may be possible to illuminate the body with light and stimulate the quantum dot to heat up sufficient to kill the cancerous cell. Nucleic acid engineering-based probes and methods offer powerful new ways to deliver therapeutic or preventative treatment for particular diseases [15]. These various methods of nanotechnology can be a potential therapeutic aid in extenuating the health problems of the animals.

Vaccine delivery

The science of vaccines revolves around stimulating a long lasting and protective antibody against a pathogen, with antigen and adjuvant forming the key component of the system. The traditional vaccination strategy has moved on from the use of live and killed organisms to much safer synthetic and recombinant candidates. Alone, these new vaccine candidates are often poorly immunogenic and sensitive to degradation, and they require an optimised adjuvant that improves immunogenicity [16]. Conventional adjuvants are not tuneable, but with the advent of nanotechnology a series of novel antigen carrying strategies are now available. These nanoparticle-based adjuvants can be engineered for reduced dosage frequency and a convenient administration route in order to provoke a target specific immune response, e.g. the intranasal route to better target mucosal immunity. This makes them highly suitable for veterinary species where large numbers of animals may need to be treated at once, or when vaccination by conventional means is inconvenient due to extensive management systems or lack of accessibility [12]. Nanoparticle adjuvants increase the immunogenicity of a vaccine by mimicking pathogen-associated molecular patterns, up-regulation of co-stimulatory molecules on antigen presenting cells, maintenance of immunity levels, provide prolonged delivery of antigens and finally, nanoparticles can be engineered to produce virus like particles that have similar morphology to virus capsid, and stimulate immune responses without the infectious [16].

CONCLUSION

Nanotechnology in animal health and reproduction is a growing and flourishing field that plays a great role in diagnostics and therapeutics of animal diseases and also it is intensified for improving livestock production and reproduction. Nanomaterials offer a vast number of breakthroughs like cost effective, lower risk to consumers and faster approach that will further advance the clinical aspect of veterinary sciences in future and conceived that bacterial infections can be eliminated in the patient within minutes, instead of using treatment with antibiotics over a period of weeks. There are endless possibilities to be tapped in this field. So it is extremely essential for professionals, researchers and academicians to have an in-depth understanding of the technology and stay abreast of the developments with risk assessment should be done before field application.

DISCLOSURE STATEMENT

The authors declare that there is no conflict of interest.

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REFERENCES

1. C. Buzea, B.I. Pacheco and K. Robbie, “Nanomaterials and Nanoparticles: Sources and Toxicity. ”*Biointerphases*, ch 2(4): pp.1-103, 2007.
2. M. Chaudhary, M. C. Pandey, K. Radhakrishna and A.S. Bawa,. “Nano-Technology: Applications in food industry,” *Indian Food Ind.,* 24: pp. 19-21, 31, 2005.
3. B. S. Sekhon, “Nanoprobes and their applications in veterinary medicine and animal health.” *Res. J. Nanosci. Nano technol.,* 2: pp. 1-16, 2012.
4. P. Assadi, “A novel multiplication algorithm in nanotechnology. ”*J. Applied Sci*., 8: pp: 2625-2630, 2008.
5. H. Boulaiz, P. J, Alvarez, A. Ramirez, J. A Marchal, J. Prados, F. Rodríguez-Serrano, M. Perán, C. Melguizo and Antonia AranegaNanomedicine: “Application Areas and Development Prospects.” *International Journal of Molecular Sciences,* 12: pp. 3303-3321, 2011.
6. S. R. Garg,“Nanotechnology for Animal Health and Production.
7. N. R. Scott, “Nanoscience in veterinary medicine.” *Veterinary Research Communications*, 31: pp.139-144, 2007.
8. N.N. Mohanty, T. K. Palai, B. R. Prusty and J. K. Mohapatra “An Overview of Nanomedicine in Veterinary Science.” *Veterinary Research International.,*vol. 2 (4) pp: 90-95*,* 2014*.*
9. K. Chen, P. S. Conti, “Target-specific delivery of peptide-based probes for PET imaging.” *Adv Drug Deliv Rev,* vol. 62, pp: 1005-1022, 2010.
10. M. Kroubi, S. Daulouede, H. Karembe, Y. Jallouli, M. Howsam, D. Mossalayi, P. Vincendeau and D. Betbeder, “Development of a nanoparticulate formulation of diminazene to treat African Trypanosomiasis.” *Nanotechnology*, vol. 21(50): 1-8, 2010.
11. D. L. V. Greenwood, K. Dynonc, M. Kalkanidis, X. Sue, M. Plebanskid and J. Y. Scheerlinck, “Vaccination against foot-and-mouth disease virus using peptides conjugated to nano-beads.” *Vaccine*, vol. 26(22) pp: 2706-2713, 2008.

12. C. Underwood, and A. W. van Eps, “Nanomedicine and veterinary science: The reality and the practicality. ” *Veterinary Journal,* 193. pp: 12-23, 2012.
13. L.R.. Hirsch, R. J., Stafford, J. A. Bankson, *et al.,Proc. Natl Acad. Sci.* USA, 100(23): 13549-13554, 2003.
14. N. R. Scott, and Chen, H. (2002): National planning workshop, www.nseafs.cornell.edu (accessed 20 Nov 2017).
15. D. Luo, Yearbook of science and technology. McGraw-Hill, New York, 93-95, 2003.
16. P. Nordly, H. B Madsen, H. M. Nielsen and C. Foged, “Status and future prospects of lipid-based particulate delivery systems as vaccine adjuvants and their combination with immunostimulators..” *Expert Opinion on Drug Delivery*, vol.6: 657-672, 2009.