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REVIEW ARTICLE

Nanotechnology in veterinary and allied sciences

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Abstract : Nanotechnology refers to the use of very tiny (nano-scale) materials in a range of novel ways. 'Nano' means tiny and nano-particles are tiny particles, more than 8000 times smaller than a human hair. The properties of nano-particles make them suitable for a range of environmental applications, both in terms of improving existing environmental problems or by anticipating and preventing future environmental problems. Some of the greatest potential uses or application of nanotechnology in the environment are as biosensors and in the sectors of treatment, agriculture, veterinary / medical sciences, fisheries, bioremediation and for green nanotech manufacturing and engineering. The present article has been constructed considering the tremendous potential and application of nanoscience and nanotechnology in the concerned fields.

Key words : Nanotechnology, Nano-particles, Veterinary science, Nanoscience

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Nanotechnology has a tremendous potential to revolutionize agriculture and livestock sector. 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 micro-fluidics, nano-materials, bio-analytical nano-sensors, etc. has the potential to solve many more puzzles related to animal health, production, reproduction and prevention and treatment of diseases. It is reasonable to presume that in the upcoming year's nanotechnology research will reform the science and technology of the animal health and will help to boost up the livestock production. Nanotechnology will have a profound impact, but not in the immediate future as it is in the early stages of its development and needs to equip scientists, engineers and biologists to work at the cellular and molecular levels for significant benefits in healthcare and animal medicine. But It is reasonable to presume that in the upcoming year's nanotechnology research will revolutionize animal health and help to boost up livestock production (Patil *et al*., 2009).

Veterinary health care is a highly responsible and growing concern not only for pet owners, but also for our nation and government. With an ever increasing pet population throughout the globe, along with higher costs for medications and veterinary care, the need for new solutions is urgent. At this period of time the main objectives of veterinary medicine is to excel according to the accepted standards of scientific excellence in the creation of new knowledge and its translation into improved health for the other species with which we share our world, to create more effective veterinary services and products and to strengthen the veterinary education system.

Livestock and fisheries will be affected by the nanotechnology revolution (Ganguly *et al*., 2010). Nanotechnology can be used in veterinary and medicine for disease detection and for development of new pharmaceuticals for humans. Veterinary applications of nanotechnology may become the proving ground for untried and more controversial techniques - from nano-capsule vaccines to sex selection in breeding.

Nanotechnology, dealing with functional structures and

materials smaller than 100nm, is emerging as a truly interdisciplinary research area spanning several traditional scientific disciplines. In keeping with the growing trend, there is a strong need for a platform to share original research related to applications of nanotechnology in biomedical fields (Ganguly and Mukhopadhayay, 2011).

In the era of new health related technologies, veterinary medicine will enter a phase of new and incredible transformations. The major contributor to those changes is our recent ability to measure, manipulate and organize matter at the nano-scale level. Our understanding of the principles that rule the nano-scale world will be of great impact on veterinary research leading to new discoveries never before imagined. Nanotechnology has the potential to impact not only the way we live, but also the way we practice veterinary medicine. Today scientists foresee that the progress in the field of nanotechnology could represent a major breakthrough in addressing some of our technical challenges not only in engineering but also in the fields of both human and veterinary medicine. Very soon engineers will develop tiny motors to power computers and appliances and doctors will have miniature devices that aim to fight cancer on the molecular level at their disposal.

In the veterinary community, some of the principal areas of nanotechnology research are currently being undertaken in the world of medicine because of the vast scope of the medical applications of nanotechnology. Many discoveries of veterinary and allied professions in the field of nanotechnology have been made till date and it is needed to provide a glimpse of the potential important targets for nanotechnology in the field of veterinary medicine. However, nanotechnology is in its early stage of development and it may take several years to perform the necessary research and conduct clinical trials for obtaining meaningful results, but professionals should begin to take note of it (Feneque, 2003).

Use of biochips (Microarrays) to study genetic sequences:

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. In DNA arrays, each DNA strand acts as a selective probe and when it binds to material in a sample (e.g. blood) an electrical signal is recorded. Rather like conducting a word search across a piece of text, the biochip is able to report back on found genetic sequences based on the DNA probes built into it. The best known biochips are those produced by Affymetrix, the company that pioneered the technology and was first to produce a DNA chip that analyses an entire human genome on a single chip the size of a dime (ETC Group Report, 2004).

Use of biochips in animal breeding to remove genetic diseases:

One goal is to functionalise biochips for breeding purposes. With the mapping of the human genome behind them, geneticists are now rapidly sequencing the genomes of cattle, sheep, poultry, pig and other livestock hoping to identify gene sequences that relate to commercially valuable traits such as disease resistance and leanness of meat. By including probes for these traits on biochips, breeders will be able to speedily identify champion breeders and screen out genetic diseases (ETC Group Report, 2004).

Using biochips in biowarfare agents and in disease detection applications:

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 bio-warfare agents or disease. Biochip analysis machines the size of an inkjet printer are commercially available from companies such as Agilent (Hewlett-Packard) and Motorola - each able to process up to 50 samples in around half an hour (ETC Group Report, 2004).

Using biochips, biological samples such as blood, tissue and semen can be instantaneously analysed and manipulated. In fewer than five years, biochips have become a standard technology for genomics and drug discovery and they are now moving into commercial healthcare and food safety applications (ETC Group Report, 2004).

Using biochips for disease detection in animals and for tracing the source of foods:

Chips can be used for early disease detection in animals. Researchers at the University of Pretoria are developing biochips that will detect common diseases borne by ticks. Biochips can also be used to trace the source of food and feeds. For example, bioMérieux's "FoodExpert-ID" chip rapidly tests feed to detect the presence of animal products from forty 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 (ETC Group Report, 2004).

Microfluidics and Nanofluidics:

Microfluidics is a newer technology platform on the same scale as biochips. Microfluidic and nanofluidic systems analyse by controlling the flow of liquids or gases through a series of tiny channels and valves, thereby sorting them, much as a computer circuit sorts data through wires and logic gates. Microfluidic channels, often etched into silicon, can be less than 100 nm wide. This allows them to handle biological materials such as DNA, proteins or cells in minute quantities - usually nano-liters or pico-liters (1000 times smaller than a nano-liter). Microfluidics not only enable very precise analysis, they also open up the potential for manipulation of living matter by mixing, separating and handling different components at the nano-scale (ETC Group Report, 2004).

Uses of microfluidic devices in biomimetics:

Matthew Wheeler, University of Illinois professor of animal science, has gone one further in developing a microfluidic device that not only sorts sperm and eggs but also brings them together in a way that mimics the movement of natural reproduction and then handles the resulting embryo. According to Dr. Wheeler, such a technique would make mass production of embryos cheap, quick and reliable. He and his colleagues have started a spin-off company, Vitaelle, to commercialise this technology (ETC Group Report, 2004).

The U.S. Food and Drug Administration (FDA) regulates a wide range of products, including foods, cosmetics, drugs, devices, veterinary products, and tobacco products some of which may utilize nanotechnology or contain nanomaterials. Nanotechnology allows scientists to create, explore and manipulate materials measured in nanometers (billionths of a meter). Such materials can have chemical, physical, and biological properties that differ from those of their larger counterparts.

Use of microfluidics in livestock breeding:

Microfluidics is being used in livestock breeding to physically sort sperm and eggs. Leader in this field is XY, Inc. of Colorado (USA), which is using a microfluidic technique called flow cytometry to segregate male and female sperm for sex selection. XY has successfully bred sex-selected horses, cattle, sheep and pigs and now provides its technology to commercial breeders. Nanotech startup Arryx, which has developed a new microfluidic system called MatRyx, uses a nanotechnique in which tiny laser tractor beams trap individual sperm and then sort them by weight. MatRyx can sort around 3,000 sperm per second, and aims for commercialisation in cattle breeding. (ETC Group Report, 2004).

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