Editorial

Nanorobots: Changing Trends in Cancer Therapy

Nanorobots are the most sophisticated artificial intelligence, gifted to the field of medicine by the biotechnologists. This novel powerful tool is destined to change the foundations of the cancer detection and therapy. The field of nanorobotics mainly focuses on designing, simulation, control and coordination of robots with nanoscale dimensions along with manipulation and/or assembly of nanoscale components. Any active structure capable of actuation, information processing, sensing, signalling, or swarm behavior at the nanoscale can be a component of the nanorobot system. In context to biology, such natural biomolecules do exist, the challenge was to develop synthetic nanorobotic systems.[1]

One such biomolecule is deoxyribonucleic acid (DNA). It was the choice of material for building nanorobots because of certain advantageous properties, like, it can be readily programmed and manufactured, modified with enzymes, besides being a stiff polymer. Its use in nanotechnology was pioneered by Nadrian Seeman in 1980s.[2] After 3 decades, in 2012, Douglas et al built a DNA nanorobot that could recognize and induce apoptosis in diseased cells.[3] In the same year, Zhao et al showed that it can be used as a successful cancer drug delivery system with controlled release properties.[4] Deoxyribonucleic acid can be programmed based on the precise Watson-Crick binding of DNA bases. This is the fundamental principle of self-assembling of DNA. The goal is to create dynamic DNA nano-structures which can accomplish definite tasks through a series of change of state.[5]

The structural design of the nanorobots are derived from the bacterial models. It consists of mechanical parts such as structural support, power supply, sensors, on-board computers, etc. The smooth outermost shell is most likely to be made of diamondoid material due its inert nature, diminishing the chances of an immune response. The ideal environment for the nanorobots with biosensors can be body fluids. Some of the nanorobots designed by Robert A Freitas Jr as components of artificial blood includes, respirocytes (RBCs), microbivores (WBCs) and clottocytes (platelets).[6] The same author has also put forward the concept of chromallocytes, which are cell repair nanorobots for chromosome replacement therapy. In dental speciality, these nanorobots have been named as 'dentifrobots'.[7]

The applications of these nanobots or nanoids, as they have been called, is immense. With respect to oncology, especially pertaining to our field of oral cancer, they can be utilized in every phase, i.e. preventive, diagnostic and therapeutic. Preventive approach would include elimination of the root cause, which in most cases, is the mutations arising due to carcinogens or faulty cell replications.[8] The nanobots should be able to locate and repair the defective portion of DNA strand; or identify the carcinogen molecules and eliminate them; or coat the cells, protecting them from the harmful agents. This would be the ideal approach, but presently it is only a theoretical proposal and a science fiction.

The preventive approach is still underdeveloped, but cancer cell detection looks promising.[8] Nanobots with embedded biosensors can be programmed to locate micro-metastatic deposits. Lastly, it can be used as an ultimate targeted therapy modality, wherein it can deliver chemotherapeutic drugs at a higher dosage only to the altered cells, which is not possible through the conventional methods due to lethal toxicity to the normal cells. Thus, it can efficiently destroy the cancer cells, reduce patient side-effects and treatment duration.[6] This is advantageous, with respect to the cancers arising in the oral cavity, as the accessibility is limited and vital structures located in the head and neck region are vulnerable to the radiotherapy.

At present, extensive research is ongoing with respect to application of these nanorobots in the field of nanomedicine. Theoretically, the proposed ideas appear achievable, but in practical terms, many hurdles are yet to be overwhelmed.

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