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Nano-Robotics in Medicine: An Annotated Bibliography

Abhilash, M. "NANOROBOTS." International Journal of Pharma & Bio Sciences. 1.1 (2010): 1-10. Print.

The author, a researcher of Biotechnology at the Oxford college of Engineering in Bangalore, India, describes the hypothetical status of nanorobots and their many proposed uses. Within medicine, he proposes the uses of these robots will be for the early diagnosis and targeted drug delivery for cancer biomedical instrumentation, surgery, monitoring of diabetes, and dental applications. These researchers were the first to mention some of these applications that were later mentioned by other researchers such as Prajapati, Solanki and Sen as well as the Sivasankar and Durairaj team listed later in this bibliography. Despite the paper only being 2 years old, it was noted in the newer articles that the "hypothetical" status of some of these applications were no longer hypothetical but were now either operational or in the experimental phases of testing. This author predicted the use of nanorobots in certain applications that are in use as of today. This demonstrates the fast pace at which this field of research is growing.

Copot, Mircia, Andreea Popescu, Ioan Lung, and Alexandru Moldovanu. "Achievements and Perspectives in the Field of Nanorobotics." Romanian Review Precision Mechanics, Optics & Mecatronics. 19.36 (2009): 61-66. Print.

The authors, researchers at the National Institute of Research and Development for Mechatronics and Measurement Technique in Bucharest, Romania, presented a study of the different types of nanorobots, their uses and the companies that are developing them.

This study was helpful from the perspective of clarifying the classifications of robots into 5 generations. The first generation consists of the tools or mechanical instruments that allow an operator in another place to control or manipulate. The second generation of robots has electro-mechanical components. The third generation also has electro-mechanical components but they can be on a widely varying scale ranging from macro-mechatronics to nano-mechatronics. The fourth generation includes programmable computers. The fifth generation of robots is capable of "learning" from their own experiences and artificial intelligence is part of its software. The researchers use these 5 generations as the foundation for how nanorobots can operate using what we already know about robots. The article also included several helpful illustrations and included some examples of accomplishments in the field of nanorobotics. These examples are slightly dated, however, and more impressive and current accomplishments were noted in the article by Catherene Paddock in May, 2012 listed in this bibliography.

Hamzelou, Jessica. "DNA nanorobot takes drug direct to cancer cell." New Scientist. 25 Feb 2012: 9. Print.

The author, a writer for New Scientist, discusses the recent success by a team of Harvard University researchers who used a clam-like nanorobot created from strands of DNA to deliver a drug to specifically targeted Leukemia cells. The team used special software that models DNA to help them understand base pairs and how they bind together to form certain shapes. The nanorobot was then programmed to recognize the diseased cell shape and, upon finding it, deliver medication to that cell which is being held inside of the clam-shell structure of the robot. In this study, it was found that the nanorobots killed over half of the cancer cells after 3 days. They also found that all of the healthy cells

were untouched by the nanorobots and they remained healthy. Some of the other sources in the Bibliography made mention of the fact that no working nanorobot has been built. This newer article shows that the field is advancing and that an actual nanorobot has been created and used successfully in a medical trial.

Jain, Kewal. "Nanomedicine: Application of Nanobiotechnology in Medical Practice." Medical Principles & Practice. 17.2 (2008): 89-101. Print.

The author, a researcher for PharmaBiotech in Basel, Switzerland, discusses the various uses of nanorobots as the other researchers do. However, Jain adds a new dimension to the discussion by addressing the applications of nanorobots in vaccinations, cell therapy, bone disorders and gene therapy. Jain also delves into nanopharmaceudicals and their delivery methods by nanorobots. Jain is the first to mention and stress safety issue which was also echoed by Catherene Paddock in her article from May, 2012.

Malhotra, Pawan, and Aneeta Singh. "Nano Medicine - A Futuristic Approach." JK Science. 12.1 (2010): 3-5. Print.

The authors, researchers at ASCOMS & Hospital, Jammu, India, enumerate the different applications that nanorobots might be used on medical applications while focusing on the promising outlook of early research and feasibility. They see a future for nanorobotics in medication delivery, skin cancer treatment, nanosurgery, tissue-targeting, cell repair and diagnostic applications. One item that made this particular article stand out among the others in this bibliography was that the researchers use it as a platform to plea for government support and financing for additional research of nanomedicine. They accomplish this by enumerating the various ways in which using this type of futuristic

medicine will be much more cost effective than what we have today. Some examples of the way that they see lower expenses are early diagnosis in prevention of the advancement (and more rigorous treatment of the disease), detection of pathologic conditions in the body, reduction of the severity of disease and improved clinical outcomes. Instead of giving macro doses of medication orally or through injection, nanorobots can deliver smaller and more exact dosages of medication to highly localized areas in the body, thus reducing the cost of treatment by reducing the amount of drugs used for treatment.

Paddock, Catharine. "Nanotechnology In Medicine: Huge Potential, But What Are The Risks?." Medical News Today. 04 May 2012: Web.

The author, a PhD and writer for Medical News Today, gives a broad summary of what researchers all over the world are doing in the field of nanomedicine. She describes how some nanorobots are programmed to target and enter the cancer cells of Lymphoma and Leukemia and deliver molecules that trigger “cellular suicide”. This is also closely related to the article by Jessica Hamzlou who wrote about the success of Harvard University researchers whose nanorobots successfully targeted and destroyed Leukemia cells while leaving healthy cells alone. She ends with a warning about exploring safety and building public trust and confidence and how we only need to look at the destructiveness of genetically modified food to see what kinds of things can go wrong. This echoes what earlier researcher Kewal Jain wrote when he covered the importance of safety issues in the study of nanorobotics in 2008.

Pedersen, Amanda. "Researchers make programmable ‘nanorobot’ to target diseases." Medical Device Daily. 31 JUL 2012: 1,6. Print.

The author, a senior staff writer for Medical Device Daily, discusses how lab researchers at the University of Florida in Gainesville were able to create programmable nanoparticles that could potentially be used to halt production of disease-related proteins in the body. The idea is for the nanorobot to enter the body and target diseased cells or specific DNA and work only on the targets while leaving healthy cells alone. This article, a very recent one, corroborates with the one by Jessica Hamzelou earlier in the Bibliography where it discussed the success of a clam-like nanorobot that was used to destroy Leukemia cells while leaving healthy cells alone. The article focuses on the fact that significant steps have been made in actually creating working nanoparticles and nanorobots that can be programmed to do a very specific work.

Prajapati, P.M., A.S. Solanki, and D.J. Sen. "Importance of Nanorobotics in Health Care." International Research Journal of Pharmacy. 3.3 (2012): 122-124. Print.

The authors, researchers at I.K. Patel College of Pharmaceutical Education & Research, JJT University and Shri Sarvajanik Pharmacy College in India, describe a variety of ways in which nanorobots can be used in a medical capacity. They describe applications for a variety of conditions from mild (tooth replacement) to severe (blood clots). They also describe how the nanorobots would need to be designed to keep the body from attacking as well as how they could be controlled and powered. Many of the applications that they cover in their work are previously mentioned by other researchers in this bibliography.

There was not a lot in this article that had not been written about by other researchers before this was written.

Sivasankar M, Durairaj RB. “Brief Review on Nano Robots in Bio Medical Applications.” Advances in Robots and Automation. 1:101. (2012): Print.

The authors are researchers at Arunai Engineering College and SRM University (respectively) in Tamilnadu, India. They relay the possibility of creating nanorobotic devices that can of interface with the macro world for the purposes of being controlled. They discuss how there are countless machines that exist in nature and how science can mimic nature in assisting the control of these nanorobots. The researchers cover many of the same applications that Prajapati, Solanki and Sen covered in their work. Some of the similarities in their papers were applications to target blood clots and dental repairs. Both articles describe in similar ways how these medical applications might be performed by nanorobots.

Yadav, Akash, Meenal Ghune, and Dinesh Jain. "Nano-medicine based drug delivery system." Journal of Advanced Pharmacy Education & Research. 1.4 (2011): 201-213. Print.

These researchers from the College of Pharmacy at Indore Professional Studies (IPS) Academy in Indore, India have focused their research on the way that nanorobots can and will be used for delivering pharmaceuticals within the body. The authors discuss, among other things, the way in which carefully crafted nanorobots coded with a particular RNA can be sent to extremely specific cell sites within the body to identify a particular, untreated cell, attach itself and unlock its load of precisely measured medicine to that

cell. A year after this was written, Harvard researchers were able to accomplish this as described in the article written by Jessica Hamzelou in February, 2012.