Nanotechnology in Medical Applications

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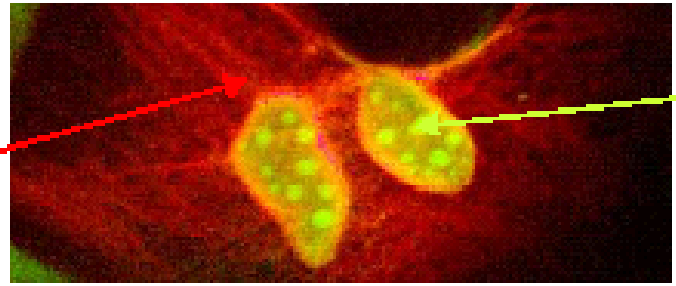
Background

- Nanomedicine is the monitoring, repair, construction, and control of human biological systems at the molecular level using engineered nanodevices and nanostructures.
- Microscopic machines were first hypothesized by Richard Feynman in 1959.
- K. Eric Drexler described many applications of these machines in *Engines of Creation*.
- Currently, several university and industrial research groups are developing medical applications for nanotechnology.

Nanocrystals as Fluorescent Biological Labels



- Significant advantages over conventional dyes:
- Reduced photobleaching
- Multi-color labeling, parallel screening
- Infrared labels, blood diagnostics
- Molecular size nanocrystals are bio-compatible, with many other possible applications

•*Bruchez, M. Jr., M. Moronne, P. Gin, S. Weiss, and A.P. Alivisatos. 1998. Semiconductor nanocrystals as fluorescent biological labels. Science 281:2013-2016.*

•*Chan, W.C.W., and S.M. Nie. 1998. Quantum dot bioconjugates for ultrasensitive nonisotopic detection. Science 281:2016-2018.*

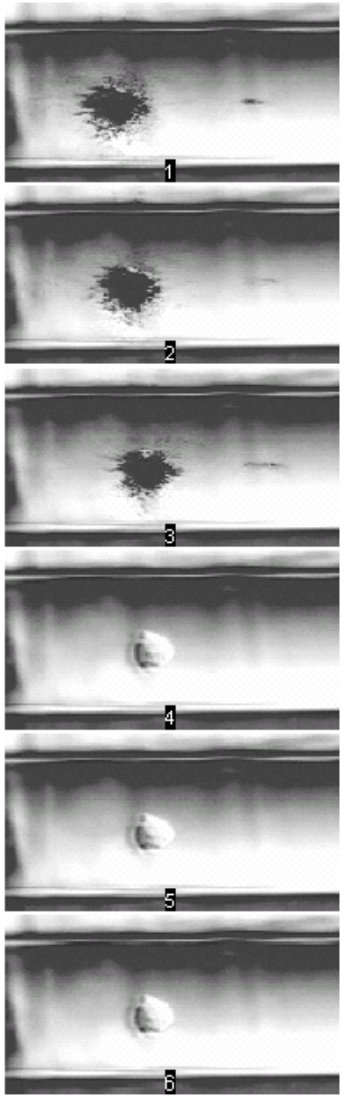
•*http://www.wtec.org/loyola/nano/IWGN.Research.Directions/chapter08.pdf*

NanoBMI

Biofunctional devices based on magnetic nanoparticles

Charles Seeney
President of NanoBMI

- Delivery and controlled release of therapeutics
- Bioswitches for organ function
- Imaging

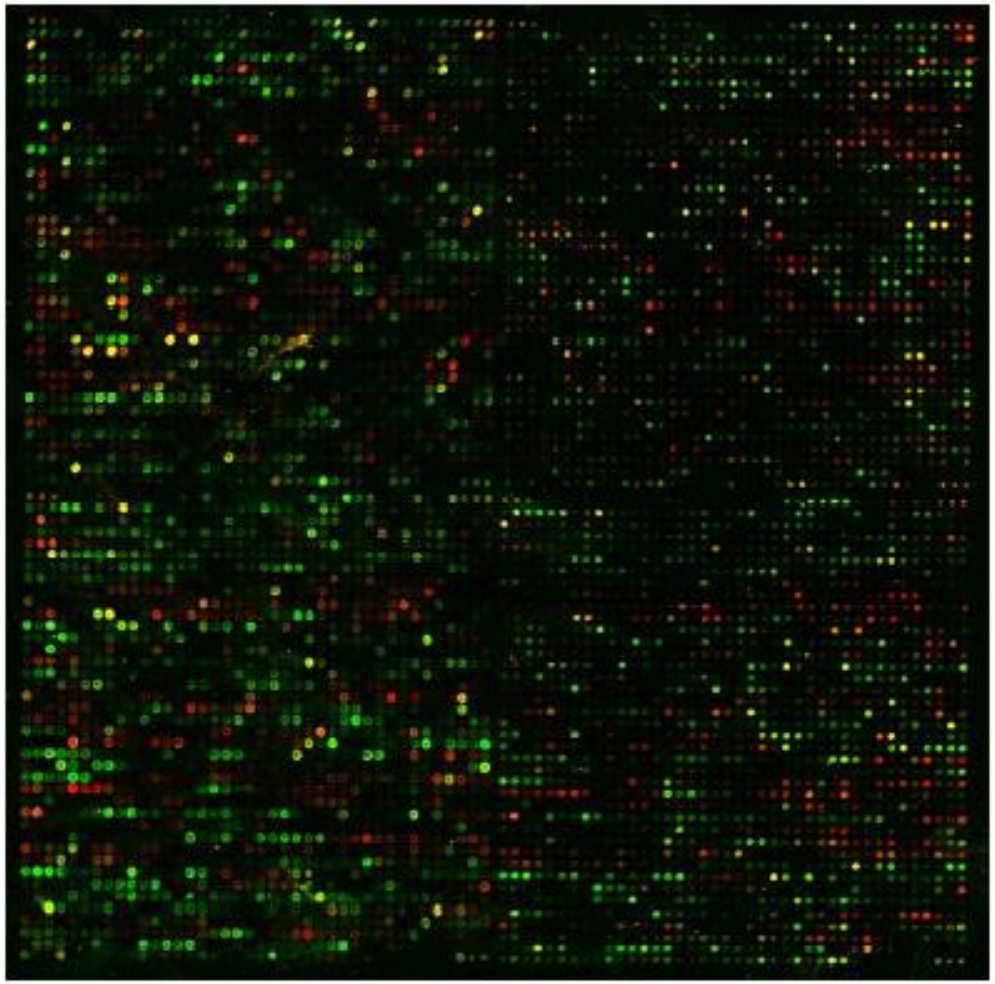


Tissue Engineering

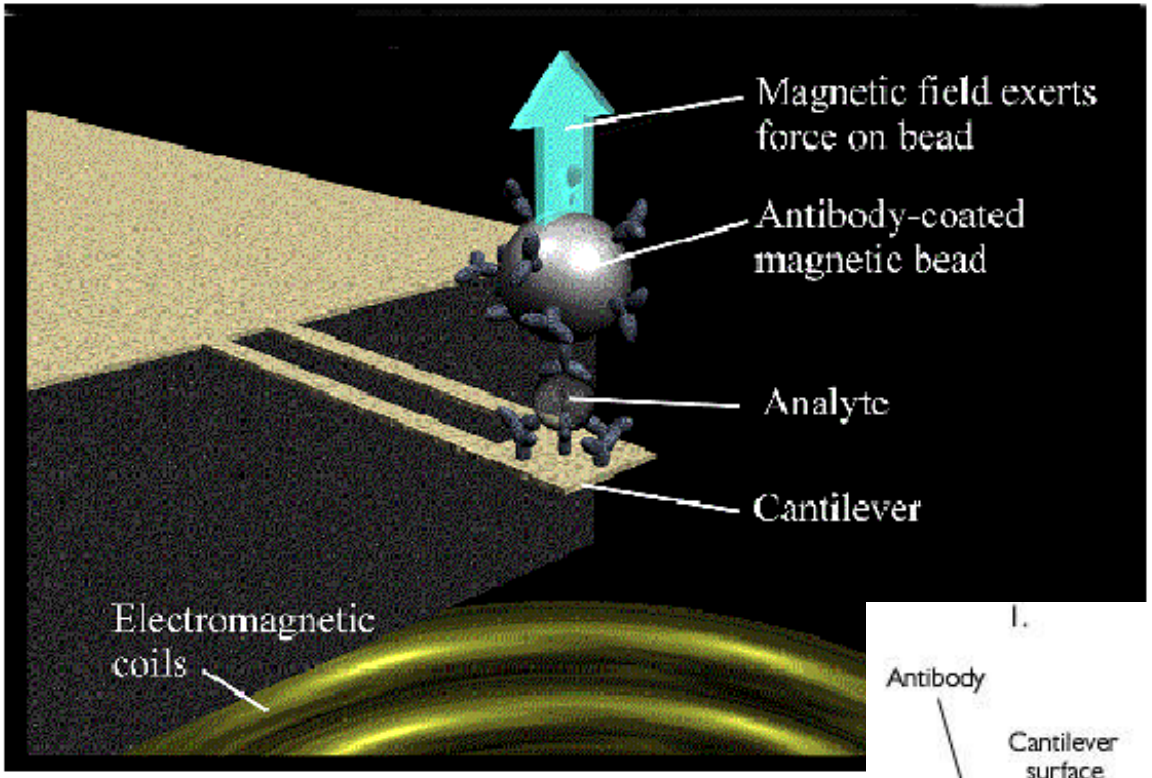
•Nano/micro particles, including living animal cells, bacteria, and colloidal gold (100 nm), can be optically guided and deposited in arbitrarily defined three-dimensional arrays, a process called “laser-guided direct-writing.”

DNA Chips

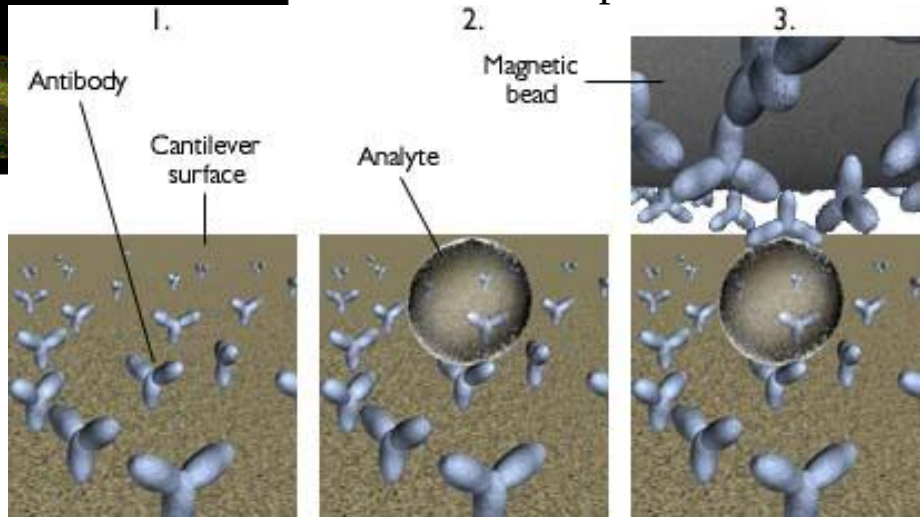
Yeast cells were grown under various conditions; the amount of red or yellow light represents the level of RNA produced from the DNA in that gene, under those conditions.



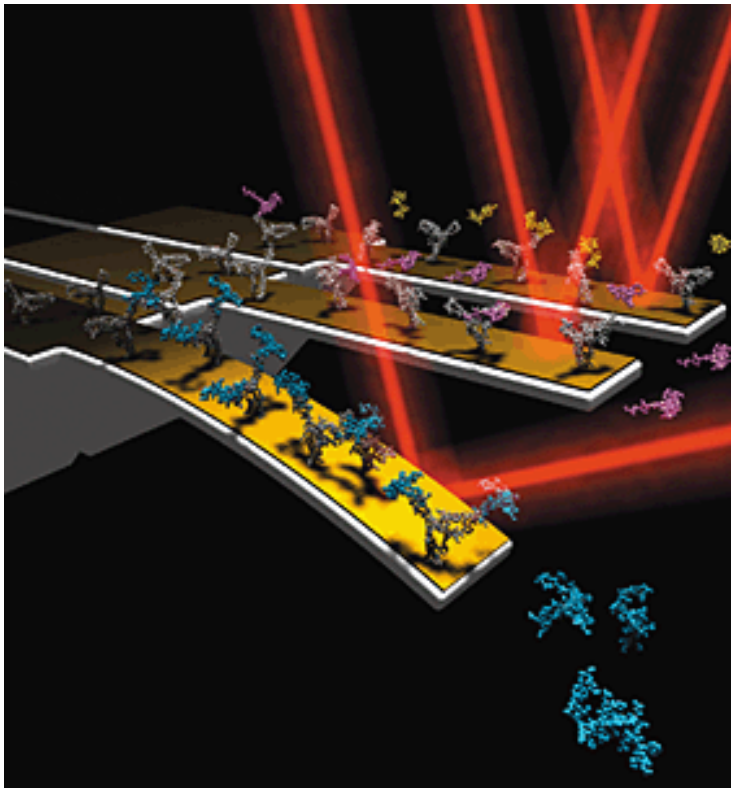
Detection of Chemical and Biological Warfare Agents



One technique uses atomic force microscopy with a sandwich immunoassay attaching magnetic beads to a microfabricated cantilever sensitive to small displacements.

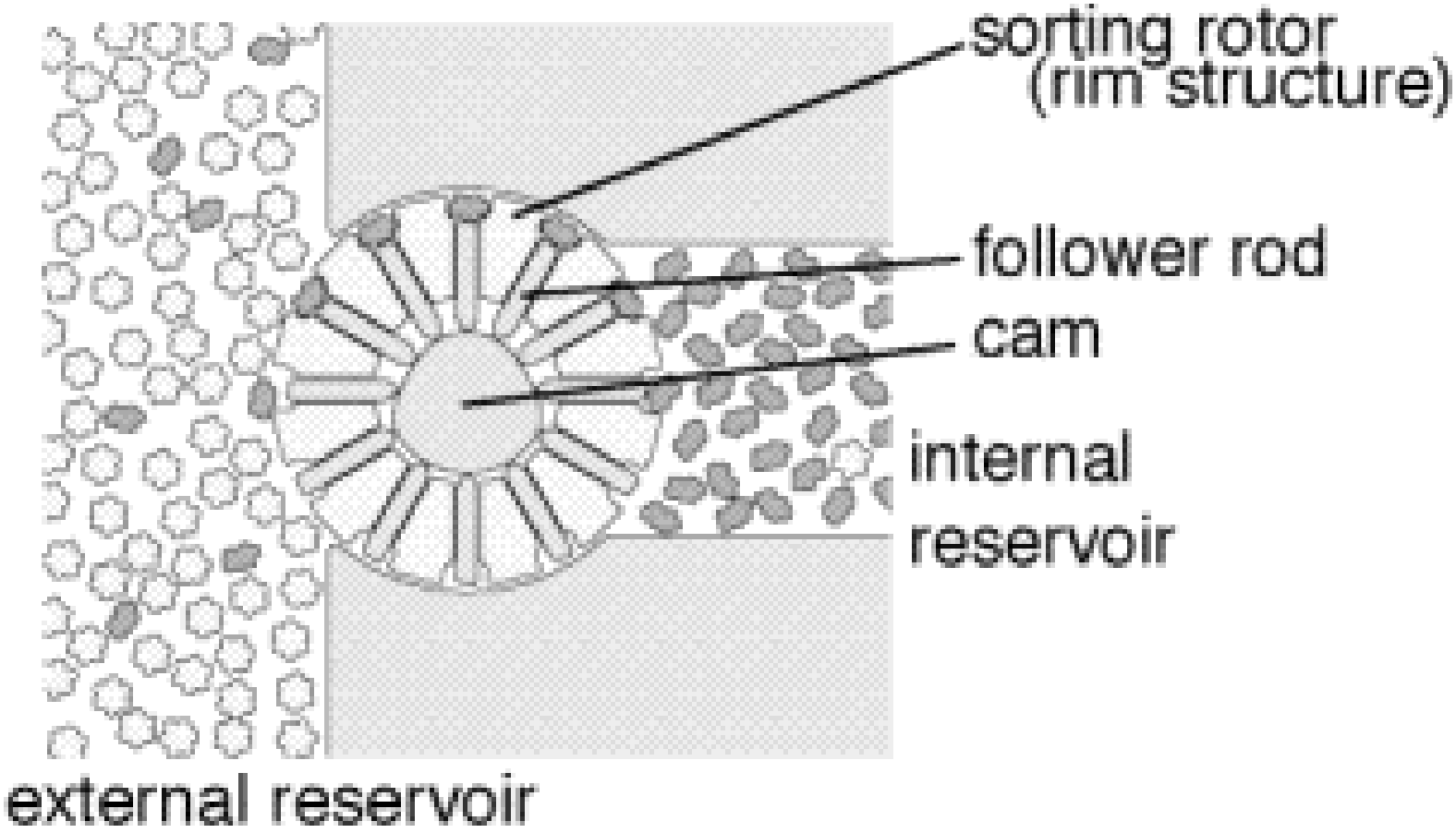


BioCOM Chip

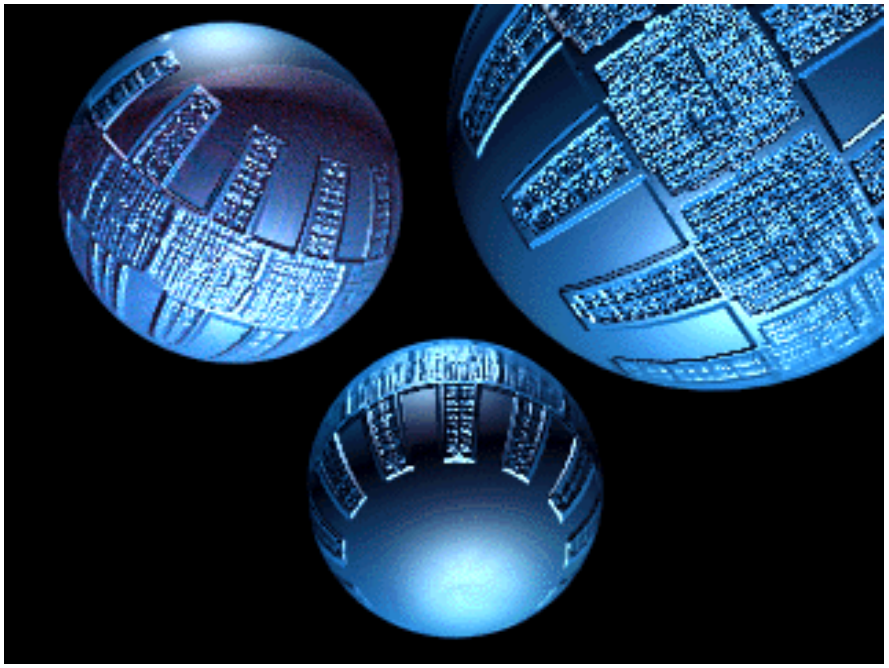


•Three cantilevers coated with three different antibodies, are exposed to prostate-specific antigen (PSA)
•The left cantilever bends as PSA binds to the anti-PSA antibody on the cantilever
•The other cantilevers do not bend because their antibodies do not bind to PSA.

Future Possiblities: Oxygen Selective Pump

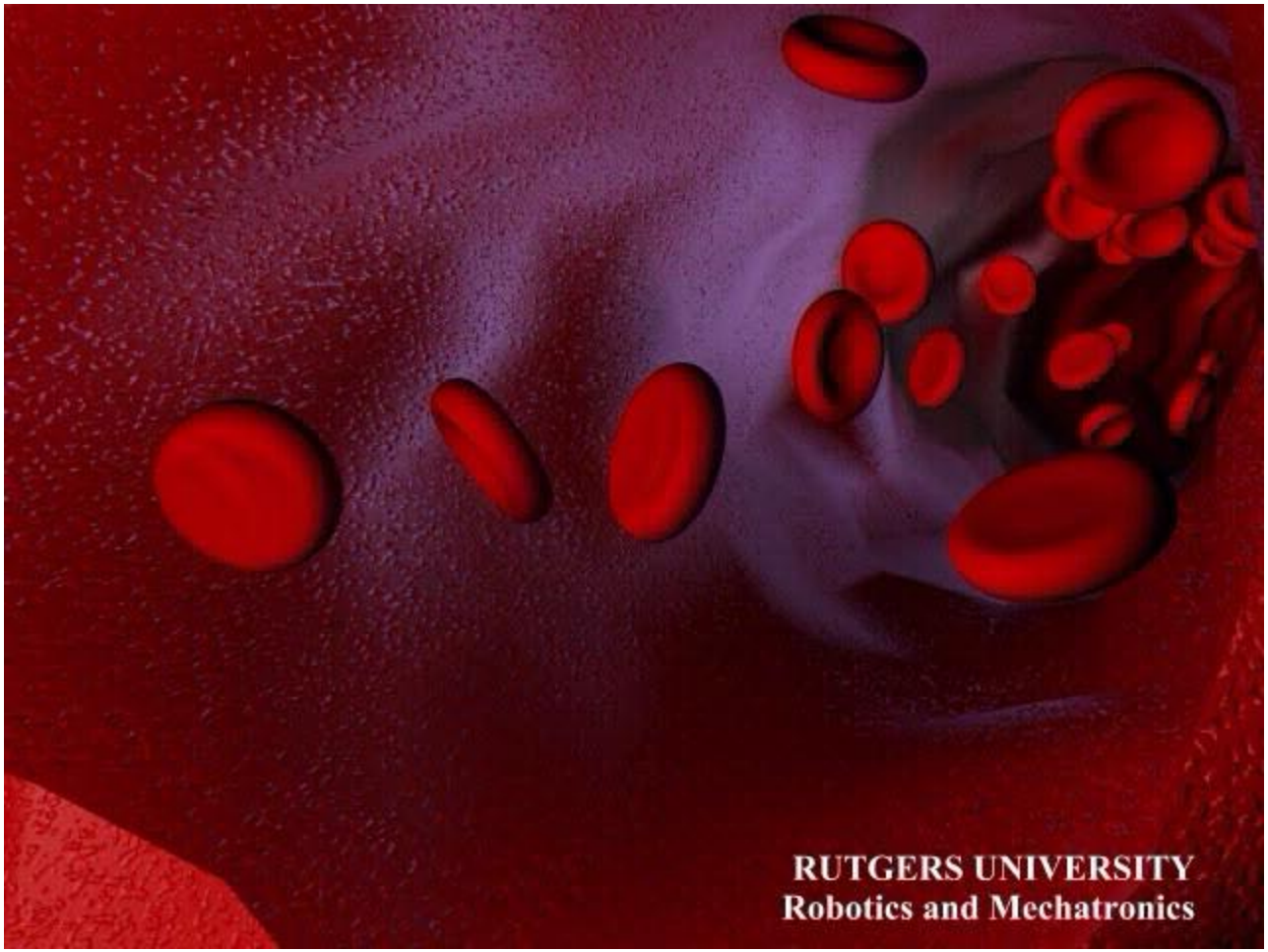


Respirocytes: A Mechanical Artifical Red Blood Cell



•Bloodborne spherical 1-micron diamondoid 1000-atm pressure vessel
•Active pumping powered by endogenous serum glucose
•Able to deliver 236 times more oxygen to the tissues per unit volume than natural red cells and to manage carbonic acidity

Fixing Damaged Blood Cells



Conclusion

- Currently, a variety of research is being performed on nanomedical devices.
- Few industrial products exist right now.
- The possibilities are endless, but will take time to develop.

In the Near Future:
Humanoid Shaped Nanorobots!