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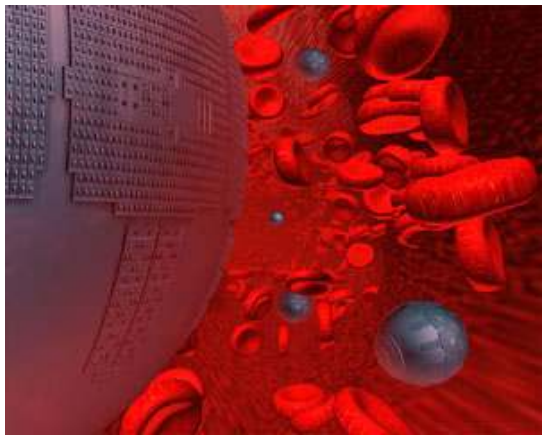
Nanotechnology and Medicine



When we consider the nanotechnology in the medicine, we can easily find, that such applying could help in future by giving new opportunities of what is create now.

Disease and ill health are caused largely by damage at the molecular and cellular level. Today's surgical tools are, at this scale, large and crude. From the viewpoint of a cell, even a fine scalpel is a blunt instrument more suited to tear and injure than heal and cure. Modern surgery works only because cells have a remarkable ability to regroup, bury their dead and heal over the injury.

Nanotechnology, "the manufacturing technology of the 21st century,"[i] should let us economically build broad scope molecular machines complexity (including, not incidentally, molecular computers). It will let us build fleets of computer controlled molecular tools significantly smaller than a human cell and built with the accuracy and precision of drug molecules. Such tools will let medicine, for the first time; get involved in a sophisticated and controlled way at the cellular and molecular level. They could eradicate obstructions in the circulatory system, kill cancer cells, or capture the function of subcellular organelles. Nowadays, we have the artificial heart, so in the future we could have the reproduction mitochondrion.

Equally dramatic, nanotechnology will give us new instruments to examine tissue in unparalleled detail. Sensors smaller than a cell would give us an inside and gracefully exact look at ongoing function. Tissue that was either chemically fixed or flash frozen could be analyzed literally down to the molecular level, giving a completely detailed "snapshot" of cellular, subcellular and molecular activities.[ii]

The first apply may given such molecular tools, we could design a small device able to identify and kill cancer cells. The device would have a small computer, several binding sites to determine the concentration of specific molecules, and a supply of some poison, which could be selectively unrestricted and was able to kill a cell identified as cancerous.[iii]

A second application would be to provide metabolic support in the event of impaired circulation. Poor blood flow, caused by a variety of conditions, can

result in serious tissue damage. A major cause of tissue damage is inadequate oxygen. A simple method of improving the levels of available oxygen despite reduced blood flow would be to provide an "artificial red blood cell." We will consider a simple design here: a sphere with an internal diameter of 0.1 microns (100 nanometers) filled with high pressure oxygen at ~1,000 atmospheres (about 10^8 pascals). The oxygen would be allowed to trickle out from the sphere at a constant rate (without feedback).[iv]

While providing oxygen to healthy tissue should maintain metabolism, tissues already suffering from ischemic injury (tissue injury caused by loss of blood flow) might no longer be able to metabolize properly oxygen. In particular, the mitochondria will fail at the same point. Amplified oxygen levels in the presence of nonfunctional or partially functional mitochondria will be ineffective in restoring the tissue. However, more direct metabolic support could be provided. The direct release of ATP, coupled with selective release or absorption of critical metabolites (using the kind of selective transport system mentioned earlier), should be effective in restoring cellular function even when mitochondrial function had been compromised. The devices restoring metabolite levels, injected into the body, should be able to operate autonomously for many hours (depending on power requirements, the storage capacity of the device and the release and uptake rates required to maintain metabolite levels).

While levels of critical metabolites could be restored, other harm caused during the ischemic event would also have to be dealt with. In particular, there might have been significant free radical damage to various molecular structures within the cell, including its DNA. If damage was significant restoring metabolite levels would be insufficient, by itself, to restore the cell to a healthy state. Various options could be pursued at this point. If the cellular condition was deteriorating (unchecked by the normal homeostatic mechanisms, which presumably would cease to function when cellular energy levels fell below a critical value), some general method of slowing further deterioration would be desirable.[v] Cooling of the tissue, or the injection of compounds that would slow or block deteriorative reactions would be desirable. As autonomous molecular machines with externally provided power could be used to restore function, maintaining function in the tissue itself would no longer be critical. Deliberately turning off the metabolism of the cell to prevent further damage would become a feasible option. Following some interval of reduced (or even absent) metabolic activity during which damage was repaired, tissue metabolism could be restarted again in a controlled fashion.

To sum up I would like to say that, advances in medical technology necessarily depend on our understanding of living systems. With the kind of devices

discussed earlier, we should be able to explore and analyze living systems in deeper detail than ever before considered possible.
Nanotechnology in its assumption is the best cure for incurable illnesses and very complicated operations that require us to be precise. However, we regard it not realistic we should be aware of what we created in the past and keep going to discover new devices, need for patient victims of new technology.
The abilities discussed here might well take years or decades to develop. It is quite natural to ask: When might we see these systems actually used? The scientifically correct answer is, of course, "We don't know." That said, it is worth noting that if progress in computer hardware continues as the trend lines of the last 50 years suggest, we should have some form of molecular manufacturing in the 2010 to 2020 period. After this, the medical applications will require some additional time to develop.
How long it will take to develop these systems depends very much, on what we do. If we start to pay attention on efforts to develop molecular manufacturing and its medical applications will be pursue, we will have such systems well within our lifetimes. “If we make no special efforts, the schedule will slip, possibly by a great deal”[vi]. Therefore, it is significantly worth to take this idea up and trying figure out on what we should do to prove disruptive devices for now.

[i] http://library.thinkquest.org/TQ0313009/Theory.htm
[2] http://www.zyvex.com/nanotech/nanotechAndMedicine.html
[3] http://www.rpi.edu/dept/materials/COURSES/NANO/graham/RedBloodCells.htm
[4] *Merkle, R.C. (1993) Two types of mechanical reversible logic, Nanotechnology 4 pages 114-131*
[5] *Merkle, R.C. (1991) Computational nanotechnology, Nanotechnology , 2, pp. 134-141*
[6] http://www.nanotechwire.com/news.asp?nid=1241