

Nanotechnology in medicine/Nanomedicine

Nanomedicine is a medical field dealing with applications of the results of nanotechnology and nanoscience in general in clinical medicine. It mainly follows molecular medicine, but in the future it may have a very wide field of application. In addition to the already investigated applications consisting mainly of the use of nanostructured materials, the possibilities of using methods of molecular nanotechnology, for example for the construction of miniature sensors, or even the construction of miniature "maintenance" nano bots, are also being investigated.

Scope definition

Nanomedicine is basically the application of the results of nanotechnology in medicine. Jain provides a relatively comprehensive definition of nanomedicine as a field related to molecular medicine and applied biotechnology:

Nanomedicine is the application of nanotechnology in medicine: It is based on three mutually overlapping and progressively developing molecular technologies:

1. Nanostructured materials and devices that show great promise in improving the function of diagnostic biosensors, targeted drug delivery, and in the development of smart drugs
2. Molecular medicine, especially genomics, proteomics and the use of artificial organisms
3. Molecular machines, such as nanobots, which enable practically immediate diagnosis followed by causal intervention, i.e. by eliminating pathogen, repairing a damaged chromosome or nanosurgery on the cell. Molecular machines should be able to amplify and enhance natural physiological functions.^[1]

Founded by Eric Drexler, the *Foresight Nanotech Institute* defines nanomedicine in a much bolder way: *Nanomedicine can be defined as the monitoring, repair design and control of the human biological system at the molecular level using nano devices and nanostructures.*^[2]

In general, nanomedicine can be divided into **nanodiagnostics** and **nanotherapy**. This division makes sense, because other procedures are often used. Hypothetical nanobots stand outside this division, whose task should be both diagnosis and therapy, both carried out at the level of individual molecules.

Possible clinical applications of nanomedicine

Nanomedicine in diagnostics

Sensors made by applying the knowledge of nanotechnology can be placed, for example, on a chip with a relatively high integration density. For example, there are already commercially available biochips that can sequence DNA. Such a biochip using nanotechnology is sometimes referred to as a nanochip or nanoarray.

Nanomedicine in imaging methods

Nano particles can serve as contrast agents. In radiodiagnostics, for example, gold nano particles can be used, which have a higher absorption and a longer biological half-life compared to iodine contrast agents.

However, another application is in connection with magnetic resonance imaging, as contrast agents can be used, for example, nanoparticles of iron oxides coated with short chains of dextran.

More interesting is the possibility of combining such a contrast agent with a specific receptor, e.g. with a virus, the transmitted image will then provide an idea of the distribution of target cells.

Nanoparticles do not need to contain a contrast agent for only one modality. For example, nanoparticles containing a paramagnetic and fluorescent tag can be at the same load. Using NMR the extent of the binding can be determined, direct visual inspection is possible intraoperatively.

Nanomedicine in pharmacotherapy

The main direction of research into the application of nanotechnology in medicine is moving towards the use of nanoparticles as transport media for the delivery of drugs. In particular, they are used for this:

- liposomes
- dendrimers
- fullerenes
- Nanotubes
- Nanospheres

Nanomedicine in surgical fields

Surgery can take advantage of some properties of nanostructured materials. It turns out that the surface structure of some nanostructured materials significantly facilitates the healing and integration of a foreign body into the organism. Another application of nanotechnology in surgery is the impregnation of suture material with silver

nanoparticles. These particles have an antimicrobial effect to which resistance is unlikely to develop.

Nanomedicine in Oncology

 For more information see *Nanotechnology in medicine/Nanomedicine in oncology*.

Nanomedicine provides means that can be used both diagnostically and therapeutically. Nanosensors can be used as sensitive sensors, e.g. on biochips analyzing a whole range of analytes, incl. possible DNA or RNA sequence analyses. Nanoparticles can also be used as contrast agents in imaging methods to determine the extent of tumor disease. In therapy, nanoparticles are used both as a transport medium for the targeted application of substances toxic to tumor cells and as carriers of substances that increase the tumor's sensitivity to other stimuli, or they can increase this sensitivity themselves.

Links

References

1. JAIN, Kewal K.. *The Handbook of Nanomedicine*. 1. edition. Humana Press, 2008. ISBN 9781603273183.
2. Robert A. Freitas Jr.: Nanomedicine (<https://foresight.org/Nanomedicine/>)

Literature

- JAIN, Kewal K.. *The Handbook of Nanomedicine*. 1. edition. Humana Press, 2008. ISBN 9781603273183.

Related articles

- Medical application of nanofibers
- Nanomedicine in oncology

External links

- Robert A. Freitas Jr.: Nanomedicine (<https://foresight.org/Nanomedicine/>)
- Václav Gerla: Nanotechnology in medicine (semester thesis of FEL ČVUT) (<http://nanomedicina.sweb.cz/>)

Tutorial Presentations

- Carmel J. Caruana: Nanotechnologie v medicíně ([http://www.med.muni.cz/biofyz/doc/lec-cs/NanotechnologieV Medicine-1h.ppt](http://www.med.muni.cz/biofyz/doc/lec-cs/NanotechnologieV%20Medicine-1h.ppt))
- J.Šrámek: Nanotechnologie v medicíně (2008/09) (<http://www.med.muni.cz/~formol/doc/nano-prezentace.pdf>)