Introduction of nanotechnology in oncology and cutting-edge precision medicine

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ABSTRACT

- One of the most important aspects of cutting-edge precision medicine is novel information, materials, and/or procedures. Nanobiotechnology in precision medicine offers potential to attain a significant amount of novel information about a broad range of biological subjects. **Nanobiotechnology is material that allows researchers and scientists the ability to control matter on the scale of 1-100 nanometers, where unique phenomena enable novel applications**. Nanobiotechnology is made of nanoparticles. These nanoparticles are very small inorganic molecules that straddle quantum and Newtonian mechanics.
- Nanobiotechnology has a wide range of applications over a large range of medical disciplines, many of them having already been studied for proof of concept.
  - Nanodevices and nano systems for sequencing single molecules of DNA are feasible
  - Magnetic nanoparticles can be directed to an organ, tissue or tumor using an external magnetic field.
- Other applications of nanobiotechnology include:
  - Nanoparticles as biomarkers
  - The use of nanoparticles as delivery vehicles for drugs, cell therapy, genetic therapy, any targeted therapy, etc.
  - Nanosurgery

Quantum Mechanics

Quantum mechanics is a field of physics that deals with matter at a size so small that the field of classical Newtonian physics does not apply, due to negligible forces and unstudied properties and phenomena.

It is due to this field that the subject of nanobiotechnology hold such substantial potential in learning important novel biological information.

Nanoparticles/ Nanotechnology

Some nanoparticles that are being studied as nanobiotechnology today include carbon nanotubues, gold nanoparticles, quantum dots, highly branched dendrimers and more. It is their quantum properties that gives them the unique potential of bringing forth novel biological information.

- **Quantum Dots:** Quantum Dots are nanoscale semiconductor particles with unique optical and chemical properties. They can be used as fluorophores for molecular imaging or as nano-carriers for cellular therapies.
- **Gold Nanoparticles:** Gold Nanoparticles are usually a colloidal suspension of nanoparticles of gold. These can be used as a nano-carrier device. These nanoparticles have been shown to work by active and passive targeting through different mechanisms.
- **Liposomes:** These nanoparticles are nanoscale spheres of natural or synthesized phospholipid bilayer membrane and water phase nuclei. Liposomes can be directed and target specific cells. They can be nano-carriers by incorporating drugs into their centers.
- **Carbon Nanotubules/ Branched Dendrimers:** Dendrimers as well as nanotubules are polymeric nano-particles that are highly branched. These nano-particles can be directed toward a tumor or cell and simultaneously carry an imaging agent, drugs and more.

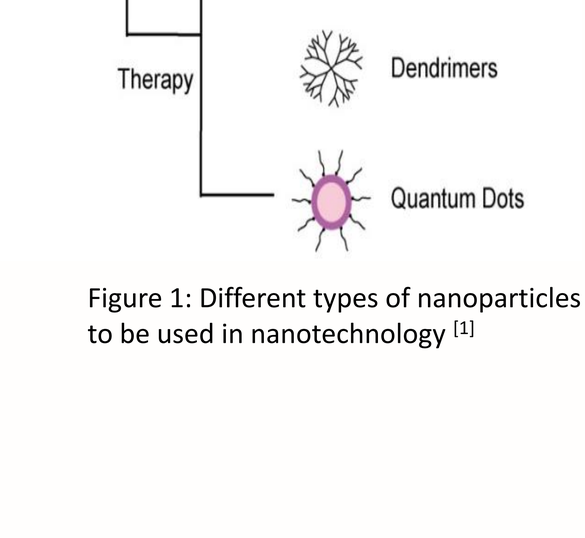

Figure 1: Different types of nanoparticles to be used in nanotechnology [1]

Cellular Delivery Mechanisms

One of the greatest potentials of nanobiotechnology is the ability to target different cellular environments with high affinity and specificity. Because of this property nanotechnology can guide many different types of drugs or therapeutic material to areas that are currently practically impossible, such as through the blood brain barrier and discriminately to tumor cells .

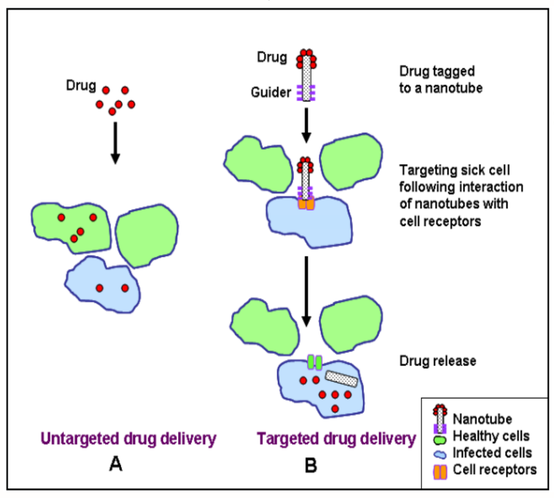

Figure 2: This figure shows the mechanism of how nanotechnology can bind to drugs or molecular material and delivery them to very specific areas distinctly from others. [2]

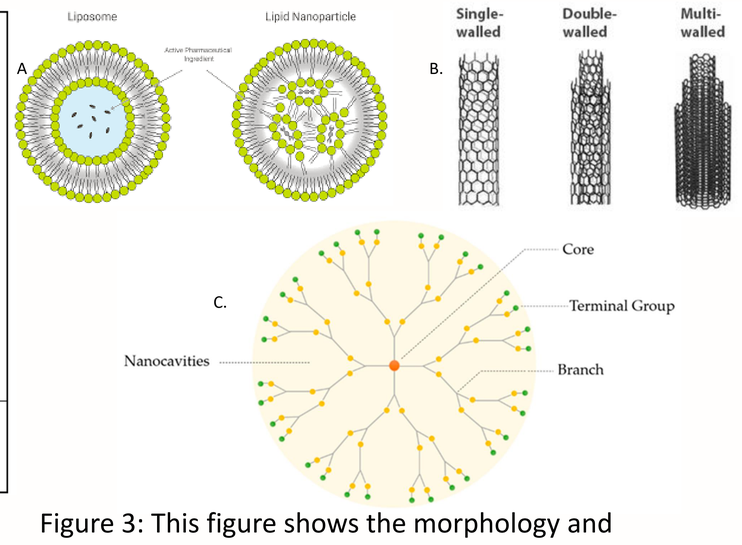

Figure 3: This figure shows the morphology and structure of some nanoparticles.
a. Liposomes b. Carbon Nanotubules c. Dendrimers

Molecular Imaging

The completeness of tumor removal during surgery is dependent on the surgeon's ability to differentiate tumor from normal tissue. Currently there is no method to determine the exact margin of tumor as opposed to healthy tissue, this is determined microscopically. Targeted delivery of an imaging agent by nanotechnology allows surgeons to differentiate between tumor cells and healthy tissue without microscopy.

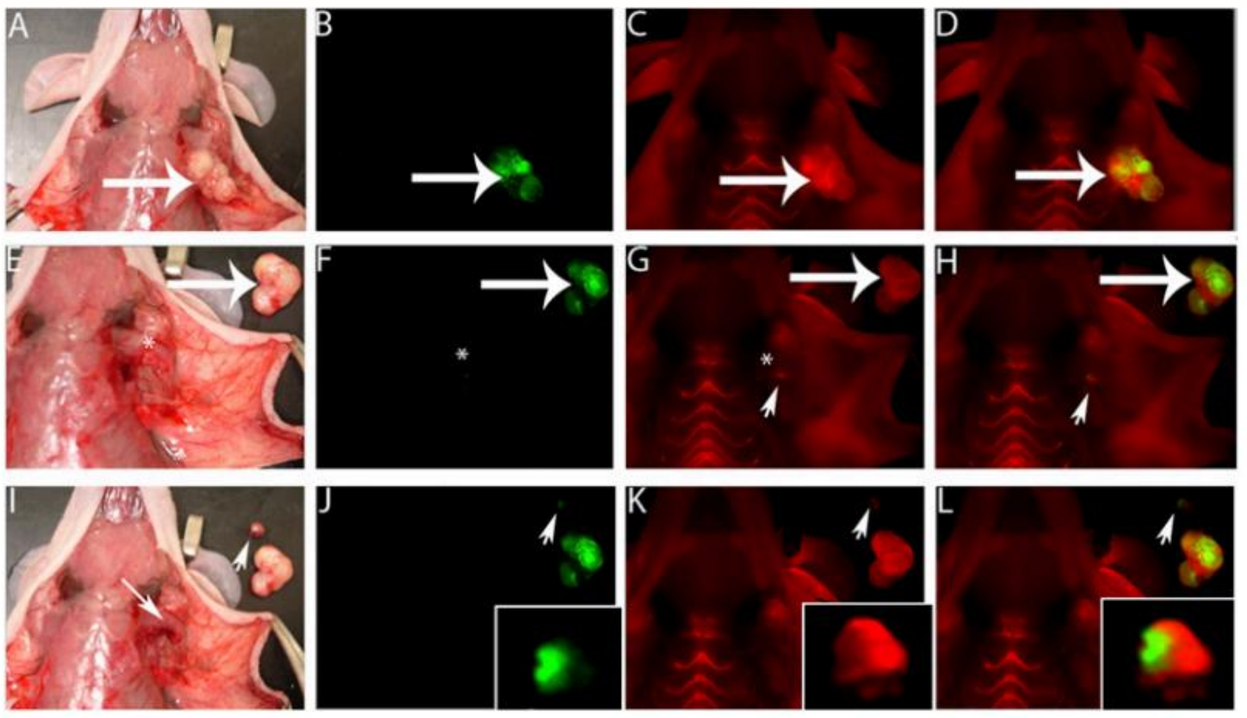

Figure 4: This figure shows proof of concept of using nanotechnology or activated cell penetrating peptides to image tumors during surgery[3]

Future Applications

The basic rationale for using nanobiotechnology in oncology is that nanoparticles have optical, magnetic, or structural properties that are not available in larger molecules or bulk solids. Nanoparticles can be used to target tumor antigens (biomarkers) as well as tumor vasculatures with high affinity and specificity. Due to these properties nanotechnology may play a role in a wide range of disciplines including[4] :

- Neurobiology
- Nanosurgery
- Cardiology
- More

References

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