ROLE OF NANOTECHNOLOGY IN ASSISTING HEALTH CARE TREATMENT: A REVIEW OF TREATMENT TECHNOLOGIES

Jennifer Toney and Dr. Pedro E. Arce

Department of Chemical Engineering , Tennessee Technological University, Cookeville

Project Goals

To develop a general organization of selected treatment technologies, Project goals are as followed:

Classification of Technologies for Treatment of Health Care Related Illness
Based on the nanotherapeutics selected, technologies associated with treatment of, for example , cancer tumors will be studied and classified.

Identification of Nanoparticles used in Each Technology
Each technology uses a unique type of nanoparticle and these will be identified, and their role highlighted.

**Understanding the Role of the Nanoparticle in Each Technology**

Motivation & Relevance to Research

Nanotechnology is known as "tiny" science due to it being on the molecular scale. Many use the term nanoparticles interchangeably with nanotechnology. It has very impactful outcomes including applications in materials, the environment, health care, and energy. Nanotechnology has a wide range of applications within the healthcare field. Nanoparticles can diagnosis and help treat early-stage cancer and other diseases. Nanoparticles offer numerous advantages in drug delivery systems which can achieve better therapeutic action, bioavailability, and reduce toxicity.

Nanotherapeutics uses nanotechnology products for highly specific medical interventions at the molecular scale for curing diseases or repairing damaged tissues. It is a two-component drug delivery. This helps gets the right amount and combination of the therapeutic to the right place which is a new shift in advanced technology. It may prove to be the first cutting-edge field that reflect the new realities of targeted medicine.

An understanding of the slected treatment approaches that use nanoparticle to either make a diagnostic of treat, for example cancer tumors is valuable to improve the knowledge related to the potential helpful possibilities that they offer in health care.

Methods & Methodology
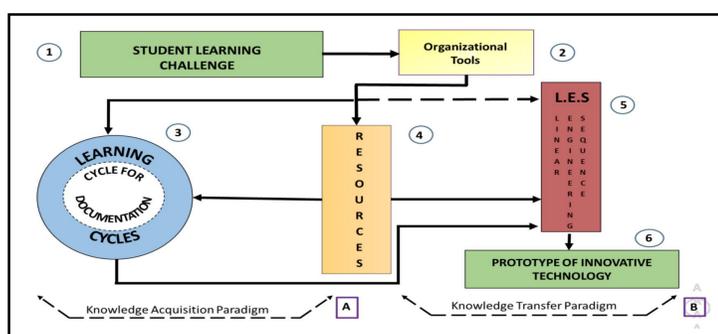
The learning challenge here is the classification of the treatment technologies and the use of the different nanoparticles. The Resources include the information found in the literature, the skills and background from the ChE 4990 class, the discussions with Dr. Arce, poster format from previous contributions at the TTU event. The Prototype of Innovative Technology is the Table with the technologies discussed and organized (see section on Results). Organizational tools include the ChE 4990 Course Syllabus and outline of the project.

Role of Nanotherapeutics on Cancer Tumor Treatment

Diagnosis
- Detects early-stage cancer
- Nanoparticles can be paired with:
  - Magnetic Resonance imaging, MRI
  - Positron emission tomography, PET
  - Computerized tomography scans, CT scans

Treatment : Targeting Tumors
- Active targeting
  - Triggered drug release components
  - Conjugation of targeting ligands to nanoparticle surface
- Passive targeting
  - Enhanced permeability and retention
    - Increases the concentration of nanoparticles in a tumor

Different Types of Nanoparticles used in Nanotherapeutics

Liposomes:
- Small, spherical shaped
  - nanoscale sphere
- Some drugs can be incorporated into liposomes
  - Not readily released from the inside
    - Due to poor avidity for acidic environments

Carbon-Nanotubes:
- Single walled
  - Composed of monolithic cylindrical graphene
- Multiple walled
  - Composed of concentric graphene
- Provide a large surface area
- Stable thermally and electrically

Magnetic Nanoparticles:
- Paired with magnetic material
  - Iron
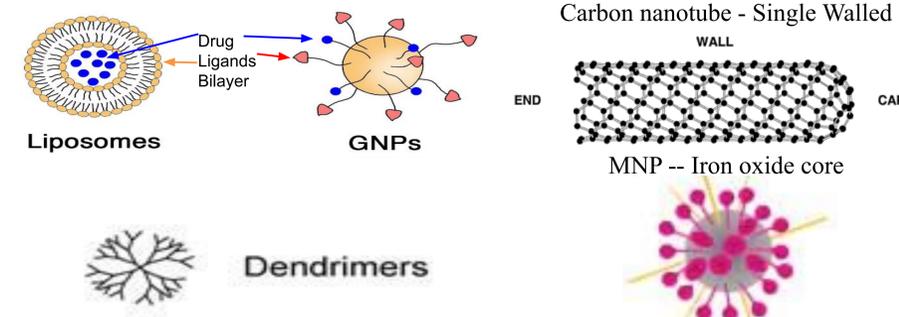- Nanoparticles are activated by magnetic field presence
- Novel drug delivery method

Dendrimers:
- Ideal delivery system
  - high encapsulation capability
  - High water solubility

Golds Nanoparticles GNP:
- Used in cancer treatment
  - Remarkable compatibility
  - Tunable stability
  - Low toxicity

Particles Visualization

Liposomes — Drug Ligands Bilayer — GNPs

Carbon nanotube - Single Walled — WALL — END — CAP

MNP -- Iron oxide core

Dendrimers

Results & Discussion

TABLE 1: CLASSIFICATION OF DIFFERENT NANOTHERAPIES AND ROLE OF NANOPARTICLE		
Nanotechnology Type	**Cancer**	**Role of the Nanoparticle**
Liposomes	Advanced cancer	drug delivery, stayed in circulation longer
Carbon nanotube	lung breast	therapy and drug delivery
Magnetic nanoparticles	breast	MRI imaging diagnosis
Dendrimers	various types	detect circulating tumor cells
Gold nanoparticles	prostate	image-guided therapy

Conclusions & Future Work

Nanotechnology is a promising area for diagnosis and treatment for cancer and other diseases. There still needs to be more research to fix the limitations of the technology. As for future work, a certain nanotechnology will be test for accuracy and precision within a certain cancer tumor.

References

Acc. Chem. Res. 2002, 35, 12, 997. Publication Date:December 17, 2002
https://pubs.acs.org/doi/full/10.1021/ar020259h

Diwate, S. B., Ataurrahman, Z., & Bhise, K. S. (2020). Trends in Nanotechnology for the Treatment of Breast Cancer. *Journal of Pharmaceutical Research International*, *32*(36), 42-57. https://www.journaljpri.com/index.php/JPRI/article/view/30991/58168

Dürr, S., Janko, C., Lyer, S., Tripal, P., Schwarz, M., Zaloga, J., Tietze, R. and Alexiou, C.. "Magnetic nanoparticles for cancer therapy" *Nanotechnology Reviews*, vol. 2, no. 4, 2013, pp. 395-409. https://www.degruyter.com/document/doi/10.1515/ntrev-2013-0011/html

He, M., Chen, L., Zheng, T., Tu, Y., He, Q., Fu, H., . . . Yuan, Z. (2018, June 19). Potential applications of nanotechnology IN Urological cancer. Retrieved April 08, 2021, from https://www.frontiersin.org/articles/10.3389/fphar.2018.00745/full

Jin C, Wang K, Oppong-Gyebi A, Hu J. Application of Nanotechnology in Cancer Diagnosis and Therapy - A Mini-Review. *Int J Med Sci* 2020; 17(18):2964-2973. https://www.medsci.org/v17p2964.htm

Zou, Lili et al. "Current Approaches of Photothermal Therapy in Treating Cancer Metastasis with Nanotherapeutics." *Theranostics* vol. 6,6 762-72. 21 Mar. 2016, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4860886/

Acknowledgements