2nd PANHELLENIC CONGRESS OF MEDICAL PHYSICS
4-6 OCTOBER 2024| EUGENIDES FOUNDATION

Exploring Nanoparticle-Based Strategies for Overcoming Biological Barriers in Drug Delivery

Maria Anthi Kouri[1] , Sotiria Theano Makridou[2] , Christina Thymiou[2], Stamatis Rallis[1], Efstathios P. Efstathopoulos[1]

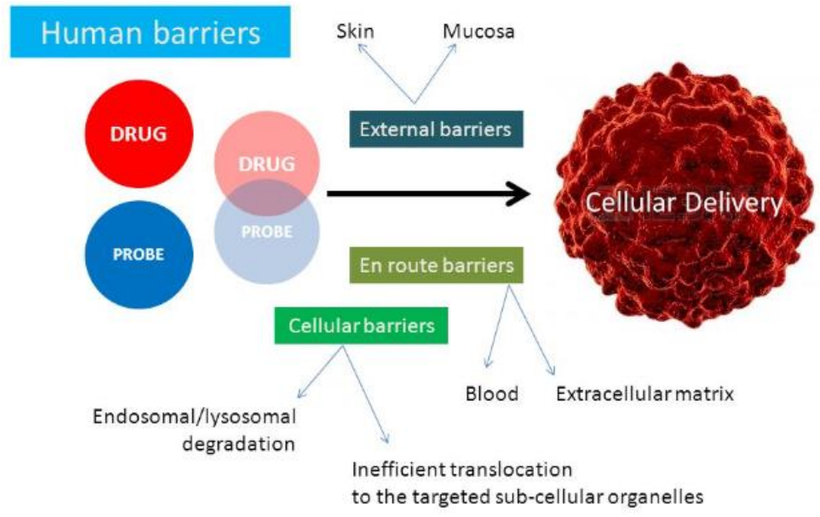
[1]2nd Department of Radiology, Medical Physics Unit, Medical School, National and Kapodistrian University of Athens, 1 Rimini str., Chaidari, 12462, Athens, Greece

[2]Medical School, National and Kapodistrian University of Athens, Athens, Greece

1. Background-Aim

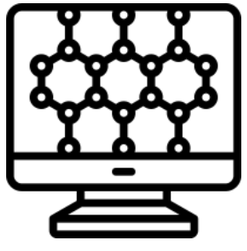
The field **of drug delivery systems** has witnessed a transformative shift, driven by the potential of **nanoparticles** as carriers across biological barriers.

Biological Barriers



These systems

- Optimize pharmaceutical agent administration
- Confront the formidable challenges posed by biological barriers within living organisms.



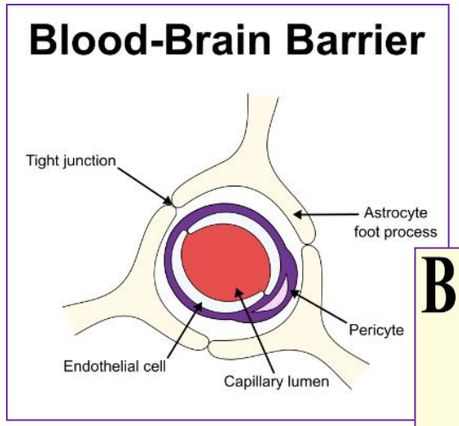
This evolution is the recognition of nanoparticles as pivotal entities in advancing the precision and efficacy of therapeutic interventions.

2. Materials & Methods

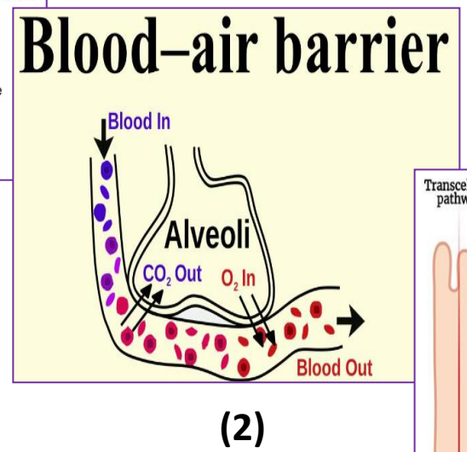
Living organisms present multiple biological barriers:

1. **Blood-brain barrier**
2. **Lung barrier**
3. **Gastrointestinal barrier**

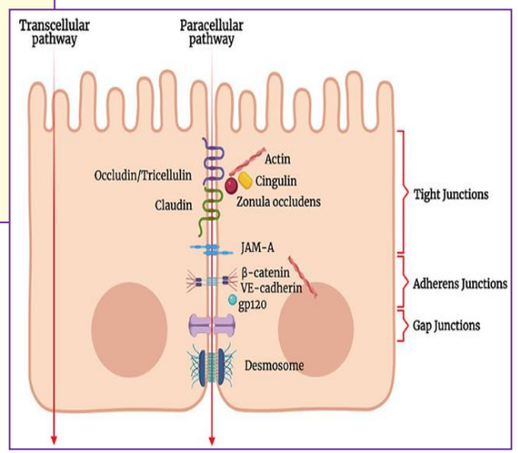
→each posing unique challenges for drug delivery systems.



(1)

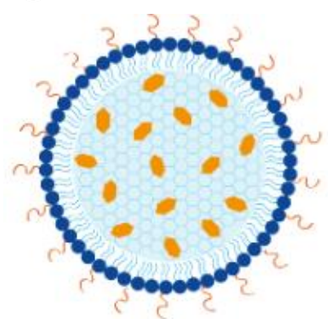


(2)

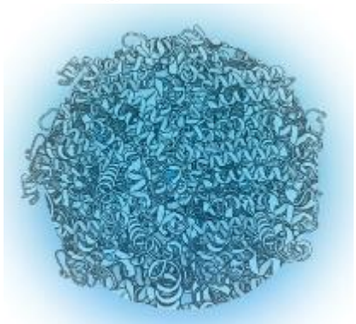


(3)

Nanoparticles, ranging from lipid-based to protein-based carriers, showcase versatile mechanisms for traversing these barriers with heightened efficiency.

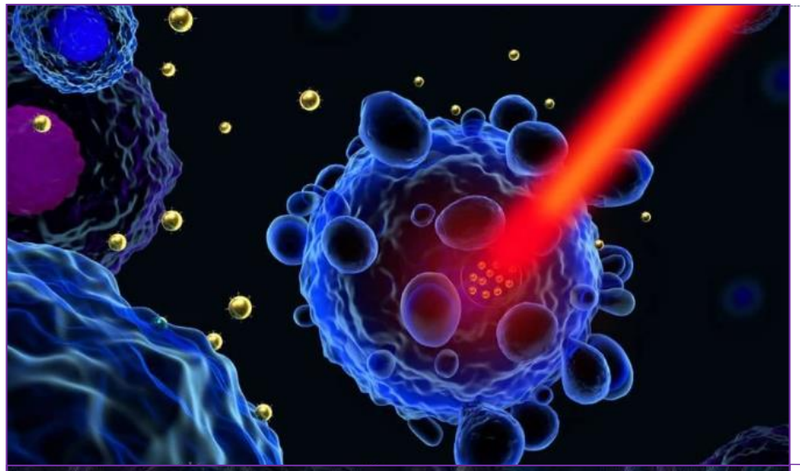


Solid-Lipid Nanoparticle



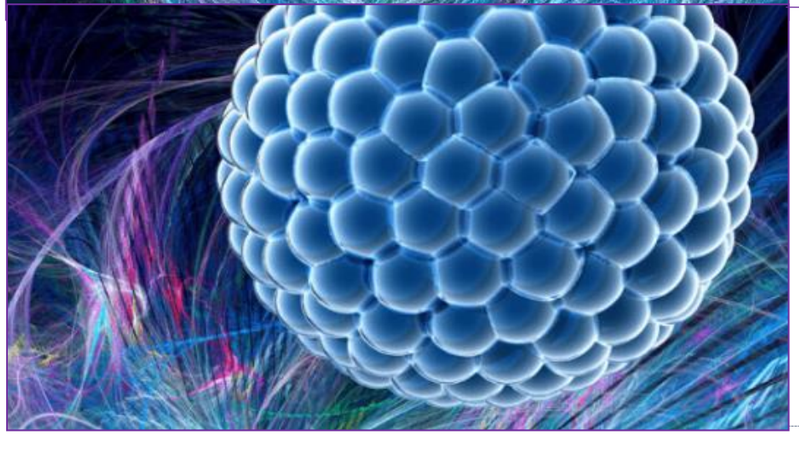
Protein Nanoparticle

3. Results



hyperthermia therapy for cancer

metallic nanoparticles



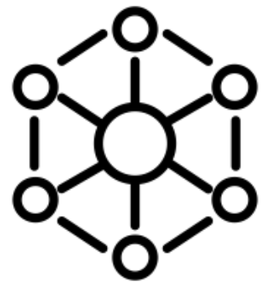
mesoporous silica nanoparticles

•In the realm of cancer treatment, nanoparticles demonstrate remarkable potential, offering precise drug delivery mechanisms and solutions to challenges like hyperthermia therapy.

•Their application spans diverse modalities, from lipid-based carriers to metallic nanoparticles and mesoporous silica nanoparticles, each offering distinct advantages in targeting cancer cells while minimizing harm to healthy tissues.

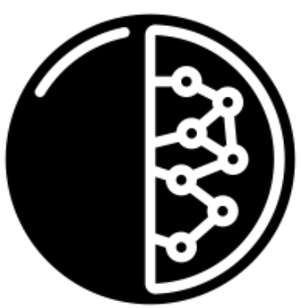
4. Conclusions

While the promise of nanoparticles in drug delivery is profound, careful consideration of potential drawbacks, **such as toxicity**, remains imperative.



The ongoing evolution in nanotechnology promises a future where precision, efficacy, and accessibility converge, heralding a new era in therapeutic interventions.

By harnessing the transformative potential of nanoparticles, researchers aim to reshape the trajectory of medical science, offering tailored solutions to overcome specific anatomical and physiological hurdles and ultimately improve patient outcomes.



5. References

1. Chenxiao Chu et al.International Journal of Pharmaceutics, Volume 636, 2023, 122811, ISSN 0378-5173,

2. Makhloufi et al. “Pulmonary delivery of siRNA against acute lung injury/acute respiratory distress syndrome.” Acta pharmaceutica Sinica. B vol. 12,2 (2022): 600-620. doi:10.1016/j.apsb.2021.08.009

3. d'Angelo, Ivana et al. “Hybrid Lipid/Polymer Nanoparticles for Pulmonary Delivery of siRNA: Development and Fate Upon In Vitro Deposition on the Human Epithelial Airway Barrier.” Journal of aerosol medicine and pulmonary drug delivery vol. 31,3 (2018): 170-181. doi:10.1089/jamp.2017.1364

4. Li, Bowen et al. “Combinatorial design of nanoparticles for pulmonary mRNA delivery and genome editing.” Nature biotechnology vol. 41,10 (2023): 1410-1415. doi:10.1038/s41587-023-01679-x

5. Biological barriers to precision medicine applications, adapted from Mitchell, Michael J et al. “Engineering precision nanoparticles for drug delivery.” Nature reviews. Drug discovery vol. 20,2 (2021): 101-124. doi:10.1038/s41573-020-0090-8

6. Biological barriers to precision medicine applications, adapted from Mitchell, Michael J et al. “Engineering precision nanoparticles for drug delivery.” Nature reviews. Drug discovery vol. 20,2 (2021): 101-124. doi:10.1038/s41573-020-0090-8

7. Jose J, Kumar R, Harilal S, et al. (2020). Magnetic nanoparticles for hyperthermia in cancer treatment: an emerging tool. Environ Sci Pollut Res Int 27:19214 – 25

8. Chen L, Chen C, Wang P, Song T. (2017). Mechanisms of cellular effects directly induced by magnetic nanoparticles under magnetic fields. J Nanomater 2017:1 -13

9. Koohi Moftakhari Esfahani, Maedeh, et al. “Application of Mesoporous Silica Nanoparticles in Cancer Therapy and Delivery of Repurposed Anthelmintics for Cancer Therapy.” Pharmaceutics, vol. 14, no. 8, 29 July 2022, p. 1579, https://doi.org/10.3390/pharmaceutics14081579. Accessed 23 Aug. 2022.

10. Zhao, P.; Li, L.; Zhou, S.; Qiu, L.; Qian, Z.; Liu, X.; Cao, X.; Zhang, H. TPGS functionalized mesoporous silica nanoparticles for anticancer drug delivery to overcome multidrug resistance. Mater. Sci. Eng. C 2018, 84, 108–117.