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Polymeric Micelles as Smart Nanocarriers in Photodynamic Cancer Therapy

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INTRODUCTION & AIM

Photodynamic therapy (PDT) has gained significant attention among cancer treatments in recent years. This method offers the major advantage of being minimally invasive, with a low risk of damage to normal cells, thereby reducing the burden on patients.

Drug Delivery Systems (DDS) have gained attention as a strategy to reduce PDT side effects. DDS is a technology that controls drug distribution within the body to maximize therapeutic effects while minimizing side effects. By leveraging the EPR effect, DDS can efficiently drug to tumor tissue and reduce systemic side effects.

EPR effect

- Tumor blood vessels are immature, with large gaps between endothelial cells.
- Drugs and nanoparticles can accumulate easily and in high amounts within tumor tissue.

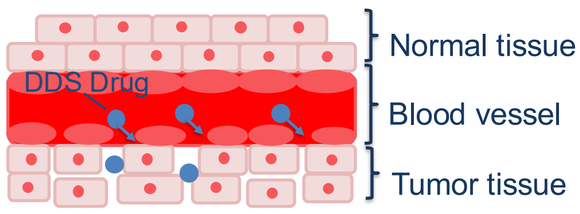


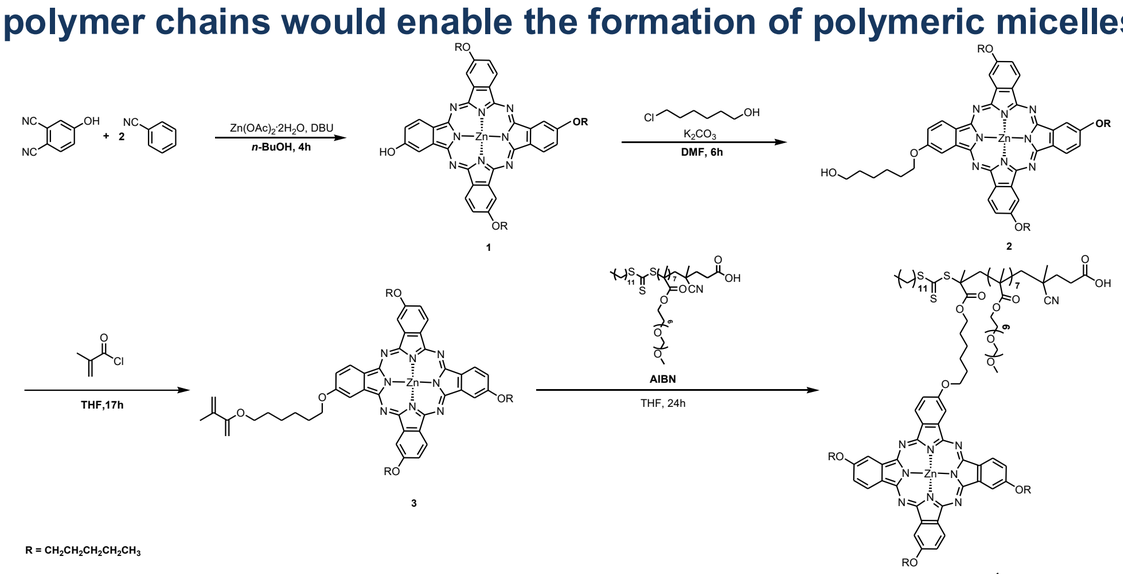
Figure 1 EPR effect

In this study, phthalocyanine, which absorbs long-wavelength light, was used as the photosensitizer. Micelles containing POEGMA chains were prepared, and photocytotoxicity evaluations were conducted using cancer cells.

METHOD

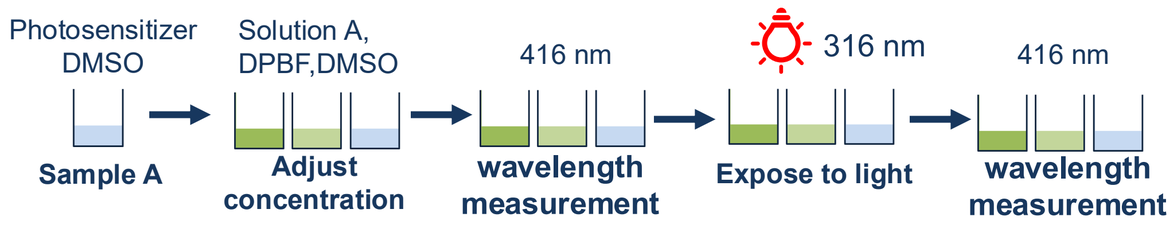
[Synthesis of compound]

We designed the molecules with the idea that phthalocyanine could function as a photosensitizer, and that the presence of polymer chains would enable the formation of polymeric micelles.



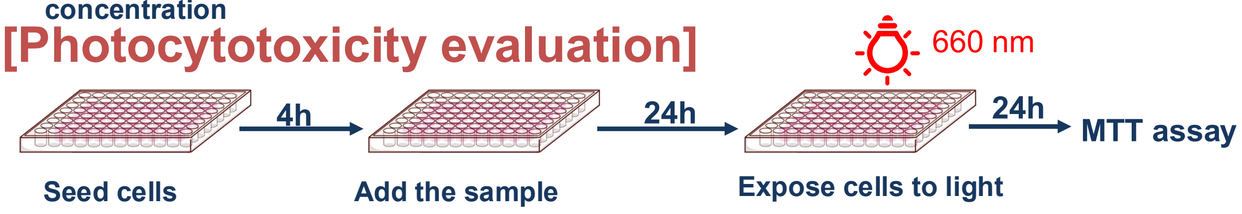
Scheme 1 Synthetic route of photosensitizer-containing block copolymers

[Singlet Oxygen generation test]



[DLS measurement]

[Photocytotoxicity evaluation]



The phototoxicity test was conducted using the MTT assay.

RESULTS & DISCUSSION

[Singlet Oxygen generation test]

1,3-Diphenylisobenzofuran (DPBF) efficiently reacts with singlet oxygen, resulting in a decrease in absorbance at 416 nm. Therefore, the greater the decrease in absorbance at 416 nm, the higher the singlet oxygen generation ability.

Table 1 Comparison of quantum yield

	No compound	compound
Before light irradiation	3.2431	3.2381
After light irradiation	3.2407	3.2348
Quantum yield (ϕ)	0.00074	0.00100

As a result, the slight change in quantum yield upon addition of POEG-MA-b-PBuPc-C6MA suggested the generation of singlet oxygen.

[DLS measurement]

The average size of the micelles were confirmed to be 484 nm and 78 nm. The 78 nm micelles are considered to be broken micelles.

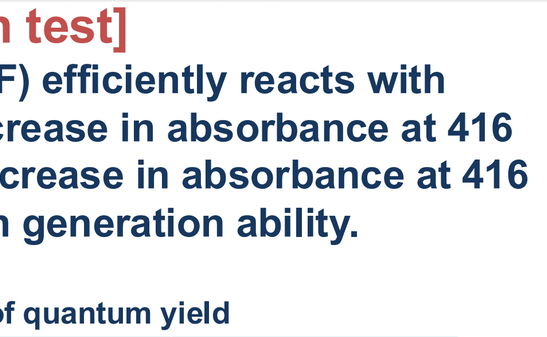


Figure 2 Absorption spectrum of POEGMA-b-PBuPc-C6MA

[Photocytotoxicity evaluation]

The phototoxicity test was evaluated using Hela cells and MCF-7 cells. The results showed a significant toxicity to MCF-7 cells, with a 35 % reduction in cell survival rate regardless of irradiation.

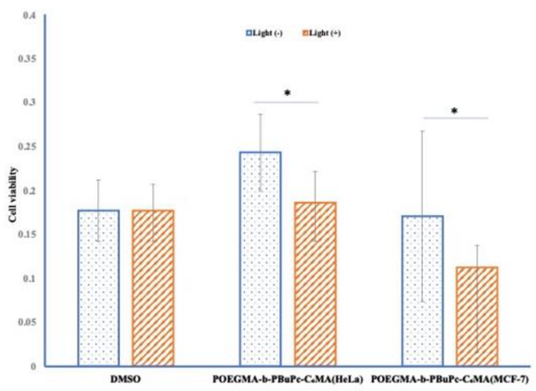


Figure 3 Photocytotoxicity using HeLa and MCF-7

CONCLUSION

Photosensitizer-loaded polymeric micelles were prepared, and photocytotoxicity assays revealed significant cytotoxic effects in MCF-7 cells.

FUTURE WORK / REFERENCES

In this study, phototoxicity was confirmed; however, it remains unclear whether this effect results from cellular uptake of the photosensitizer-loaded micelles or from their adhesion to the cell membrane. Further investigation is required to clarify the mechanism of cellular interaction.

Ongoing toxicity tests using HT-29 cells are currently underway, and the results will be presented upon completion.