Mucin detection based on Thioflavin T and lasing effect – a proposal for diagnostics of brain tumors from human tears

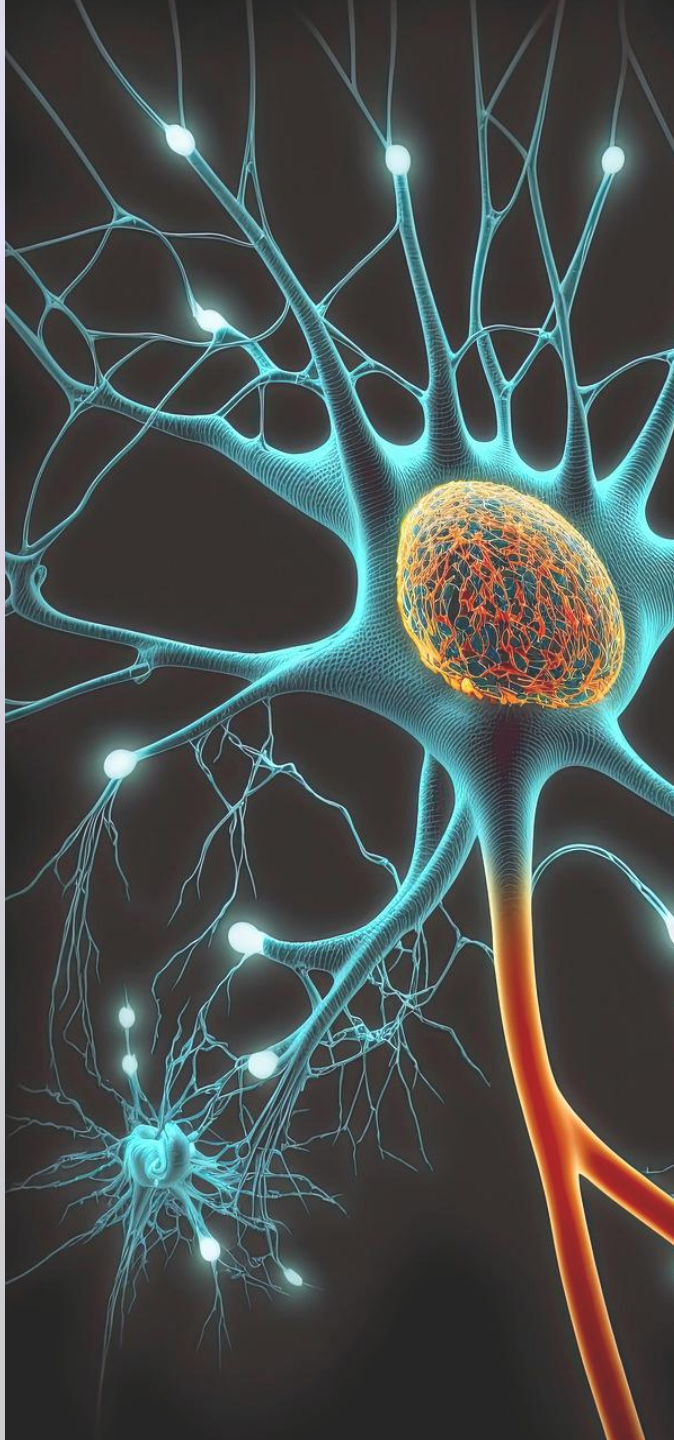
Ewelina Jalonicka[1,2], Konstantin Rusakov[3], Grzegorz Szwachta[1], Piotr Hanczyc[1,4]

[1] Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Poland

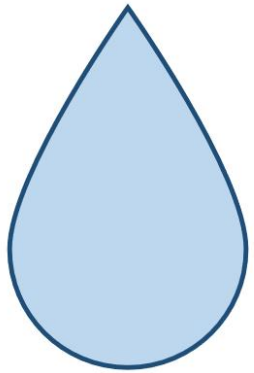
[2] Faculty of Medicine. Collegium Medicum - Cardinal Stefan Wyszynski University in Warsaw, Poland

[3] Faculty of Construction and Environmental Engineering, Warsaw University of Life Sciences, Poland

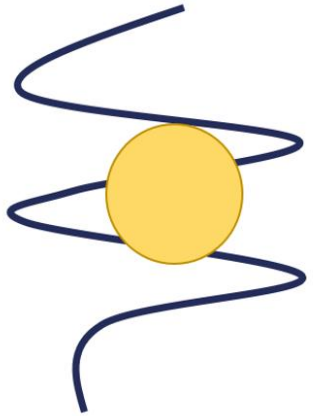
[4] Center of Cellular Immunotherapies, Warsaw University of Life Sciences, Poland



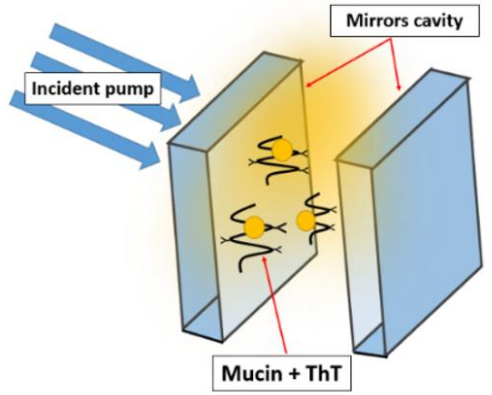
Three pillars of the idea



Tears



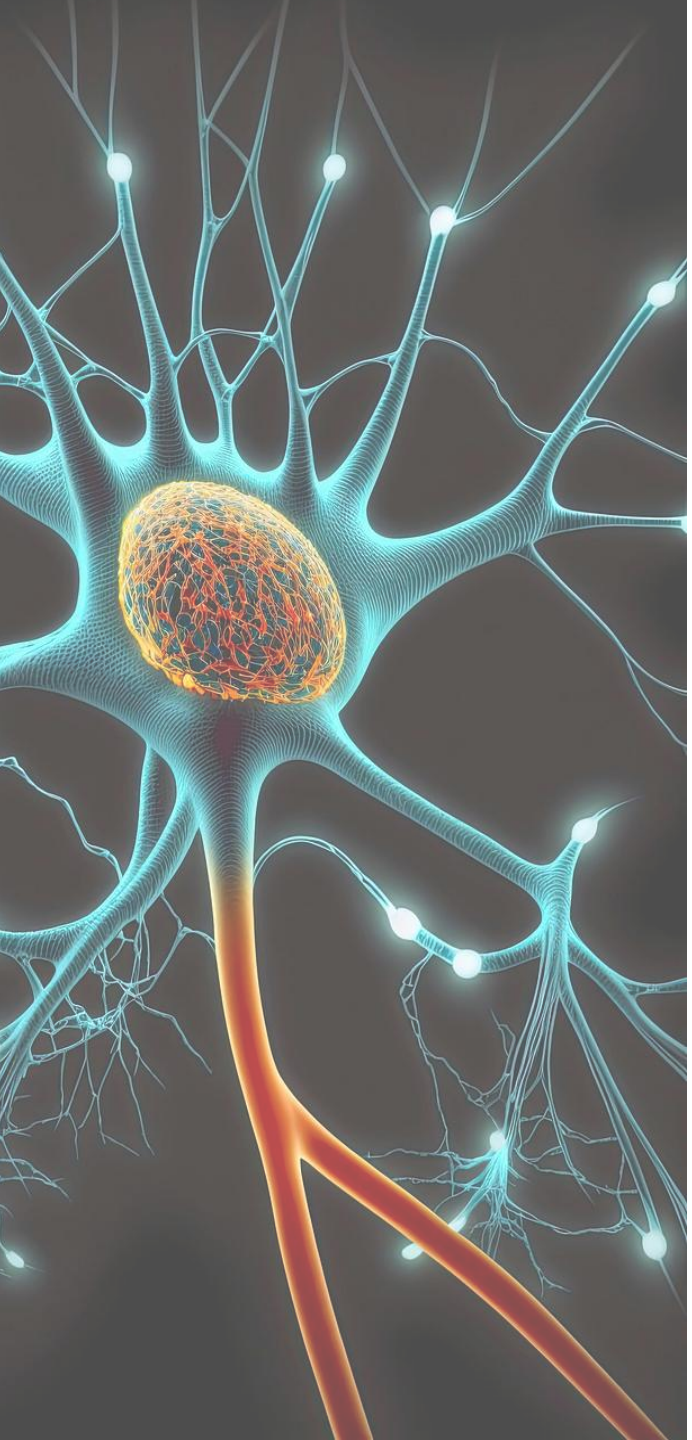
Mucins



Thioflavin T in lasing spectroscopy

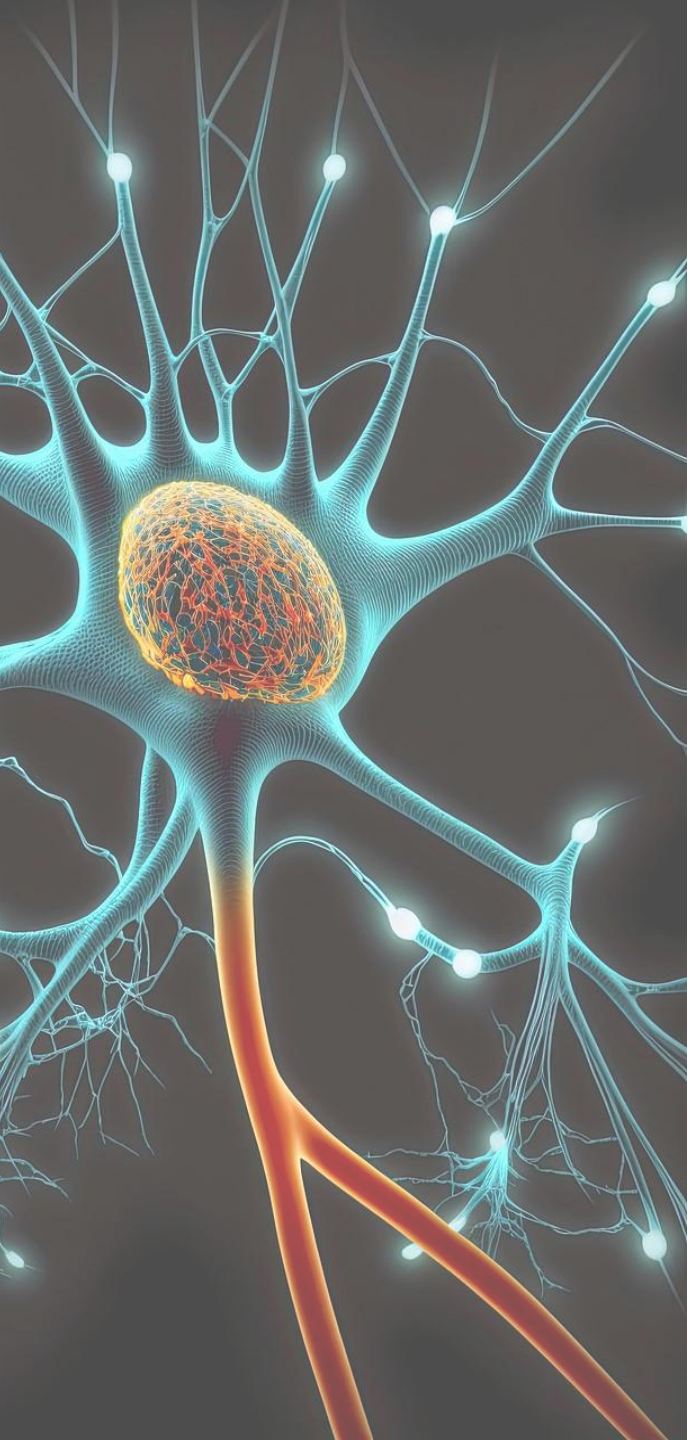
Brain tumors

- There will be 308,102 new cases and 251,329 deaths from brain and CNS cancers in 2020 (Global Cancer Statistics).
- One of the most common and malignant diseases is glioblastoma (IV grade). It is a disease characterized by extremely poor prognosis — the 5-year survival rate is only 4–5%.



Mucins

- large, highly glycosylated glycoproteins that are products of MUC genes
- characterized by a high molecular weight (200 kDa – 200 MDa) and large size (Rg 10– 300 nm)
- a high degree of glycosylation (up to90%).
- part of one of the three layers of the human tear film (in tears we have the mucin layer, and also aqueous and lipid layers).
- responsible for maintaining the stability of the tear film.



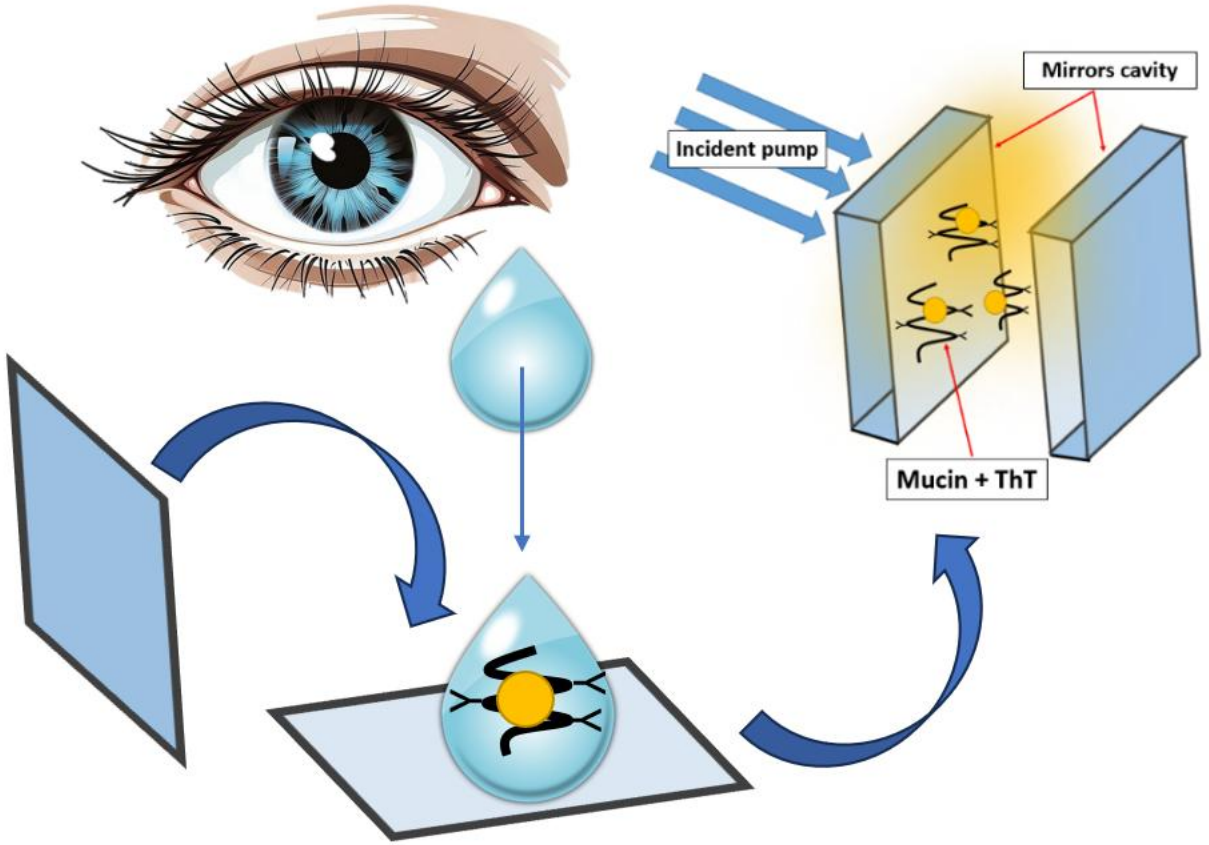
Mucins and brain tumors

- MUC 1
- MUC 4
- MUC 5AC
- MUC 7
- MUC13
- MUC 16
- MUC 21

etc.

Erickson A, Jackson LR, Camphausen K, Krauze AV. Mucins as Precision Biomarkers in Glioma: Emerging Evidence for Their Potential in Biospecimen Analysis and Outcome Prediction. *Biomedicines* **2024**, *12* (12), 2806. https://doi.org/10.3390/biomedicines12122806.

Methodology



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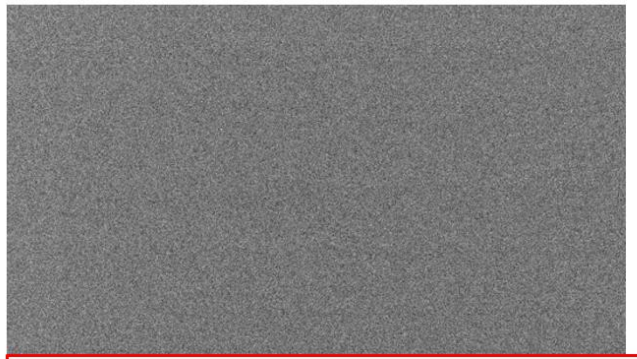
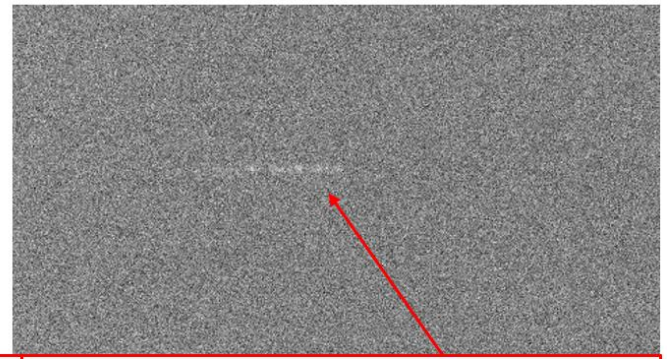
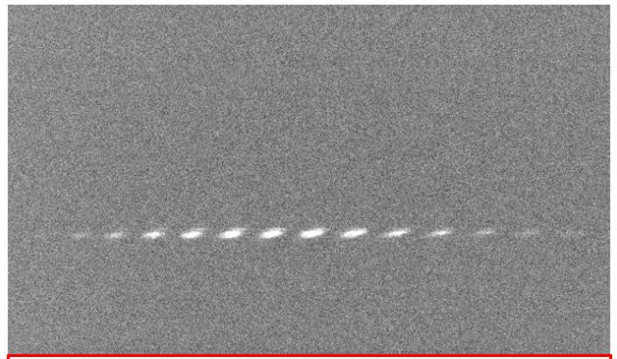
What does it look like on screen?



Negative lasing effect

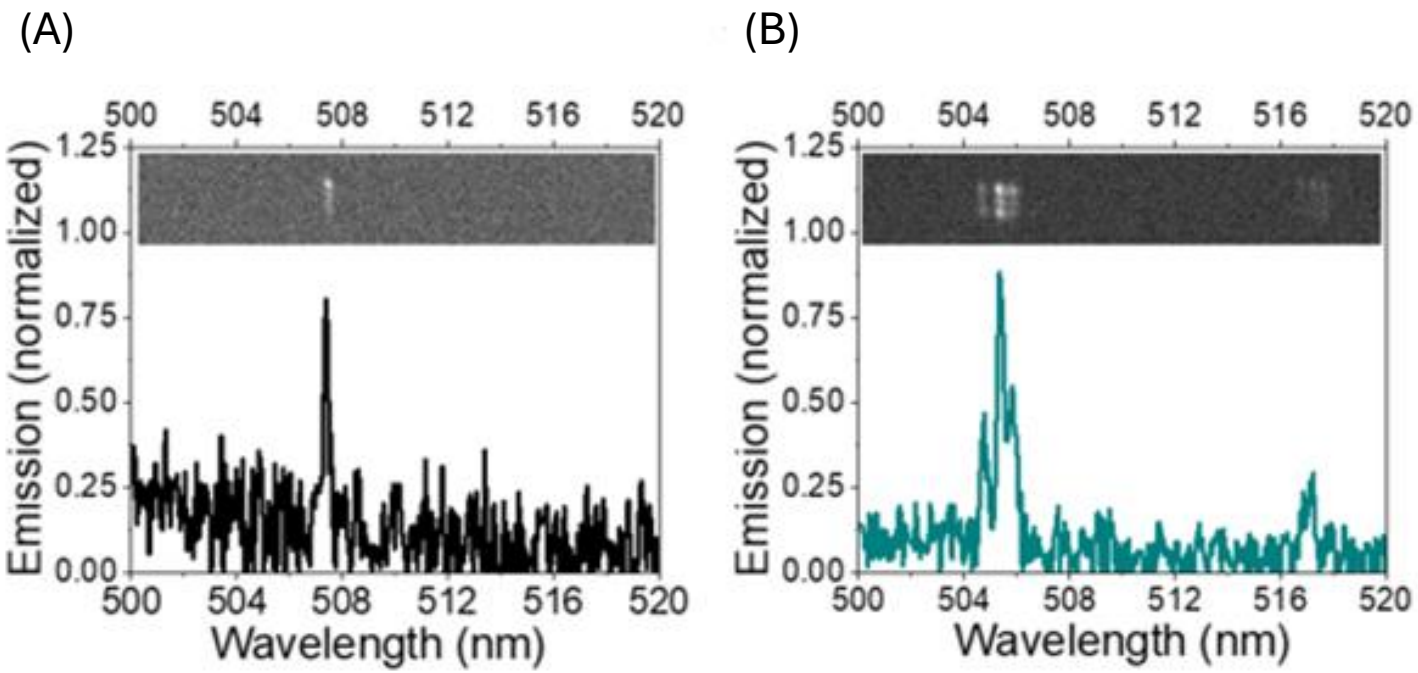


Positive lasing effect



Very positive lasing effect

Results



(A) Lasing spectrum of ThT in simulated tears solution.
(B) Lasing emission spectrum of ThT with additions of mucins (0.2 mg/mL) to simulated tears solution.

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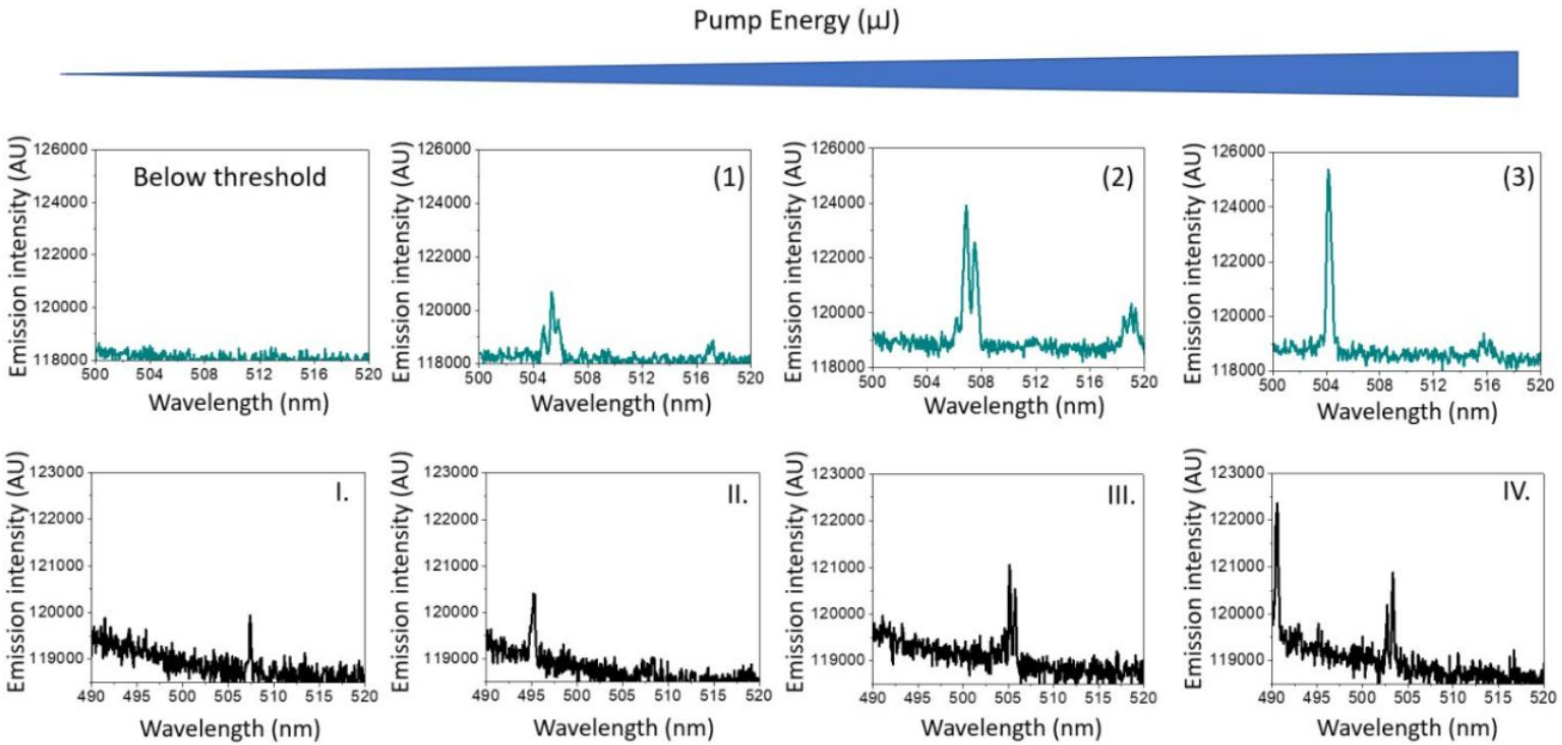
Results



Lasing spectra of ThT in simulated tears as a function of pump energy. The top panel (cyan) displays the spectra for ThT - mucin complexes in simulated tear. Black illustrates the spectra for ThT in simulated tears without mucins

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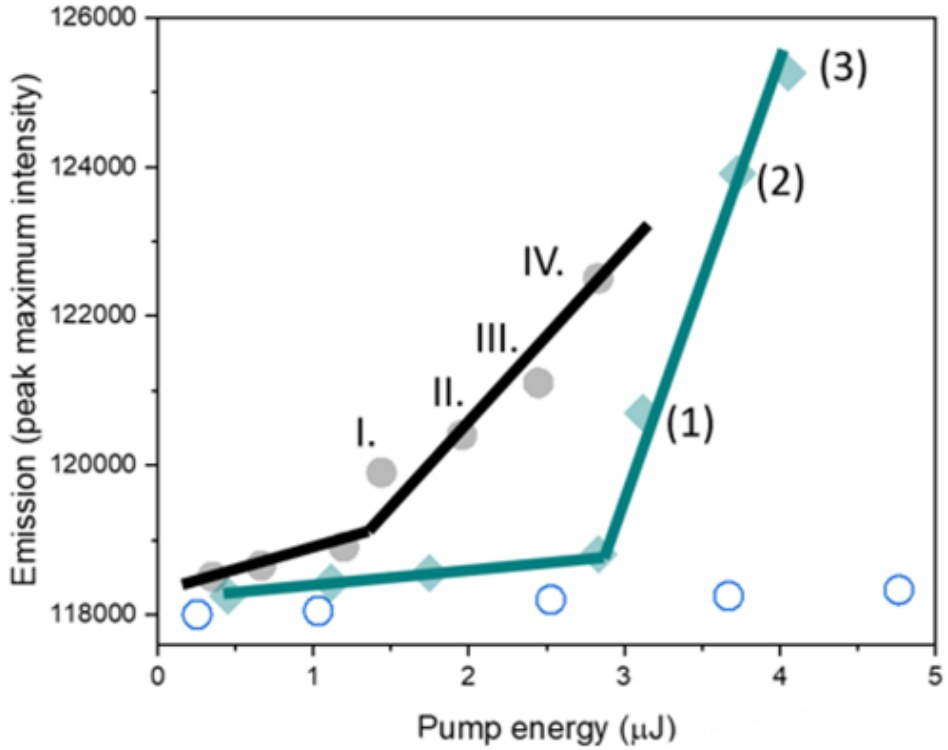
Results



Plot of pump energy versus emitted intensity, illustrating the exponential rise in intensity once the lasing threshold is surpassed. Black dots are ThT dissolved in simulated tears and cyan diamonds are ThT-mucin in simulated tears.

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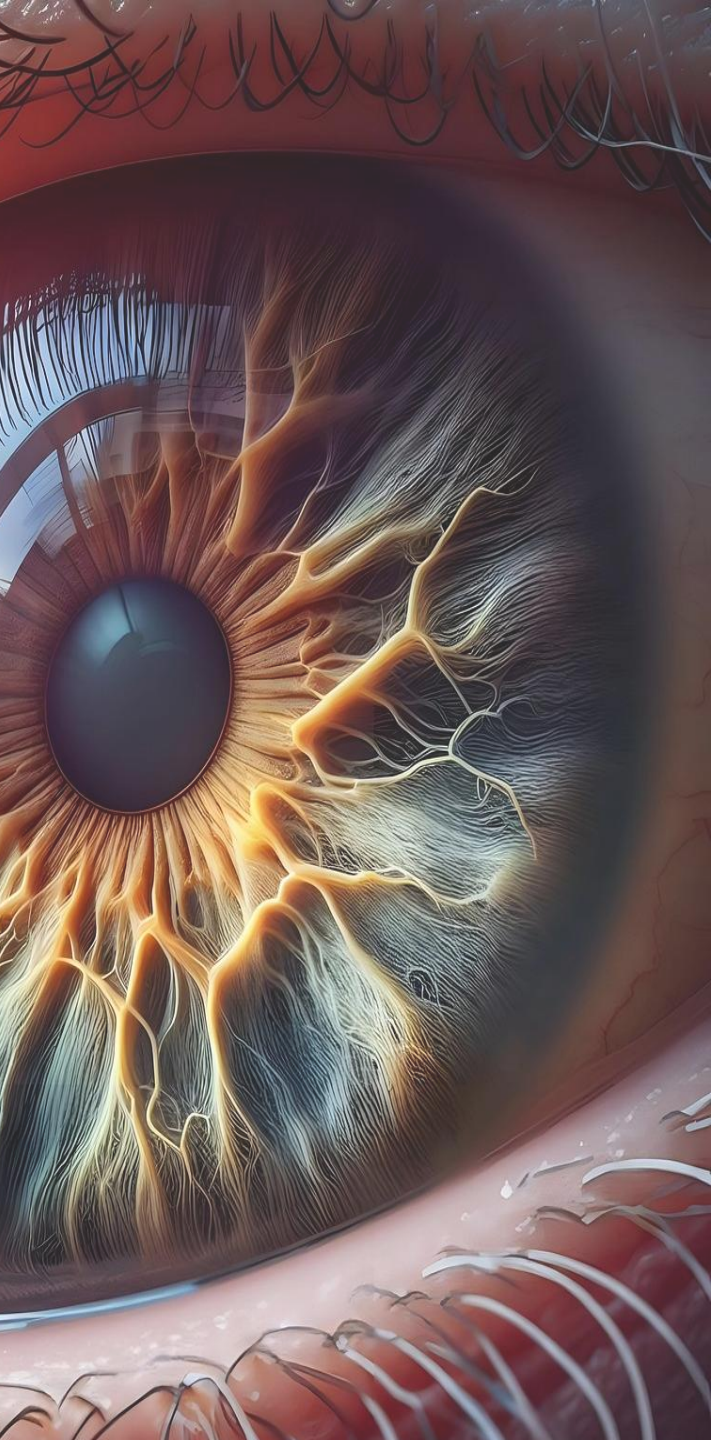
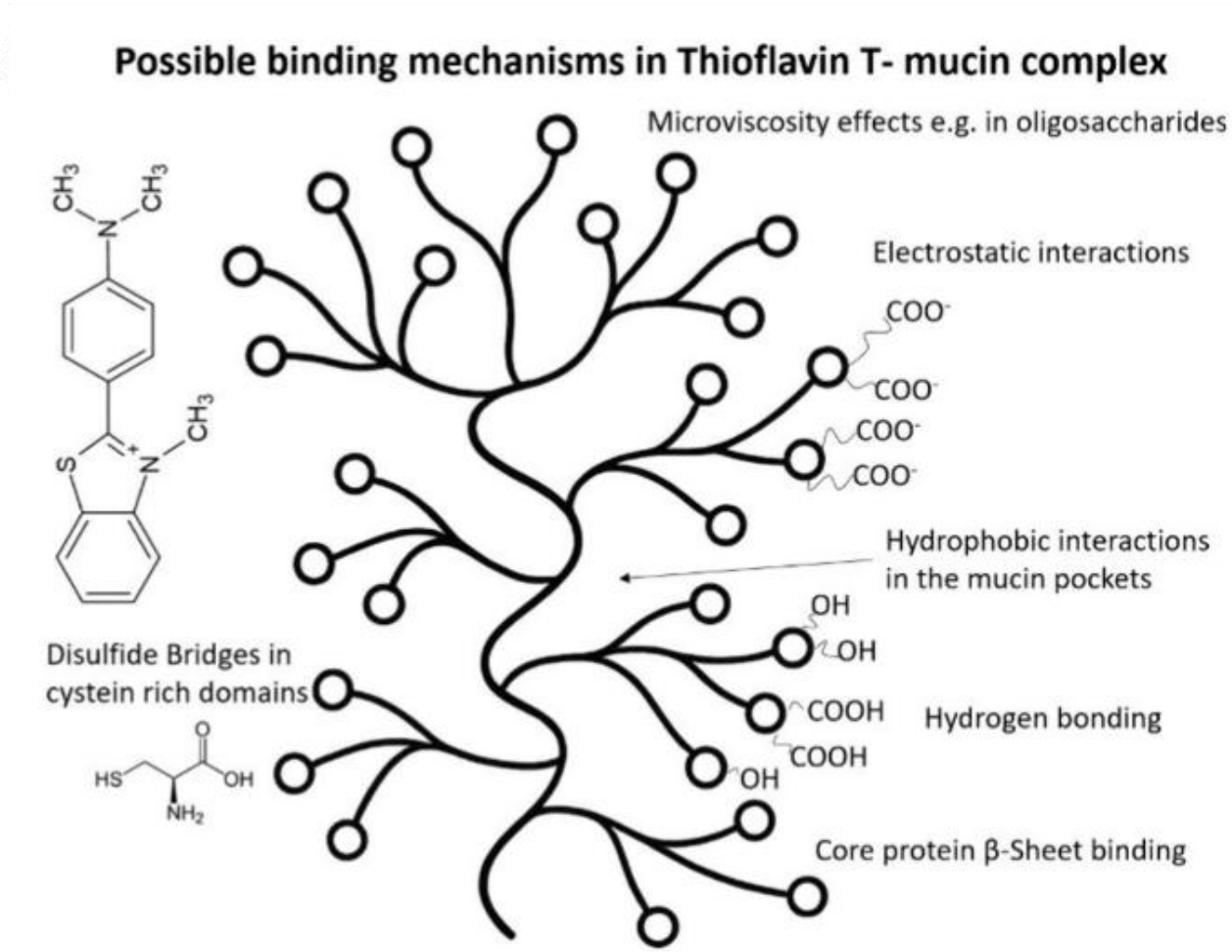


Discussion



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Letter

Thioflavin T Lasing Probe for Mucin Detection in Simulated Tears as a Targeting Strategy for Brain Tumors

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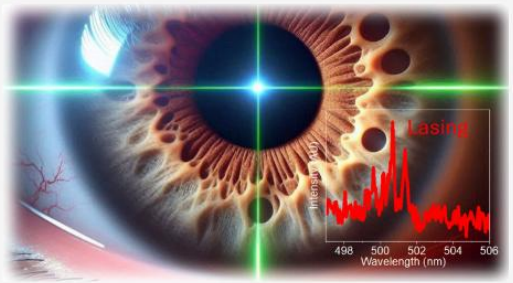
ABSTRACT: A novel optical approach for a noninvasive detection of mucins in tear fluid is proposed, aiming at the early diagnosis of brain tumors such as glioblastoma. Utilizing Thioflavin T (ThT) as a fluorescent probe, our study demonstrates that ThT selectively binds to mucins (modeled by MUC3) in DEMI water, artificial tears, and simulated tears. Steady-state and time-resolved fluorescence spectroscopy reveal that mucin binding induces a significant enhancement in ThT fluorescence and prolonged emission lifetime, indicative of restricted intramolecular rotation. Importantly, the application of Fabry-Pérot cavity lasing spectroscopy enabled the resolution of distinct spectral signatures of the ThT−mucin complex, including the emergence of dual lasing peaks and an increased lasing threshold in mucin-rich samples compared to controls. These optical fingerprints provide compelling evidence of specific ThT−mucin interactions that are not discernible with conventional fluorescence techniques. Our findings highlight the potential of the ThT probe and lasing method as a sensitive, noninvasive platform for detecting mucins in tears, offering a promising strategy for the early detection of glioblastoma.



KEYWORDS: *brain tumor, mucin, tears, thioflavin T, lasing, Fabry-Pérot cavity*

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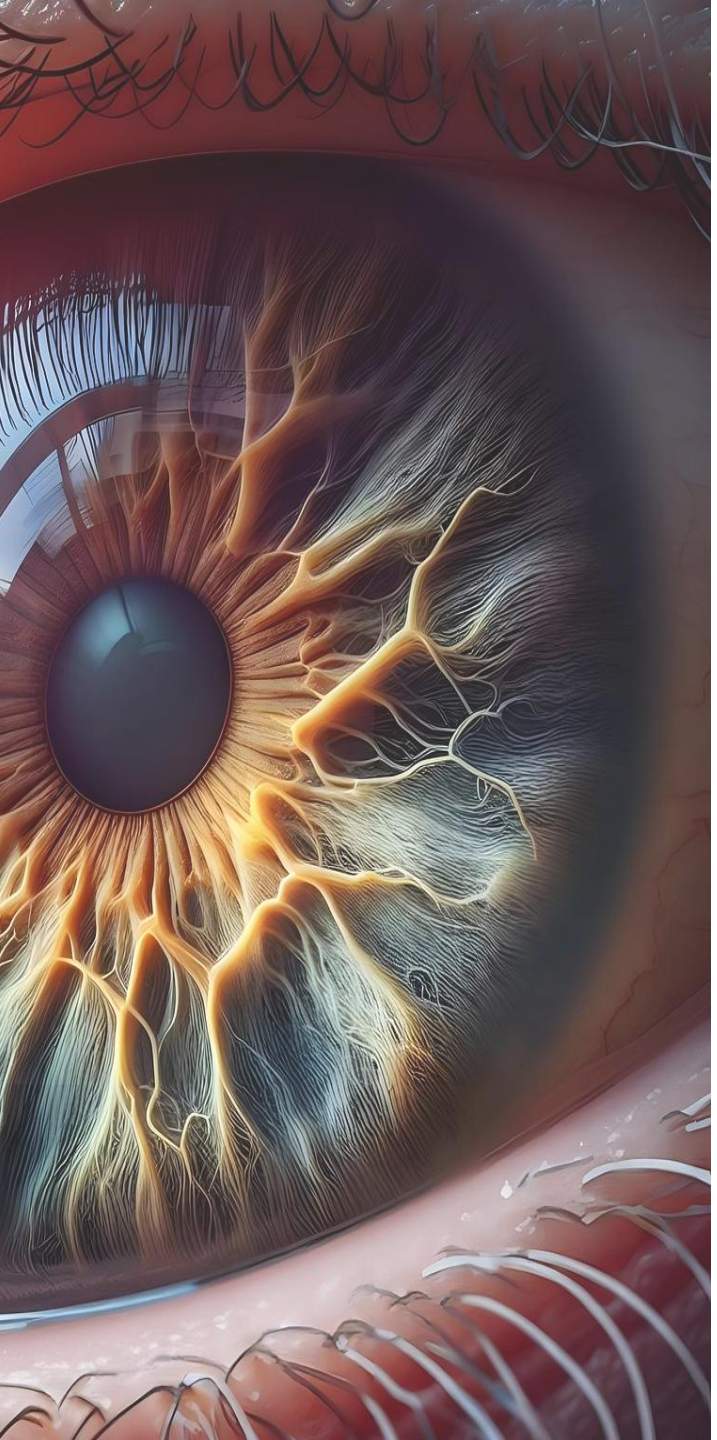

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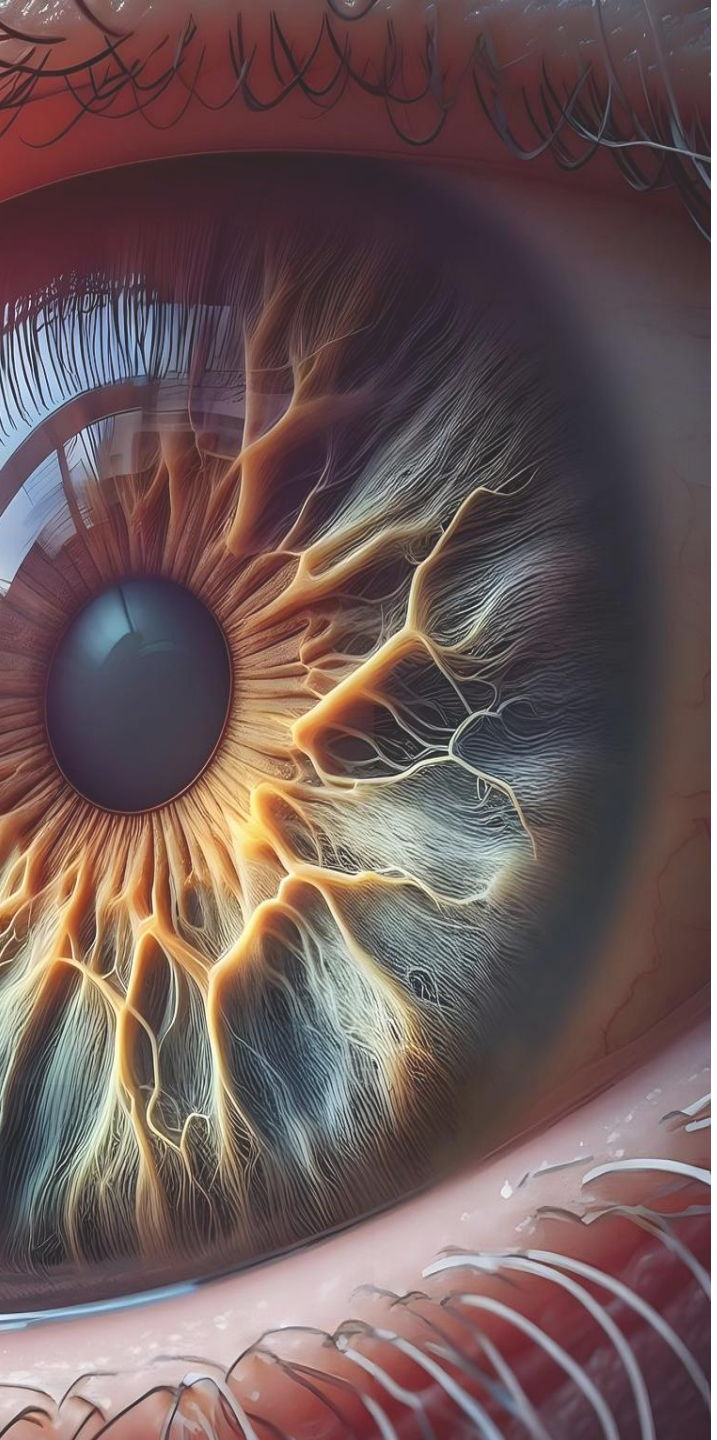

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Contact

ewelina.jalonicka.medicine@gmail.com