



Biocatalytic Nanobots: Modulating Oxidative Stress in Cellular Models of Inflammatory Bowel Disease

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Nutraceutical biopolymeric-biocatalytic microbot
against gut inflammatory disorders

Background



Inflammatory bowel disease (**IBD**) →
Crohn's Disease + Ulcerative Colitis

IBD is a chronic **intestinal inflammation**



Crohn's Disease

Ulcerative Colitis



Affects **6.8 million** people



Economic burden

IBD costs Europe over €4.6 billion annually in healthcare, with even higher hidden social costs.

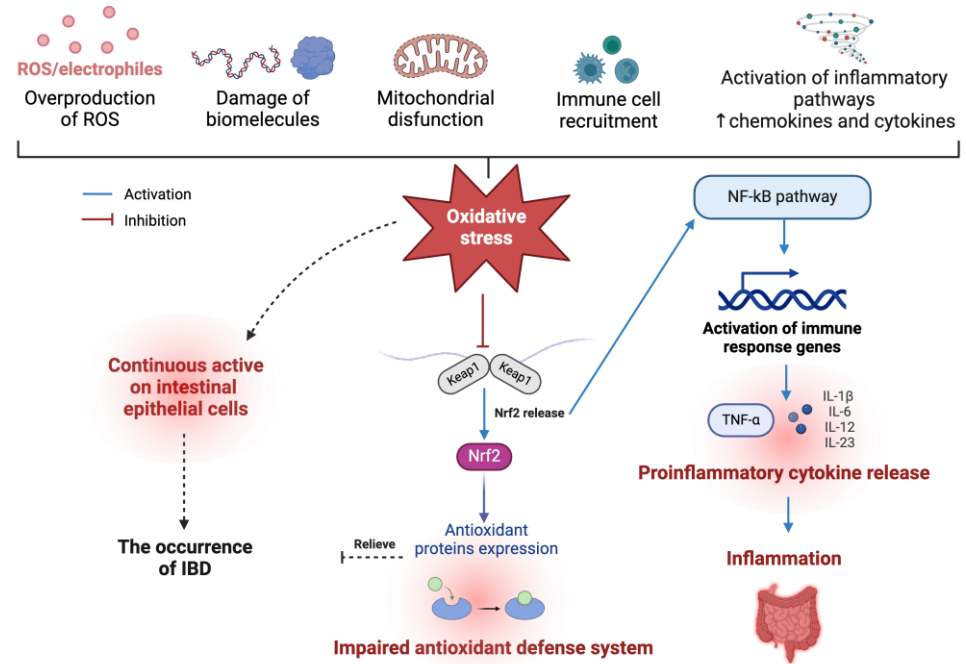


Cancer risk

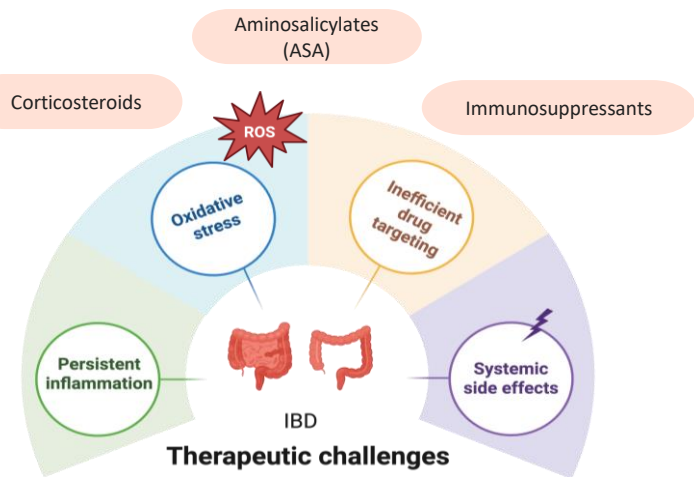
*Increased risk of **colorectal cancer** - one of the **deadliest** cancers*

Background

In **IBD**, oxidative stress increases, with excessive **ROS** leading to tissue damage.



Background



Treating **IBD** demands more than drugs — it requires **TARGETED, RESPONSIVE & SITE-SPECIFIC SOLUTIONS.**

IBD = Chronic inflammation + **ROS** imbalance

ROS → Tissue damage → Disease progression

Need: Targeted strategies to **modulate oxidative stress**

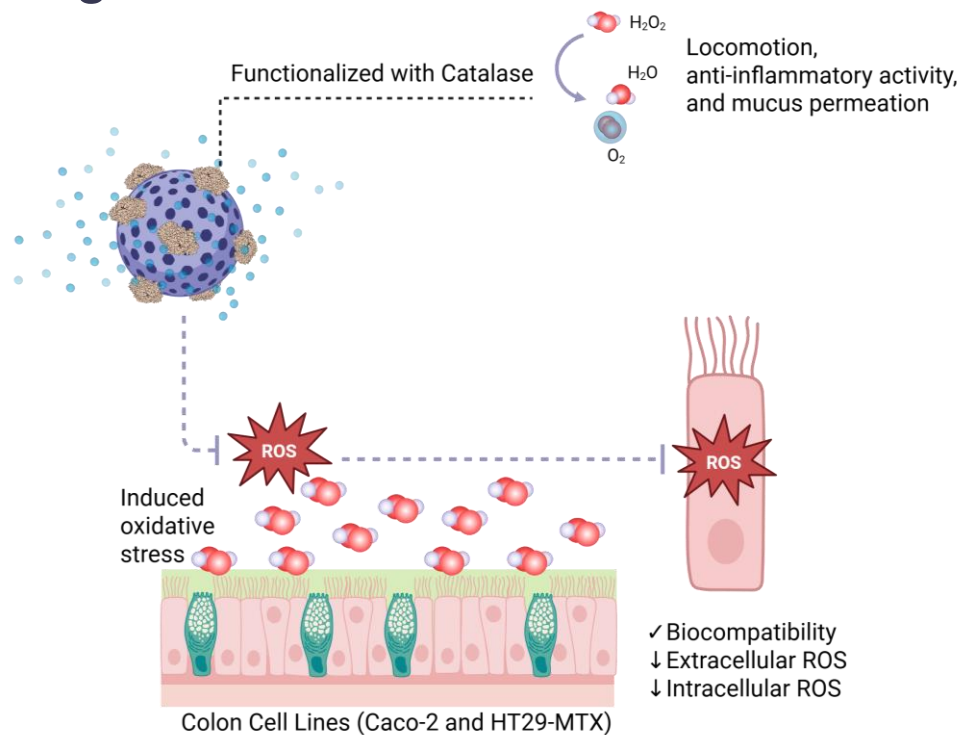
gBiOT Approach: Tiny Tools, Big Relief



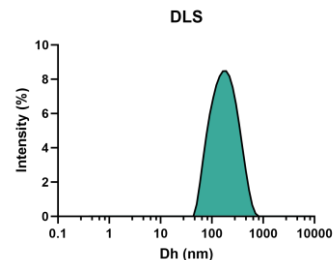
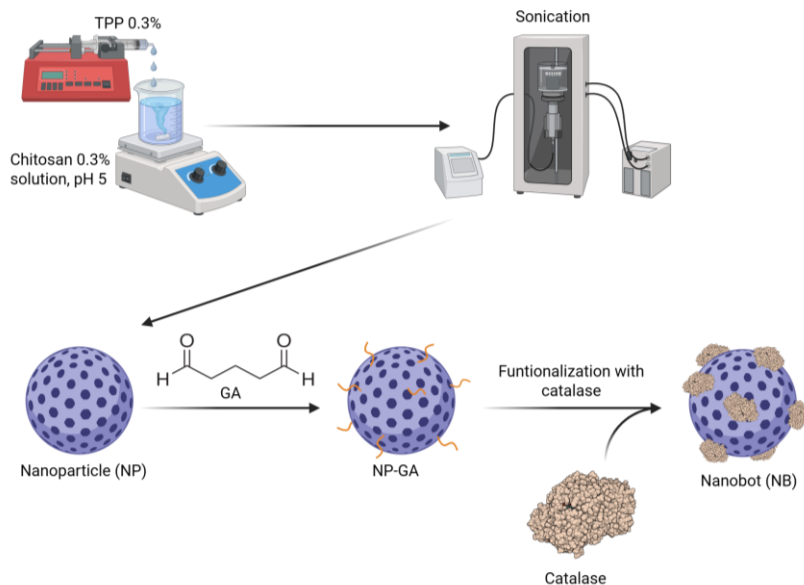
AIM

Nanobots (NB) with the capacity of restoring mucosal balance and enhancing therapeutic efficacy in **IBD** by combining **ROS-scavenging** capacity with **targeted delivery**.

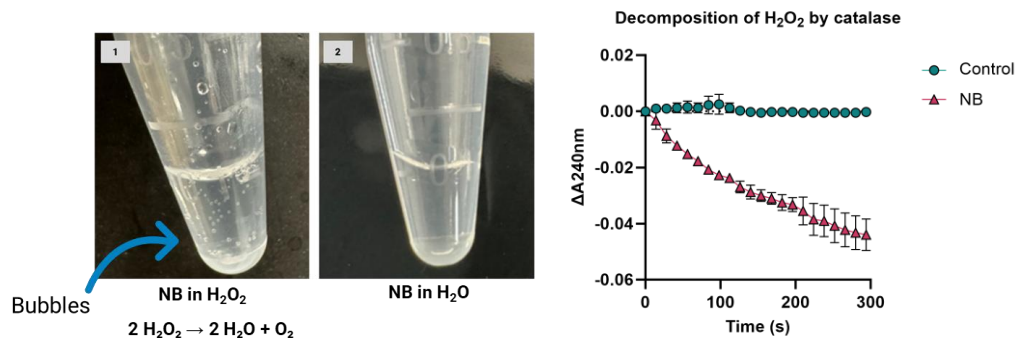
Initial Prototype Design



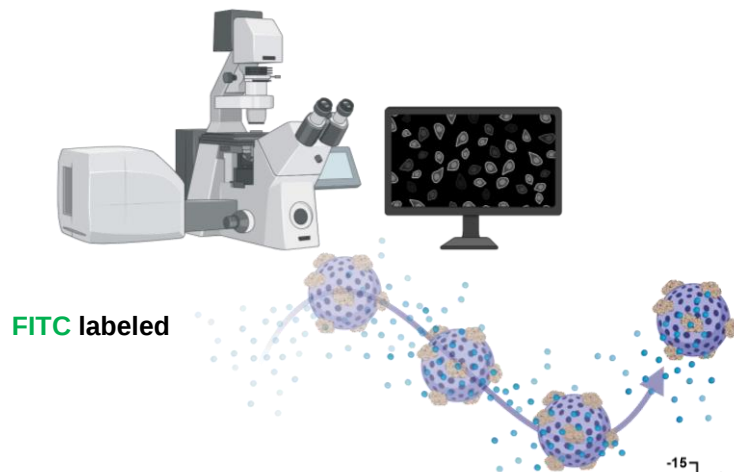
Fabrication and Functionalization



pH	Z-Average (d.nm)	PdI	ζ-potential (mV)
5.6	255 ± 3	0.274 ± 0.009	42.0 ± 0.8
7.0	176 ± 4	0.400 ± 0.052	25.5 ± 2.0

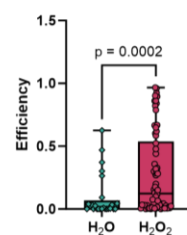
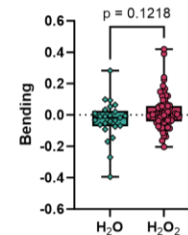
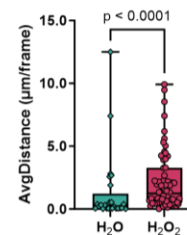
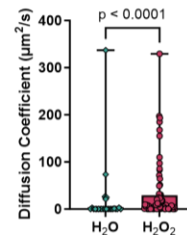
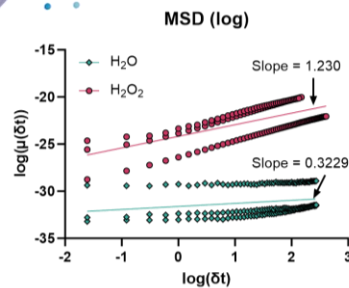
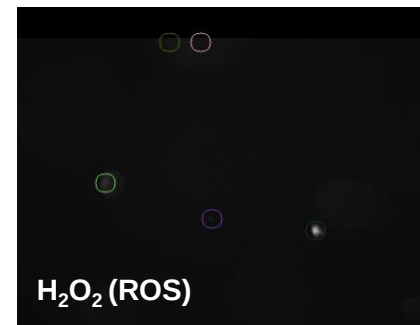
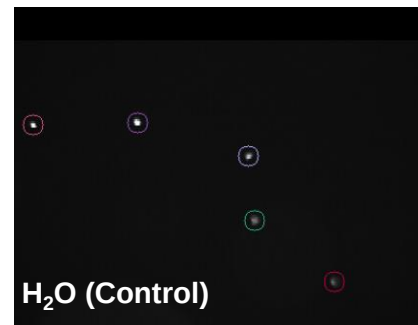


Propulsion & Motion Analysis

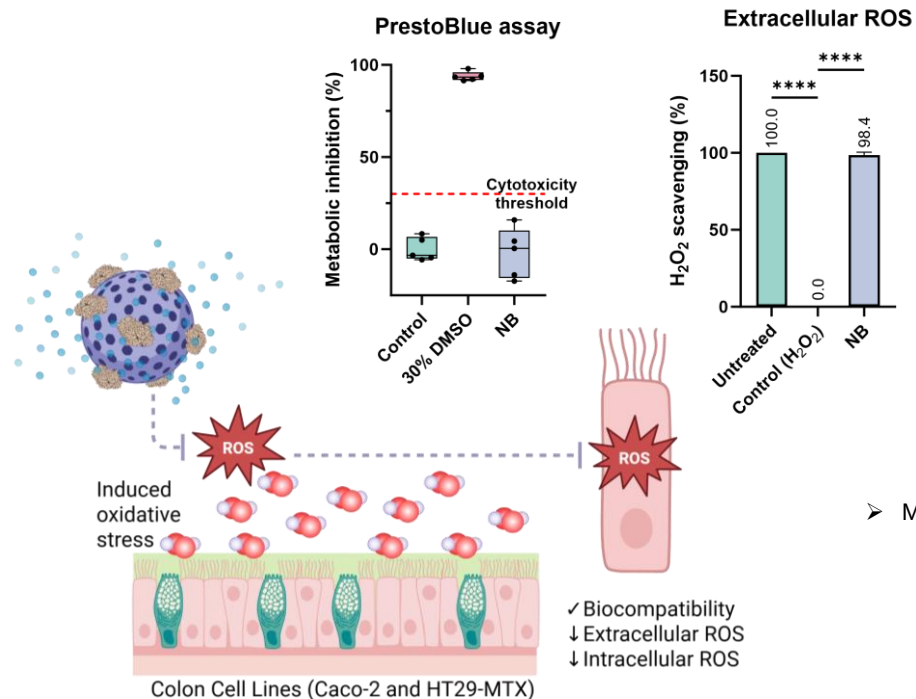


- Mean Square Displacement (MSD)
- Diffusion Coefficient
- Average Distance
- Trajectory Bending
- Displacement Efficiency

Conditions: H_2O , 300 μM H_2O_2



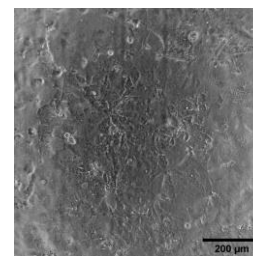
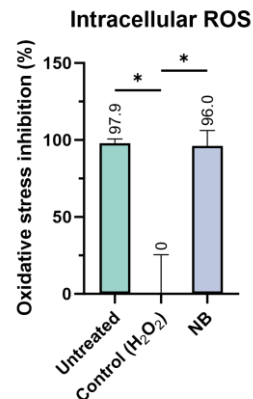
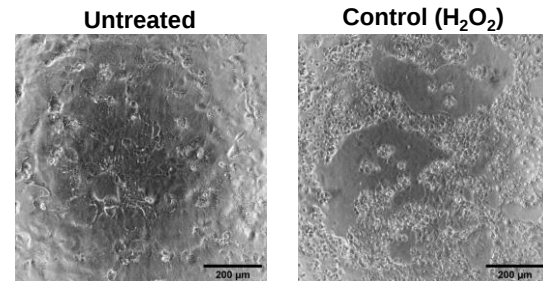
Biocompatibility and ROS Modulation



➤ Pierce™ Peroxide assay

➤ Measured by DCFDA

Treated with 10 mM H₂O₂, 4 h incubation



Key Findings

- ✓ NB respond to H_2O_2 .
- ✓ NB are biocompatible with Caco-2/HT29-MTX co-culture.
- ✓ NB reduced intracellular and extracellular ROS in a Caco-2/HT29-MTX co-culture.

Next Steps?

- High-speed imaging for single-particle tracking and swarm behavior.
- Stability analysis in gastrointestinal environment
- Assays for mucus penetration and barrier crossing in mucus model and cell models.
- Include bioactive payloads to target intracellular ROS and inflammatory pathways.

Acknowledgments

gBiOT team involved



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