

Enhancing Microbubble Drug Encapsulation Efficiency by Electrostatic Interactions

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Need

Head and Neck Squamous Cell Carcinoma (HNSCC)

- 6th most common cancer worldwide
- In 2019, ~11,000 HNSCC-related deaths (observed)
- 5-year survival rate: ~50%

Medical Problem: Current Treatments

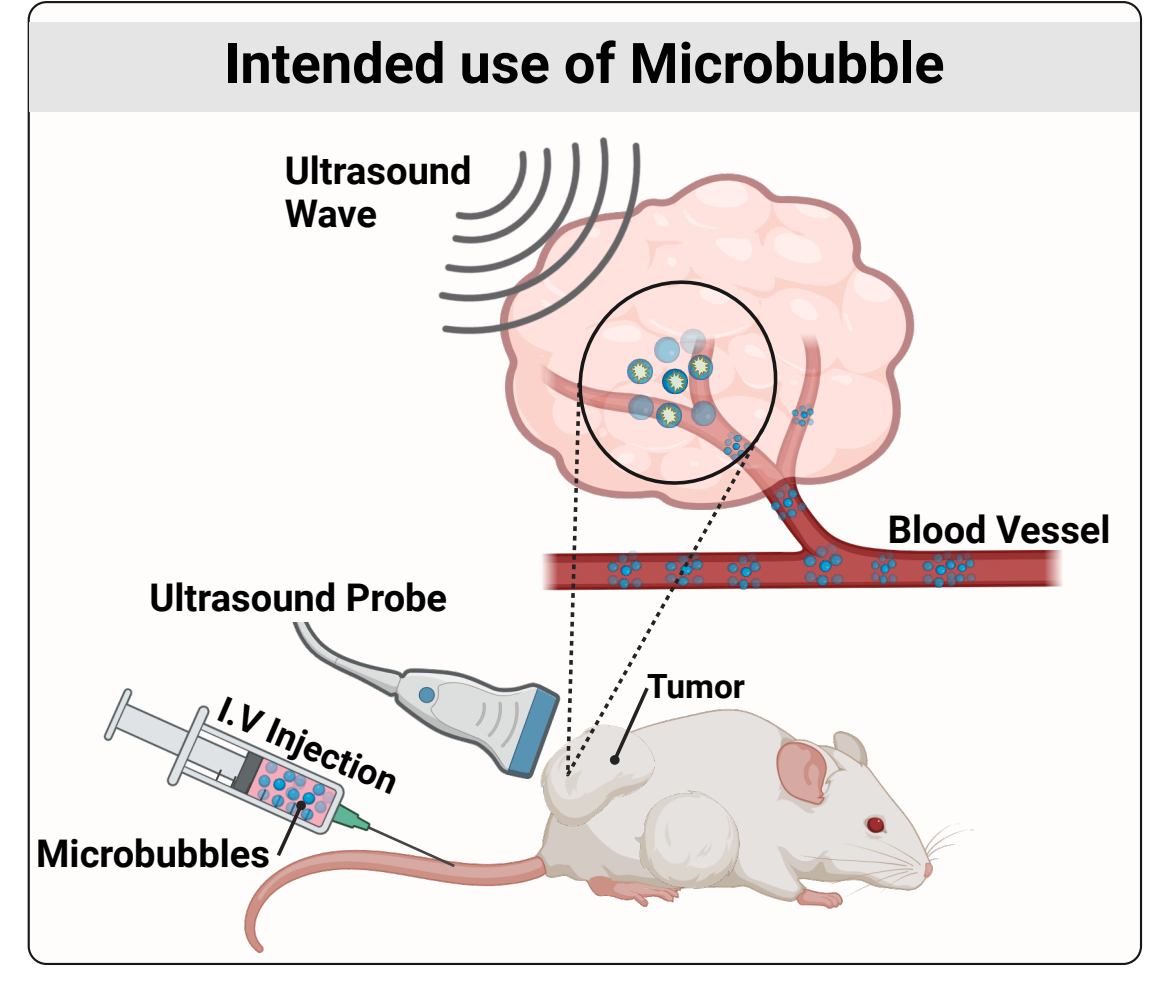
- Limited efficacy, specificity, with significant side effects
- High toxicity impacts healthy tissues
- Low drug concentration at the tumor site

Dr. Wheatley's Lab Solution

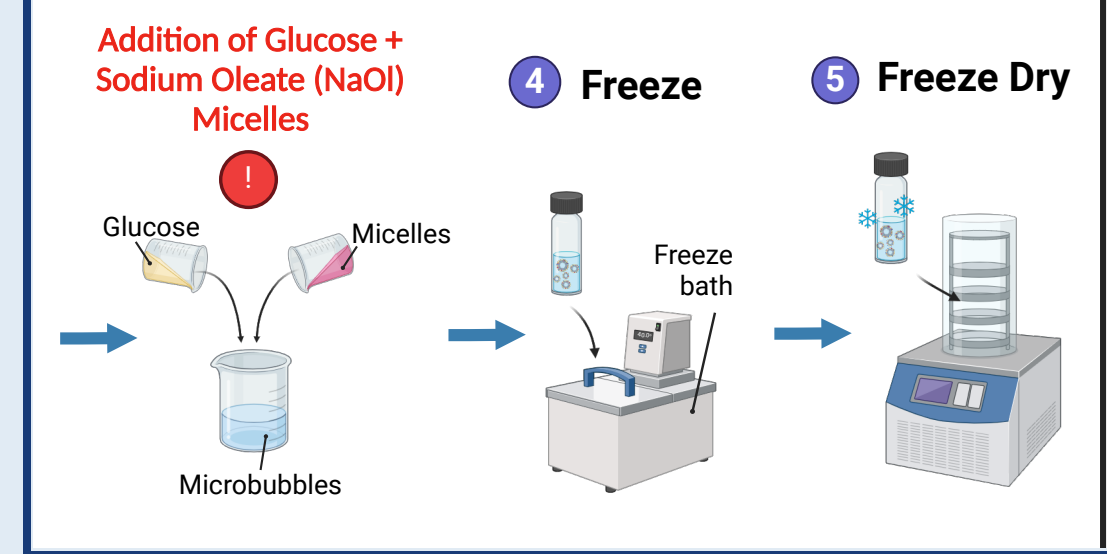
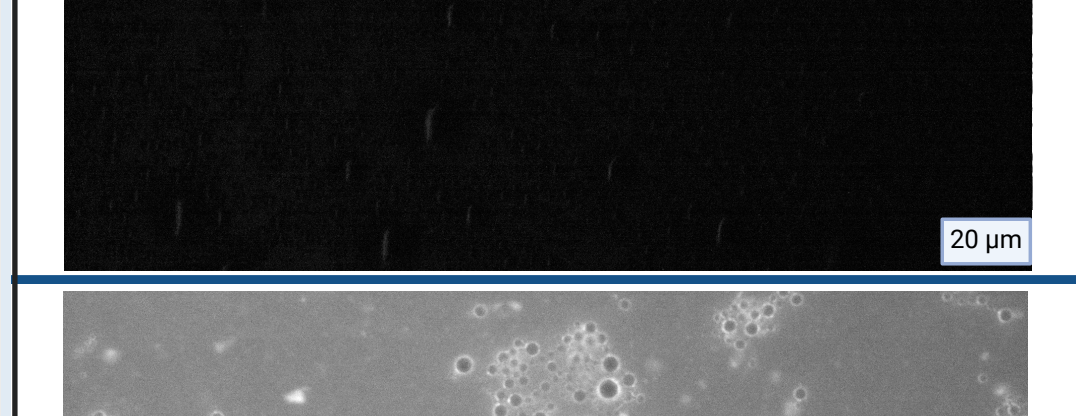
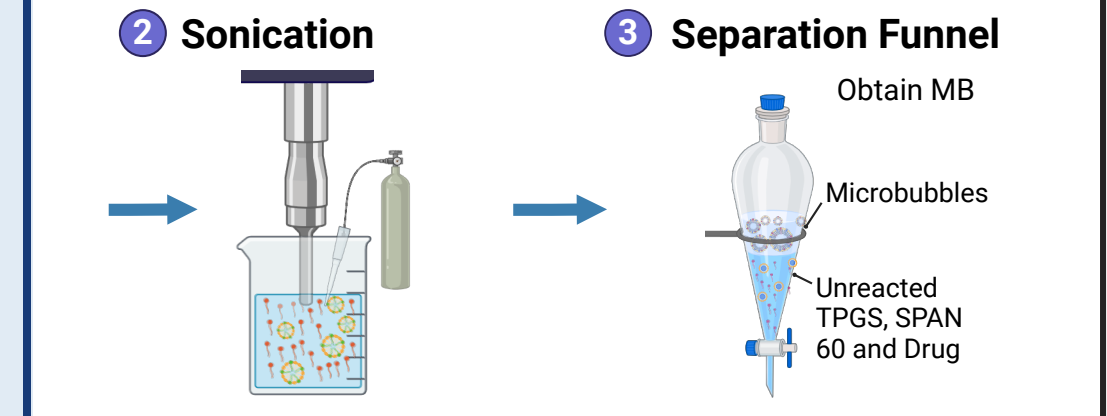
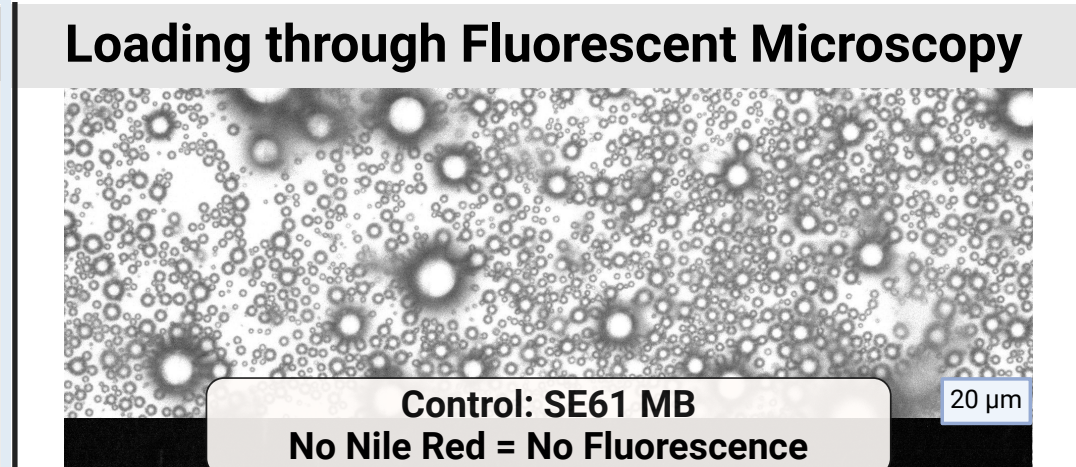
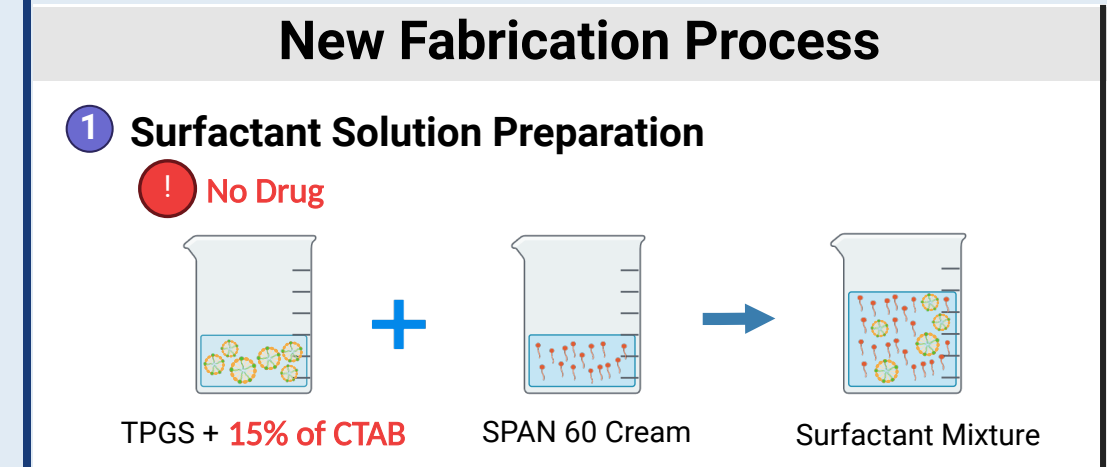
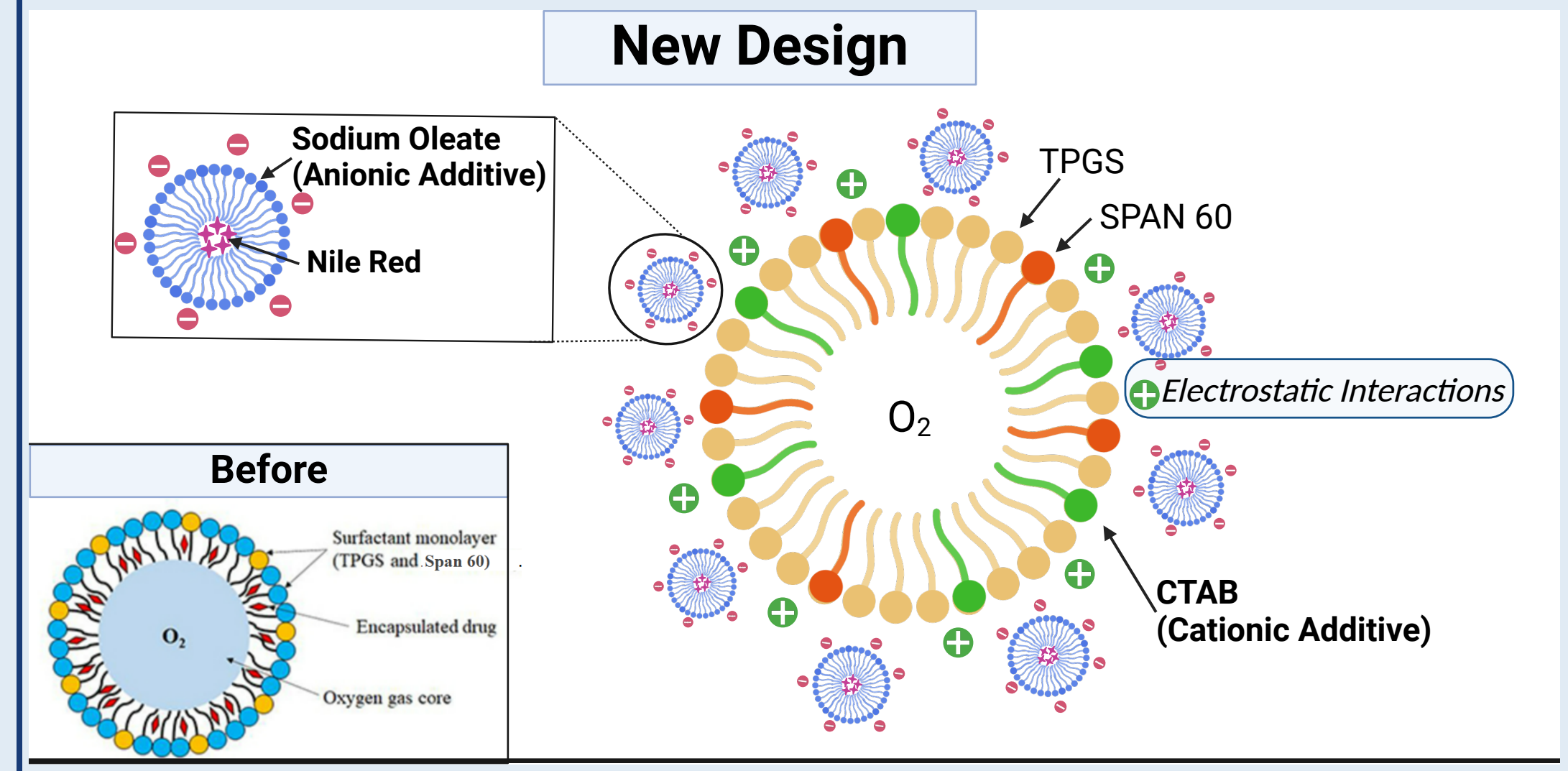
Ultrasound-mediated microbubble drug delivery to increase tissue specificity and limit off-target side effects

Clinical Problem

- Low encapsulation efficiency (~4%-10%)
- High cost of oncogenic drugs (e.g., \$160 per 10 mg Raptinal)



Solution



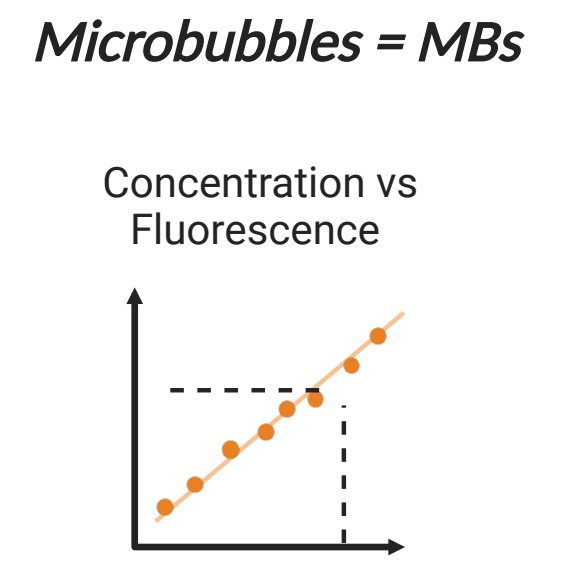
Verification Testing

VTR 1: Nile Red Standard Curve

Test if MBs have appropriate Nile Red concentration and encapsulation efficiency.

Encapsulation Efficiency:
PASS: $\mu > 10\%$

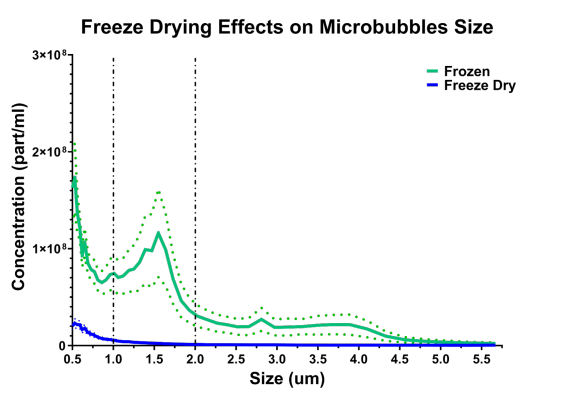
Concentration:
FAIL: $\mu \leq 12 \mu\text{g/mL}$



VTR 2: Size

Test the size of MBs. It should be able to travel through vasculature.

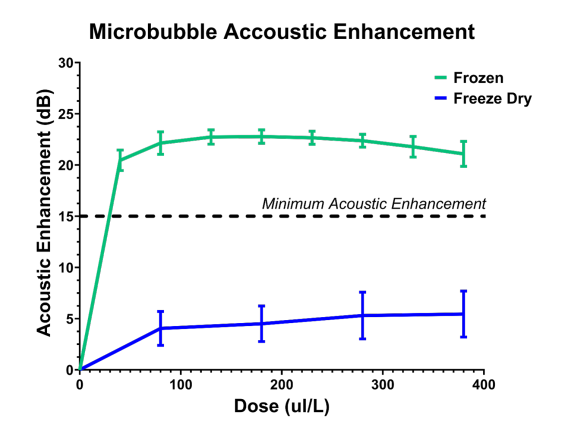
PASS: $\mu < 10\mu\text{m}$
(Only until the Freeze Step in the process)



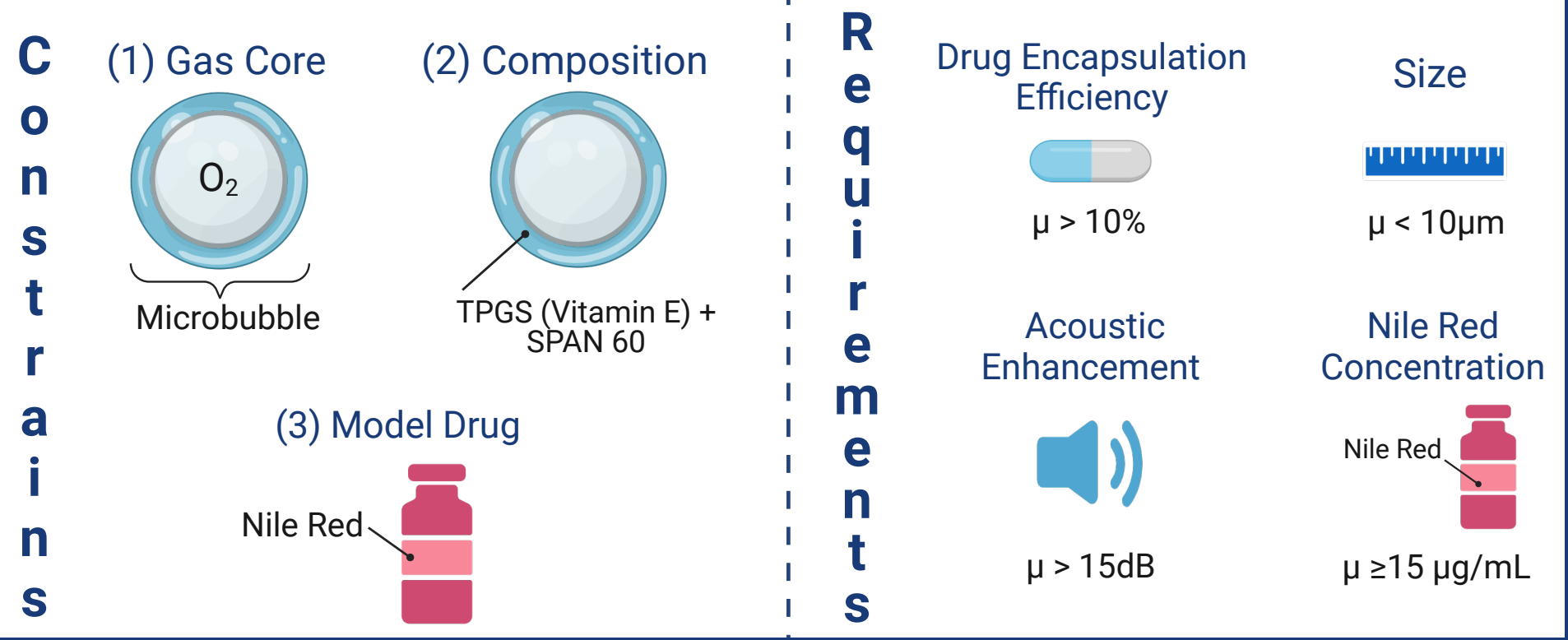
VTR 3: Acoustic Enhancement

Test if triggered MBs give an adequate back-scatter (dB) to be detectable in vitro

PASS: $\mu > 15\text{dB}$
(Only until the Freeze Step in the process)



Design Input



Future

Revisions

- Optimize NaOl micelle concentration
- Explore alternative lyoprotectants for freeze drying
- Search other loading methods
- Increase CTAB >15% ⇒ more binding sites

Impact

- Attract more attention ⇒ Garner funds
- Reduce wasted drug by ~36%
- Increase patent portfolio
- For HNSCC, could improve drug concentration per dose and reduce cost