Proposal Review 1 : 1803948

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Agency Name:	National Science Foundation
Agency Tracking Number:	**1803948**
Organization:	
NSF Program:	FD-Fluid Dynamics
PI/PD:	Young, Yuan-Nan
Application Title:	Collaborative Research: Osmophoresis: Propulsion of Semipermeable Vesicles Driven by Chemical Gradients
Rating:	Good

Review

Summary

In the context of the five review elements, please
evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

Strengths:
1) Osmophoresis will be examined in detail using microfluidics experiments and mathematical modeling. The potential for new applications of this process will be examined, including guided self-assembly and targeted drug delivery.
2) The microfluidic platform developed for this study provides a controllable way to prescribe solute concentration gradients. Giant unilamellar vesicles, synthesized by mechanically fusing smaller vesicles, were observed to move in the platform in preliminary tests. Preliminary data adequately demonstrates the feasibility of using this unique setup for the study.
3) Studies of self-assembly of a collection of vesicles will be useful to theorize how protocells could organize into larger organelles, a question in evolution that has not been examined from a fluid dynamics perspective (as proposed here).

Weaknesses:
1) The PIs speculate multiple times that osmophoresis is more likely to occur in biological systems as compared to other phoretic processes. The evidence for this is not clearly outlined.
2) Only step-like initial concentration of solute will be examined as opposed to a gradual concentration gradient that would occur on account of mixing.

This will help simplify the governing (diffusion) equation and achieve steady state earlier. But it is not clear if this simplification is biologically relevant/realistic. Also, it is unclear if the transient dynamics will even be experimentally studied since steady state is sought after.
3) Slip velocity measurement in aim 2 is needed for modeling osmophoresis. The PIV setup proposed for estimating this is not described.
4) The PIs argue that using osmophoresis for drug delivery in highly confined areas (GI tract) can be more effective than using only diffusion. While this is an interesting question, they do not present details of how optimized cargo vesicles will be designed. Details of exactly what are desired as the optimal outcome and what experiments will be done on vesicle design are not provided.

In the context of the five review elements, please
evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

Strengths:
1) Interdisciplinary training of undergraduate and graduate students in Mechanical Engineering and Applied Mathematics will give them training in microfluidics, mathematical modeling and scientific computing.
2) One of the PIs has integrated microfluidics experiments into an existing class.
3) Existing mechanisms will be used to recruit underrepresented minority students for providing research experiences.

Weaknesses:
Specific details on collaborative student training are not provided. There is no evidence that students from either institution will travel to the other site. Training in each institution seems to be mainly focused on one/two aspects of the project, such that a student for example would learn microfluidics but not be involved in modeling.

Please evaluate the strengths and
weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if
applicable

Summary Statement

Osmopheresis is a relatively underexplored area and could help develop new strategies for drug delivery in highly confined spaces. The PIs aim to explore this process via mathematical modeling and experimentation. Details on the drug delivery vesicle design were not provided, though this was one of the main engineering-type aims of the project. Student training (broader impacts) did not describe how collaborative, cross-disciplinary training across the various aspects of the project would be performed.