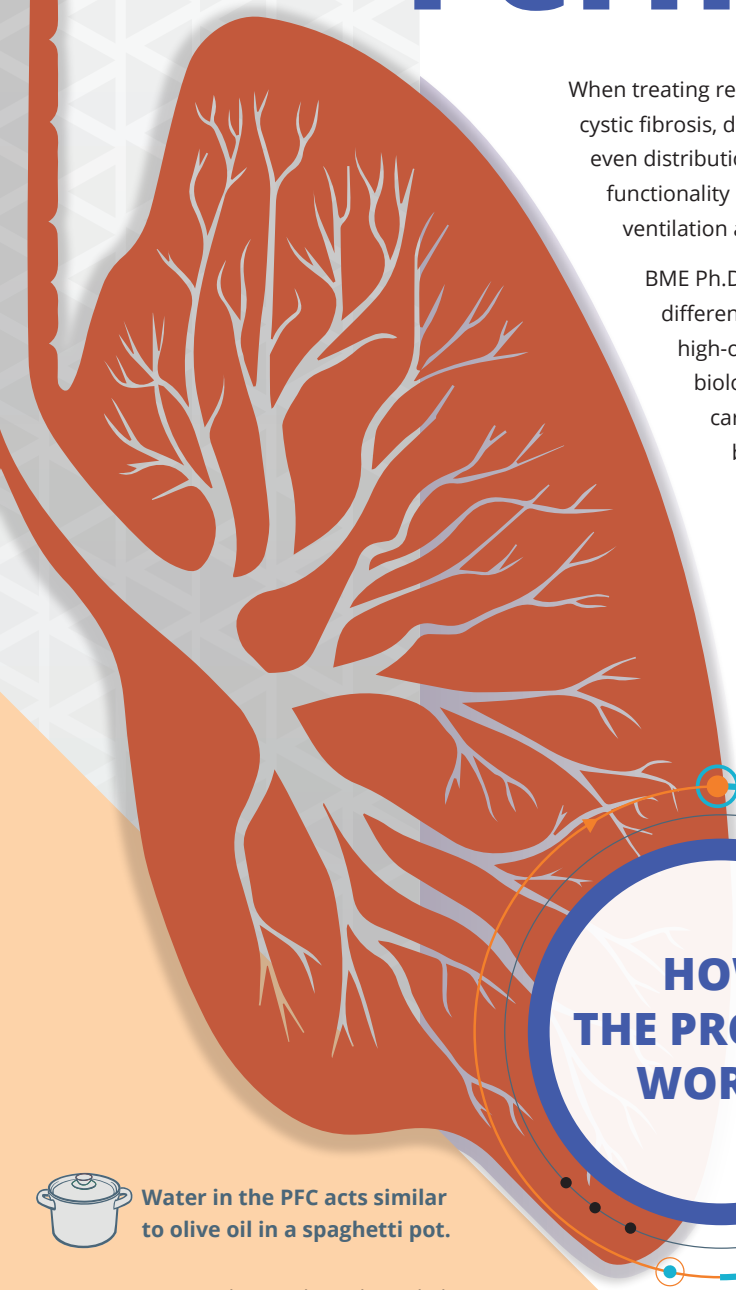
A Breath of Fresh Perfluorocarbon

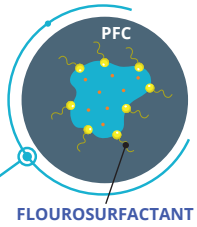
When treating respiratory diseases, such as asthma, chronic obstructive pulmonary disease, and cystic fibrosis, doctors often prescribe treatments that require patients to inhale a drug deeply for even distribution throughout the lungs. However, for patients with chronic lung disease, lung functionality lessens over time, and eventually, aerosol drug delivery can be hindered by poor ventilation and buildup of mucus.

BME Ph.D. student Diane Nelson and her advisor, Professor Keith Cook, are developing a different approach to treating lung disease: delivering drugs by filling the lungs with a high-oxygen liquid, known as liquid perfluorocarbon (PFC). PFC is a chemically and biologically non-toxic liquid that is capable of dissolving high amounts of oxygen and carbon dioxide. Though intuitively one might think flooding the lungs with any liquid breathe normally—and the drugs delivered via PFC can reach target areas without relying on airflow for distribution.



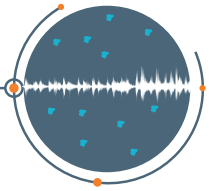
HOW THE PROCESS WORKS

DRUGS ARE DISSOLVED IN WATER



WATER-DRUG SOLUTION IS COMBINED WITH PFC AND FLUOROSURFACTANT, A SURFACE-ACTIVE AGENT

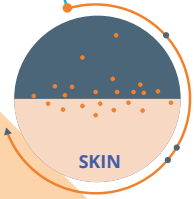
- Drug exists dissolved in water
- Water floats as small particles in PFC



MIXTURE IS SONICATED

Sound waves blasted through the solution disperse the water into small droplets

LUNGS ARE THEN FILLED WITH MIXTURE



WATER-SOLUBLE DRUG IS SUSPENDED IN PFC (VIA WATER DROPLETS) AND IS NATURALLY DRAWN OUT OF PFC TOWARD SKIN, WHICH ABSORBS DRUG.

Water in the PFC acts similar to olive oil in a spaghetti pot.

Because water is denser than olive oil, the two liquids don't mix, and the oil droplets eventually rise to the top and combine into one contiguous floating mass of oil. Because PFC is denser than water, the water droplets (which contain the drug) do not mix with the PFC. Instead, they are pulled toward the walls of the lung and combine to form larger masses of water and drug, which are then absorbed by the skin and distributed to the rest of the body.

But, unlike oil which rises quickly in water, the fluorosurfactant serves to slow down the process of water separating from PFC. This delayed reaction allows the researchers to form a uniform drug-water solution, to ensure the drug can reach the skin surface of the entire lung.

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