Targeting Phthalate Exposure: A Synthetic Biology Framework

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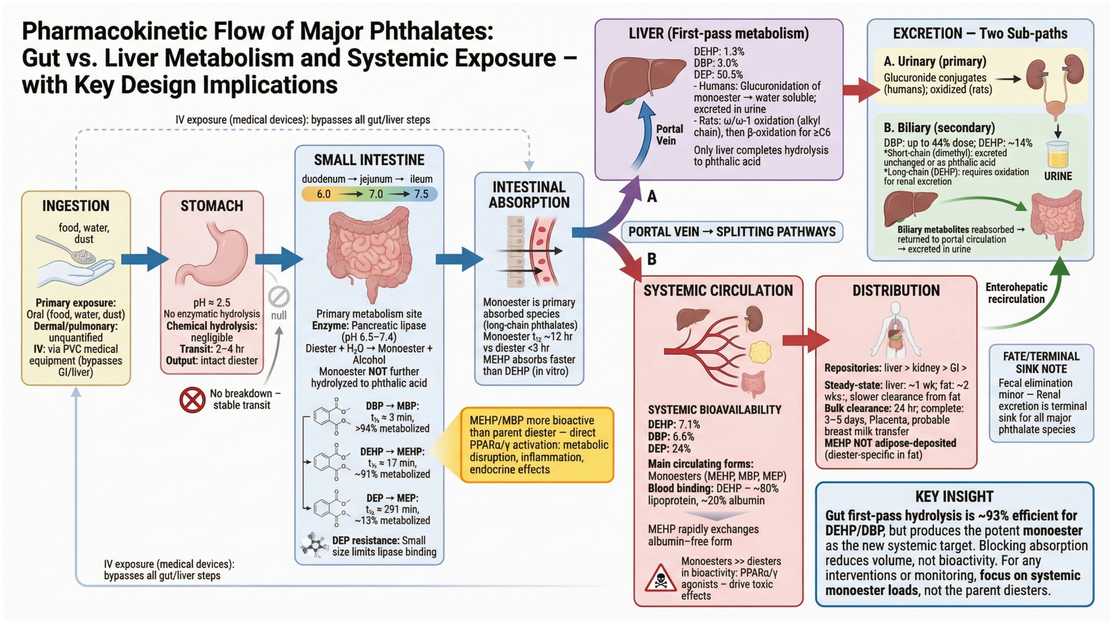
Pharmacokinetics

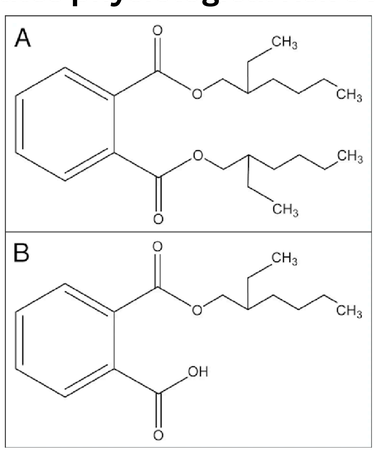


Abstract

Phthalates were engineered for versatility. Polymer chemists use these esters as plasticizers to increase the flexibility, transparency, and longevity of various plastics, primarily Polyvinyl Chloride (PVC). Unlike the covalent bonds in the polymer backbone, phthalates are physically entrained within the plastic matrix, allowing them to leach out via volatilization, migration, and abrasion. This mobility results in ubiquitous environmental distribution and continuous human exposure through ingestion, inhalation, and dermal contact. The 2026 FSU iGEM team is investigating the broader class of phthalate esters by identifying leaching mechanisms from consumer products and their collective role as endocrine disruptors. While our project evaluates the specific lifecycle of Di(2-ethylhexyl) phthalate (DEHP), we focus on the biochemical interference of multiple phthalate congeners with human hormonal signaling and quantifying the physiological risks associated with chronic, cumulative phthalate exposure.

Evidence of Harm

Phthalates function as endocrine disruptors by mimicking or interfering with endogenous hormones. Di(2-ethylhexyl) phthalate (DEHP, Fig. A) and its primary metabolite MEHP (Fig. B) exemplify how their hydrophobic benzene core and hydrophilic ester chains allow leaching from plastic matrices and competitive binding to hormone receptors, disrupting normal signaling. Chronic exposure has been epidemiologically associated with metabolic disorders including diabetes and obesity, as well as respiratory conditions such as asthma. Although phthalates are metabolized and excreted relatively rapidly, the ubiquity of phthalate-containing products results in continuous re-exposure, producing a persistent systemic burden that accumulates physiological risk over time.



Our Approach

Phthalates enter the body primarily through ingestion of contaminated food and water, making the gastrointestinal tract the most significant and actionable site of intervention. Our team proposes a synthetic biology framework targeting gut-based absorption as a means of intercepting phthalate bioavailability before systemic distribution occurs. By engineering a biological mechanism capable of sequestering or degrading phthalates within the gut lumen, we aim to reduce the total absorbed dose and mitigate downstream endocrine disruption.

Summary

Phthalates represent a significant and escalating public health concern, with particular risk to maternal and pediatric populations. The FSU iGEM team is developing a synthetic biology-based intervention targeting gut absorption as a primary prevention strategy, with the goal of reducing phthalate bioavailability and its associated disruption of endocrine function before systemic exposure occurs.