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Ethical Research Demands Human-Relevant In Silico Alternatives.

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Insight: Ethical Research Demands Human-Relevant *In Silico* Alternatives

The preclinical phase of vaccine development has long relied heavily on animal models, which raises significant ethical concerns and sometimes yields results not perfectly predictive of human responses.

By leveraging "Digital Twin" Microphysiological Systems (MPS) Modeler, public health labs can create virtual human immune-organ-on-chip models, enabling high-throughput *in silico* testing that significantly reduces the reliance on animal testing while providing more human-relevant data.

The current limitations stem from a historical reliance on animal models due to the absence of robust, scalable, and ethically acceptable human-mimicking *in vitro* or *in silico* systems that accurately reflect complex human physiological responses.

Researchers are increasingly motivated by a dual imperative: to adhere to stringent ethical guidelines for animal welfare (the 3Rs principle – Replace, Reduce, Refine) and to develop safer, more effective human therapies by obtaining more accurate, human-specific data earlier in the research process.

Continued primary reliance on animal models means ongoing ethical compromises, potentially less translational data (animal models don't always perfectly mimic human disease), and slower progress in fields where rapid, human-specific insights are critical.

We need to accelerate the development, validation, and regulatory acceptance of advanced human-derived "digital twin" MPS models to serve as primary preclinical testing platforms, thereby addressing ethical concerns while simultaneously enhancing the predictivity and speed of biological research.
