Category

Best Startup

Product/Solution Name

Digital twin of the cell

Date of Approval

2022-11-30

Indications

oncology, neurodegeneration and infectious disease

Therapeutic Categories

Not Applicable

Attached Files:

- Submit your innovation_Prix Galien USA_Startup_DeepLife_Final.docx

Background information and need for solution/product

DeepLife offers a system biology approach to secure and accelerate drug discovery by combining omics data and interpretable artificial intelligence to create digital twins of cells. A digital twin is a virtual model of a physical object or process. The concept, first emerged outside of the life sciences field, has enabled to model physical objects in silico such as wind turbines before testing it in real life. By modeling an object, researchers can simulate its responses to various situations, generating quicker insights at a lower cost compared to physical objects. DeepLife pioneers applying the concept to drug discovery, using the cells digital twin to predict the impact of molecules or environmental changes. Using DeepLife digital twin of cells as an “in silico lab”, we can rapidly test billions of drugs and drug combinations and identify the mechanisms of action which are most likely to restore a diseased cell to its healthy state.

To discover new medicines and improve treatment reliability, researchers need insights into disease mechanisms, effective treatment targets, biomarkers, and overall pathology understanding. The rapid accumulation of omics data, which reveals biomolecular activity within cells, is revolutionizing drug discovery.
In addition to providing a better understanding of the disease mechanisms using omics, there is an urge to have the appropriate tools to simulate the effectiveness of novel therapies. The current classical approaches using drug screening with in vitro and in vivo models are useful but still, this traditional target development can take up to four years and over $300 million, making it a significant contributor to the time and money needed to develop new medicines. Even after this time-consuming process, the chances to end up with an approved medicine are ridiculously low.
For targets and molecules discoveries and identification, deep learning, machine learning, and AI are ideal strategies to uncover new patterns within unexplored and complex datasets, particularly because, most of the time, researchers are not yet certain of what they should specifically search for. The Bioinformatics market is huge and it is projected to grow significantly, from $8.6 billion in 2019 to

an estimated $24.7 billion by 2027, at a CAGR of 13.4%. DeepLife's position in Omics, particularly Single Cell Multi-Omics, addresses a market valued at $2 billion in 2019, expected to reach $6.59 billion by 2027, with a CAGR of 15.82% (verified Market Research). More specifically, we address the early drug discovery with a global market size of artificial intelligence in drug discovery is estimated at $897.6 million in 2021 and was projected to reach $1,1 billion in 2022 by Gran View Research (GVR), in accordance with maximal market research (MMR) and Markets and Markets (M&M). This market is expected to reach $8.9 billion in 2030 (MRF), $4 billion in 2027 (global news wire), and $7 billion in 2029 (MMR). The anticipated annual growth rate falls within the range of 25% to 45% from 2022 to 2030, depending on specific market studies.

Attached Files:

- DeepLife_How digital twins of human cells are accelerating drug discovery.pdf

History of the development of the solution/product

The two founders, Jonathan and Jean-Baptiste met at Entrepreneur First, a Tech acceleration program, in 2019 and decided to associate their two radically different domains of expertise to create DeepLife. Driven by their passion for machine learning and using it in the omics field, and the simulation of complex systems from the aeronautics industry, the two co-founders started a journey to revolutionize healthcare using omics and digital twins of cells.

Those two individuals understood that tailoring medical research and treatments to individual specificities will enhance the discoveries of new medicines and further, within a few years, lead to overall better patient outcomes. To bring their vision to life, the two co-founders established a state-of-the-art research focused company bringing together some of the sharpest minds in AI, systems biology and software engineering. 5 years later, Jonathan and Jean-baptiste manage to develop DeepLife, a cutting-edge technology company using AI in the omics field to unravel the mysteries of human health at the cellular level and dedicated to expedite the most critical early steps for drug discovery.

Today DeepLife provides high-value-added services specifically dedicated to validate drug repositioning strategies using Digital Twin of cells to test effects of drugs on various cell types across a wide range of diseased conditions. DeepLife works with top biotech companies to advance their programs [undisclosed partners]. Internally we advance our own asset pipeline with various programs: biomarker programs, bioproduction R&D, target identification programs. Since 2019, the Company has established partnerships with INSERM, Institut Curie, McGill university and Zurich university, and many more are in discussion to deploy the digital twin of the cell within various top researchers and in different therapeutics areas. For example, DeepLife is a partner on the first European doctoral network dedicated to tauopathies, TAu imMunE (TAME), composed of 16 partners (INSERM / Université Lille / Paris Saclay / Leuven University ...) aiming to develop methods to better diagnose and treat tauopathies, including Alzheimer and frontotemporal dementia. Our collaboration partners can leverage our technology and development capabilities to augment and accelerate their discovery and development initiatives in order to publish in top ranking scientific journals.

Today DeepLife is operating all over the world, including the EU, USA, Canada, UK, Switzerland, Brazil and Australia. The team of 15 people is international with 10 different nationalities, interdisciplinary from Biology to Deep Learning and research friendly with 90% of the company owning a PhD. We promote personal initiative and creativity, while focusing on the same goals that is deploying the

digital twin technology in two main sectors: pharmaceutical companies and academic laboratories.

Why this solution/product is innovative, the broad implications for future research, and/or how it will improve the human condition

DeepLife's approach uses state-of-the-art multi-omics data, machine learning, and systems engineering in a single product, the digital twin of cells, that integrates at the same time causal identification of disease roots, as well as a rationale for curation strategies. In simple terms, a digital twin of a cell is a "copy" of a real cell that can be manipulated, tested, and analyzed in a computer environment.

With its AI augmented bio-engineering tool, aka the digital twin of cells, Deeplife carries out an innovation that will be able to accelerate the design of the cures of tomorrow by identifying molecular triggers that drive diseased cells back to their healthy state. Here, we take advantage of our understanding of the network-based origins of diseases and all the interactions inside the cells (the interactome), we uncover the effect of drugs on master biological regulators. Indeed, cells are one of the most advanced pieces of engineering resulting from trillions of chemical interactions. However, perturbations, due to mutations or external influences, can lead cells to pathological states, then causing diseases. For decades, biologists have struggled to identify those causes by iteratively reconstructing cell mechanisms in vitro. DeepLife has the ambition to integrate all the known causes of cell dysregulation and predict its effect on a biological and clinical scale.

The digital twin of the cell is data-driven, streamlined, giving the ability to analyze complex data sets and find patterns that can tell us how genes are linked to diseases and biological processes. DeepLife is able to process tons of existing scientific Omics data and uncover new targets for therapeutics at unprecedented pace, and predict clinical trial outcomes based on clinical data in ways we never imagined before. The deployment of our technology will profoundly transform the landscape of health and pharma. We have identified five fronts that will significantly impact the process of drug development and research :

- First, in the early stages of drug discovery, digital twins of cells will shape all the indications positioning strategies of pharmaceutical companies by addressing new pathologies, new mechanisms of action and new molecules. We will gain a deeper understanding of how cells function, respond to stimuli, and undergo various biochemical reactions.
- Second, by reducing the need for time-consuming and costly in vitro experiments, the pharmaceutical industry will be able to prioritize resources for more targeted experimental work and thus reduce research risks.
- Third, by creating digital replicas of individual patients' cells, physicians will simulate specific treatments based on their unique OMICS characteristics. Digital twins of the cells will modify management of patient care.
- Fourth, by providing a in silico tool to model and test cellular responses, researchers will drastically reduce the need for preclinical experiments on animals, leading to the mitigation of the ethical concerns associated with animal testing.
- Last, we are convinced that the digital twin of the cell will modernize the production of bio-medicines, such as cellular therapies and next-generation antibodies, making them easier to manufacture resulting in increased accessibility and affordability. As an example, the cost of a T-Cell CAR injection is approximately 500k€. The digital twin of the cell has the potential to significantly lower the price of cutting edge treatments, leading to reduction in healthcare expenses.

Please provide appropriate references (ie Pubmed links)

1 : How digital twins of human cells are accelerating drug discovery (nature.com) Biopharma Dealmakers (Biopharm Deal) ISSN 2730-6283 (online) ISSN 2730-6275 (print) 2022

2 : Hubstenberger A, Courel M, Bénard M, Souquere S, Ernoult-Lange M, Chouaib R, Yi Z, Morlot JB, Munier A, Fradet M, Daunesse M, Bertrand E, Pierron G, Mozziconacci J, Kress M, Weil D. P-Body Purification Reveals the Condensation of Repressed mRNA Regulons. Mol Cell. 2017 Oct 5;68(1):144-157.e5. doi: 10.1016/j.molcel.2017.09.003. Epub 2017 Sep 28. PMID: 28965817.

3 : Carron L, Morlot JB, Lesne A, Mozziconacci J. The 3D Organization of Chromatin Colors in Mammalian Nuclei. Methods Mol Biol. 2022;2301:317-336. doi: 10.1007/978-1-0716-1390-0_17. PMID: 34415544.

4 : Haschka T, Morlot JB, Carron L, Mozziconacci J. Improving distance measures between genomic tracks with mutual proximity. Brief Bioinform. 2021 Nov 5;22(6):bbab266. doi: 10.1093/bib/bbab266. PMID: 34308963.

Attached Files:

- DeepLife Overview_Galien_Final.pdf
- DeepLife_How digital twins of human cells are accelerating drug discovery.pdf