Revolutionizing Healthcare: Harnessing Digital Innovation for Precision Medicine

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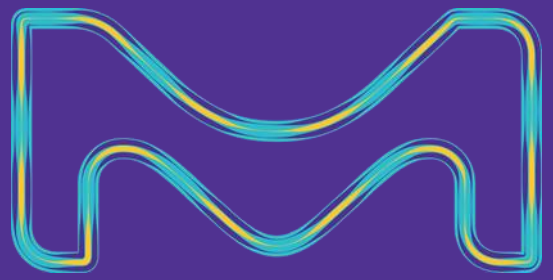
Chief Science & Technology Officer
September 11, 2024

Intelligent Health



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Traditional drug discovery and development:
time-consuming, expensive and with modest success rate

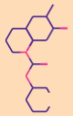
Concepts

1 Drug

~3-4.5 years

RESEARCH

Target identification
(Systems biology)



'Hit to Lead'
(Molecule Design + Make)

~1 year

PRE-CLINICAL RESEARCH

In vitro* & *in vivo
(Test)

~6.5 years

CLINICAL RESEARCH

Phase 1

Phase 2

Phase 3

COMMERCIAL

Diagnostics

MANUFACTURING

40% of time on Discovery alone

~4% success rate

~12 years

~$2.6 Bn

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Needs in Drug Discovery

- Reduce timelines
- Increase in "hit rate"
- Increase success rate
- Increase accessible chemical space
- Improve processes for synthesis
- Increase target space – beyond small mol inhibition

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Tying together our capability and expertise in developing molecules across three industries

Electronics

Advancing digital living

- Specialty chemicals & gases for semiconductor manufacturing
- OLED
- Liquid crystals

Healthcare

As one for patients

- Monoclonal Antibodies
- ADCs & PROTACs
- Small Molecules
- Growth and Fertility hormones

Life Science

Solving the toughest problems in Life Science

- Biologics and ADC Technologies
- E2E mRNA offering
- High Potency APIs
- Viral & Gene therapies

KEY FIGURES

62,908
Employees worldwide

21.0
Sales (€ billion) in 2023

2.4
R&D (€ billion)

66
Countries

1668
Founded

Source: Merckgroup 2023 Financial report

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Classification: Public

Data Revolution: Shaping our future

Innovation powered by Data & Digital

Automating processes, **analyzing large datasets** for actionable insights, enabling **predictive analytics**, and enhancing **decision-making** across various digital platforms and systems

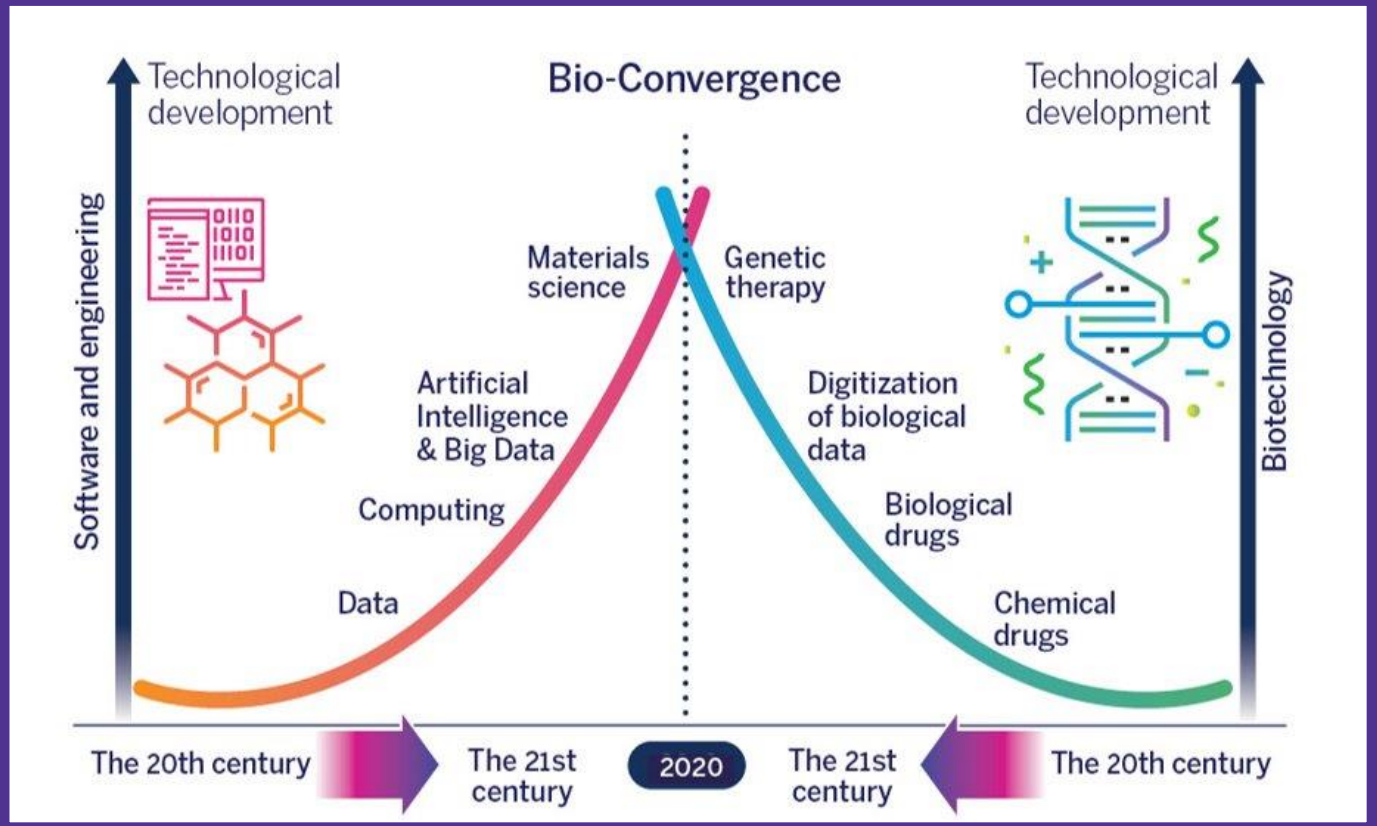
Precision Medicine

Supply Chain

Sustainability

Bioconvergence

Bioconvergence: the advancements in engineering, biology and medicine fueled by data & digital!



Source: https://innovationisrael.org.il/en/reportchapter/bio-convergence, quotes from BiCO (https://bico.com/bio-convergence/)

*"**Rapid genome sequencing** is one of the reasons that multiple **COVID-19 vaccines** were developed so quickly."*

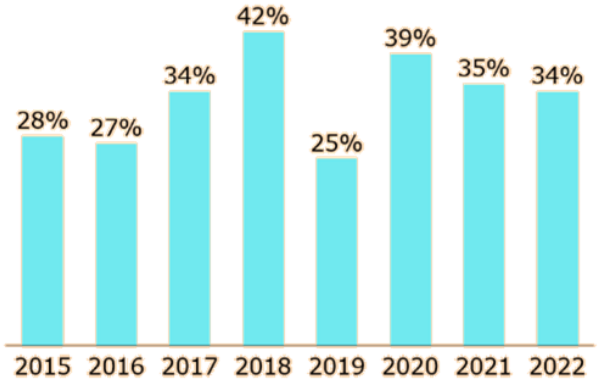
*"**Bio-convergence** is the future of human health, a future that promises targeted, **transformative healthcare**, cures for illnesses, and hope for better, more accessible care worldwide."*

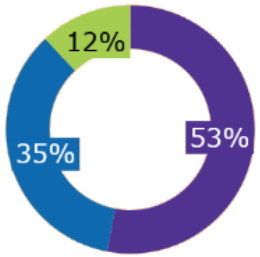
Classification: Public

AI-Driven Personalized Healthcare

Revolutionizing Drug Development

More than 25% of FDA approvals for the last eight years, were personalized medicines





Cancer
*indicates rare cancer

1. Adstiladrin*
2. Carvykti
3. Elahere
4. Kimmtrak*
5. Krazati
6. Lytgobi
7. Opdualag
8. Pluvicto
9. Rezlidhia

Rare Diseases

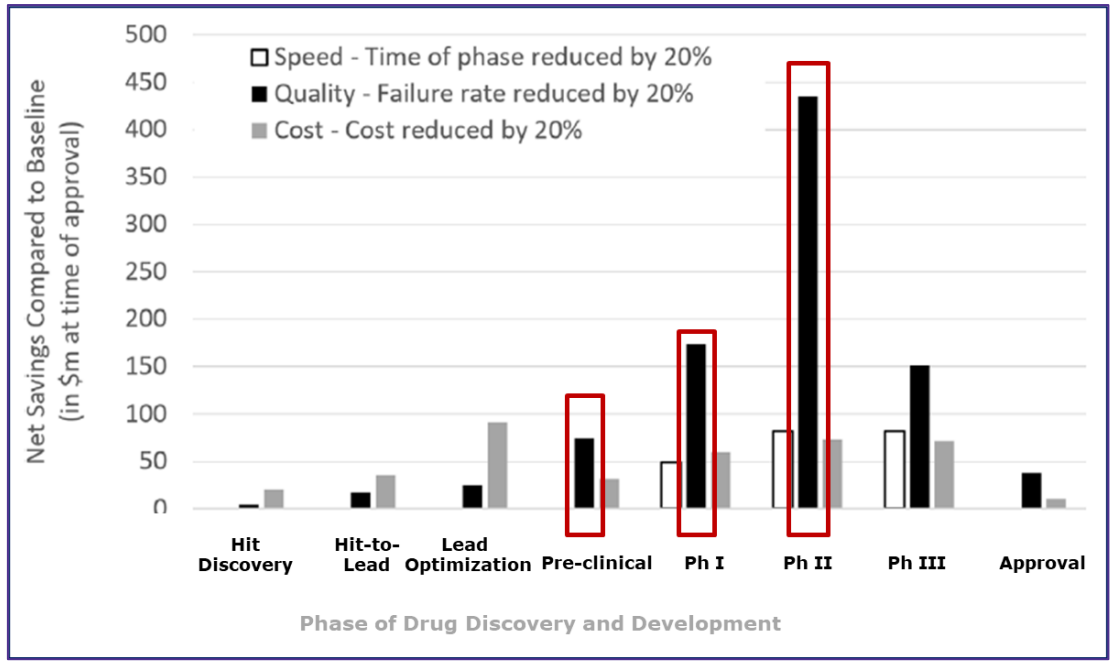
10. Amvuttra
11. Hemgenix
12. Pyrukynd
13. Skysona
14. Xenpozyme
15. Zynteglo

Other Diseases

16. Cibinqo
17. Sunlenca

Source: https://www.personalizedmedicinecoalition.org/Userfiles/PMC-Corporate/file/report.pdf

Leveraging AI to improve the quality of drug development has the greatest impact on the success of a project



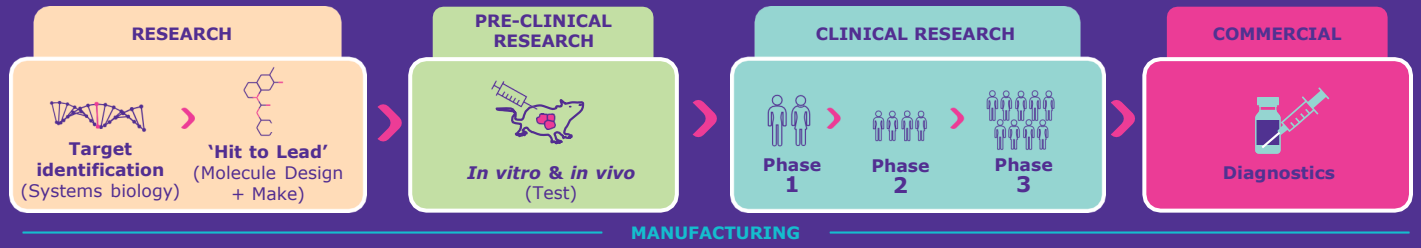
Adapted from Bender and Cortès-Ciriano (2021) Drug Discovery Today 26, 2: 511 https://doi.org/10.1016/j.drudis.2020.12.009

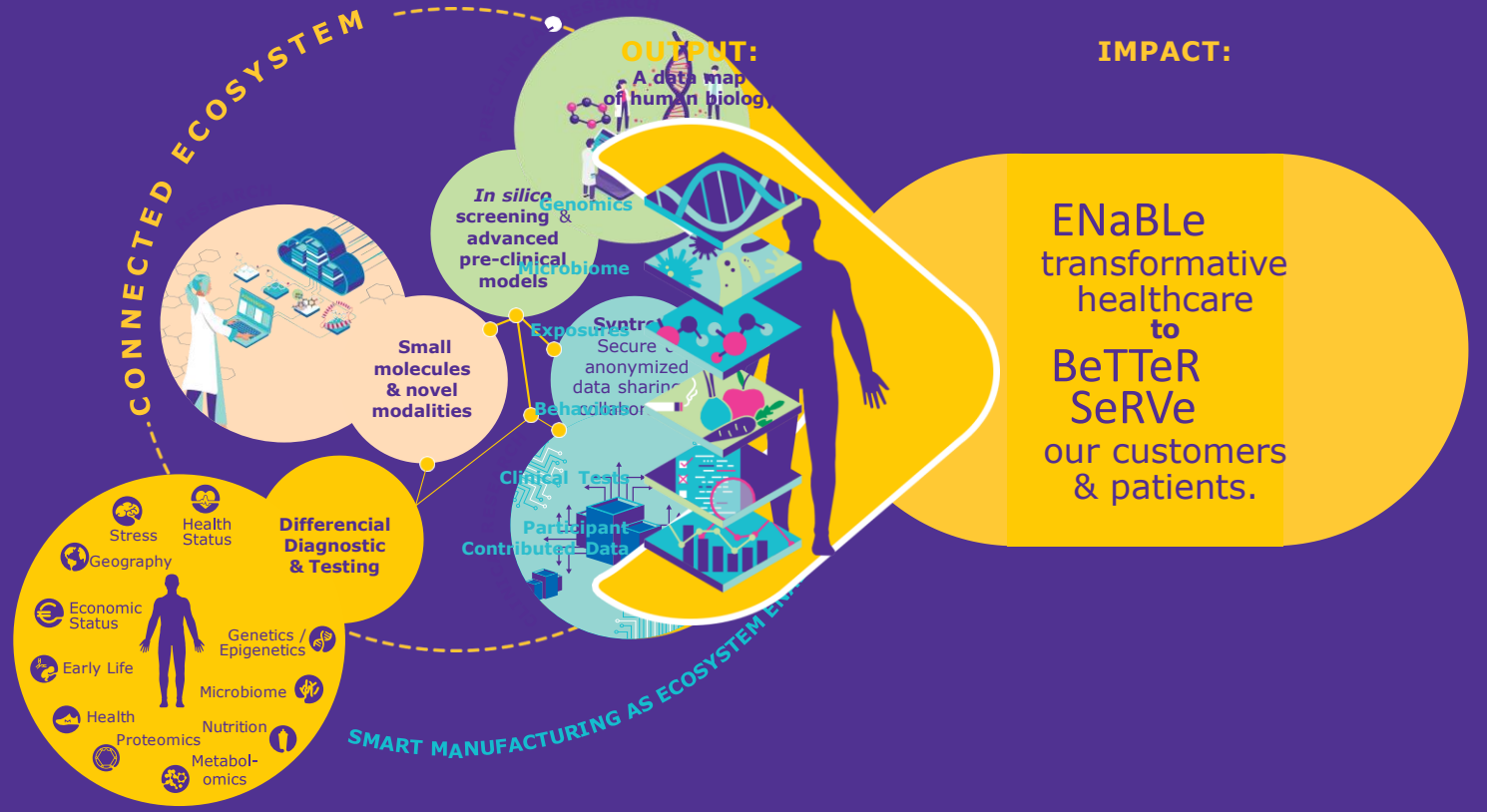
The "how" of the future drug development

A digital ecosystem to deliver transformative healthcare solutions to patients and healthcare systems faster

TODAY

TOMORROW





AI in Drug Discovery (AIDD)

Combined expertise in drug discovery in Healthcare & chemistry leadership in Life Science, and data collaboration ecosystems powered Electronics chips

AIDDISON™ –
AI-powered drug discovery software for new molecule design

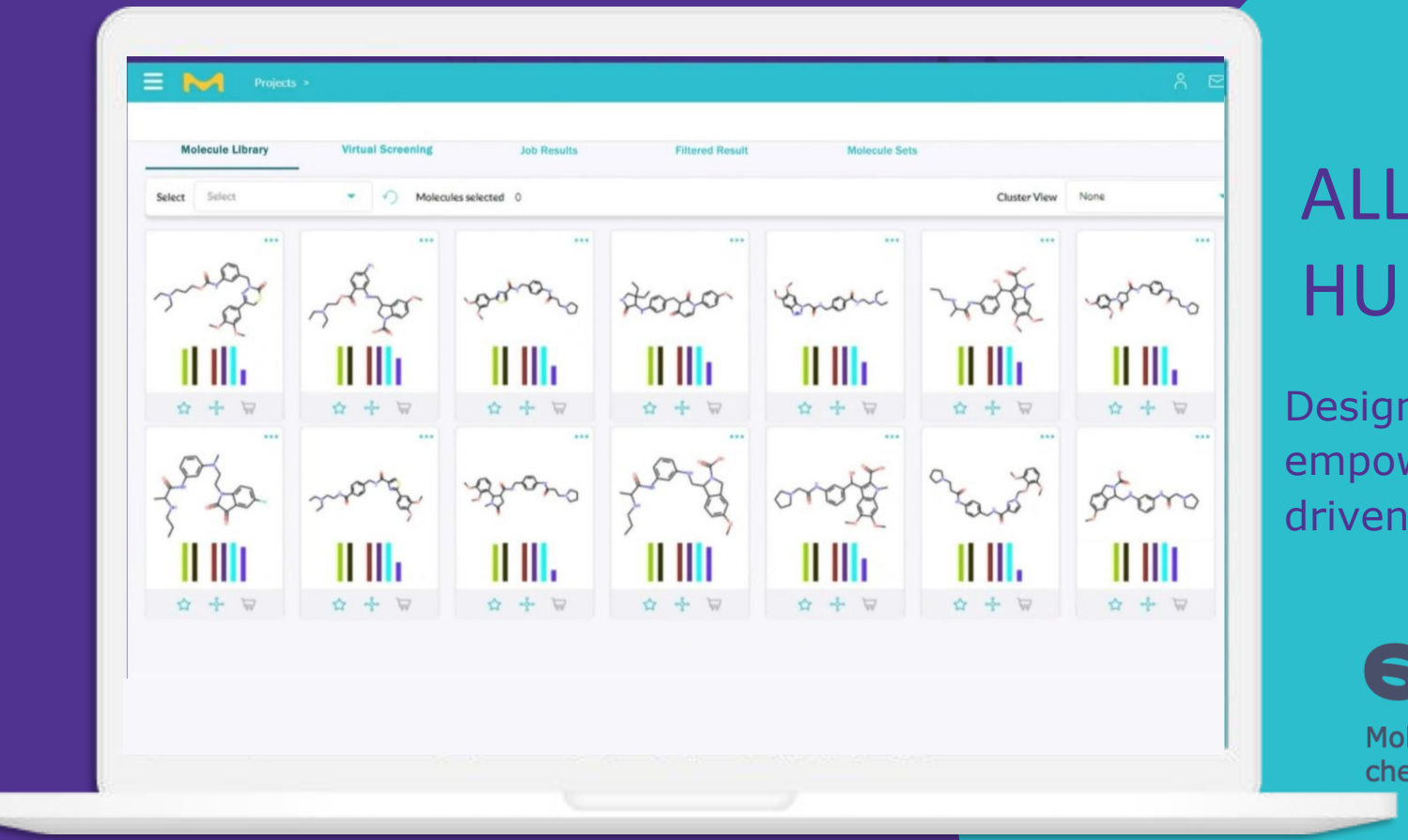
Design
Software

1

Classification: Public

AIDDISON® Generative AI-Powered Drug Discovery Platform
Partnership with Life Science and Healthcare for drug discovery

✓ External customers signed for 2023 and completed AIDDISON-Synthia Integration!



ALL-IN-ONE AI FOR DRUG HUNTERS

Design to full retrosynthesis, AIDDISON™ empowers medicinal chemists to make data-driven decisions at every stage of drug discovery.

64B
Molecules in chemical space

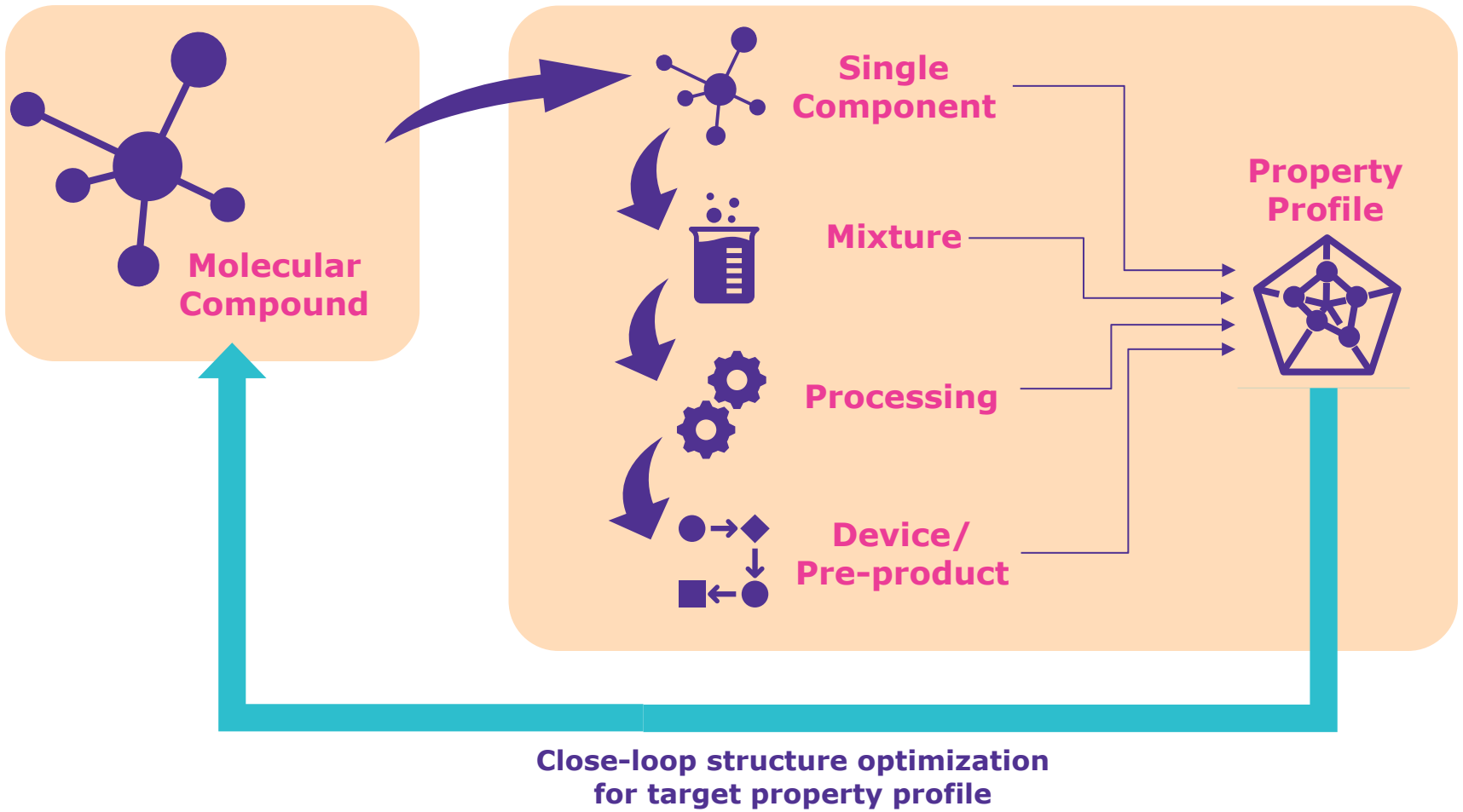
99%
Faster than screening

20 +
Years of validated data models

Classification: Public

Accelerating drug discovery

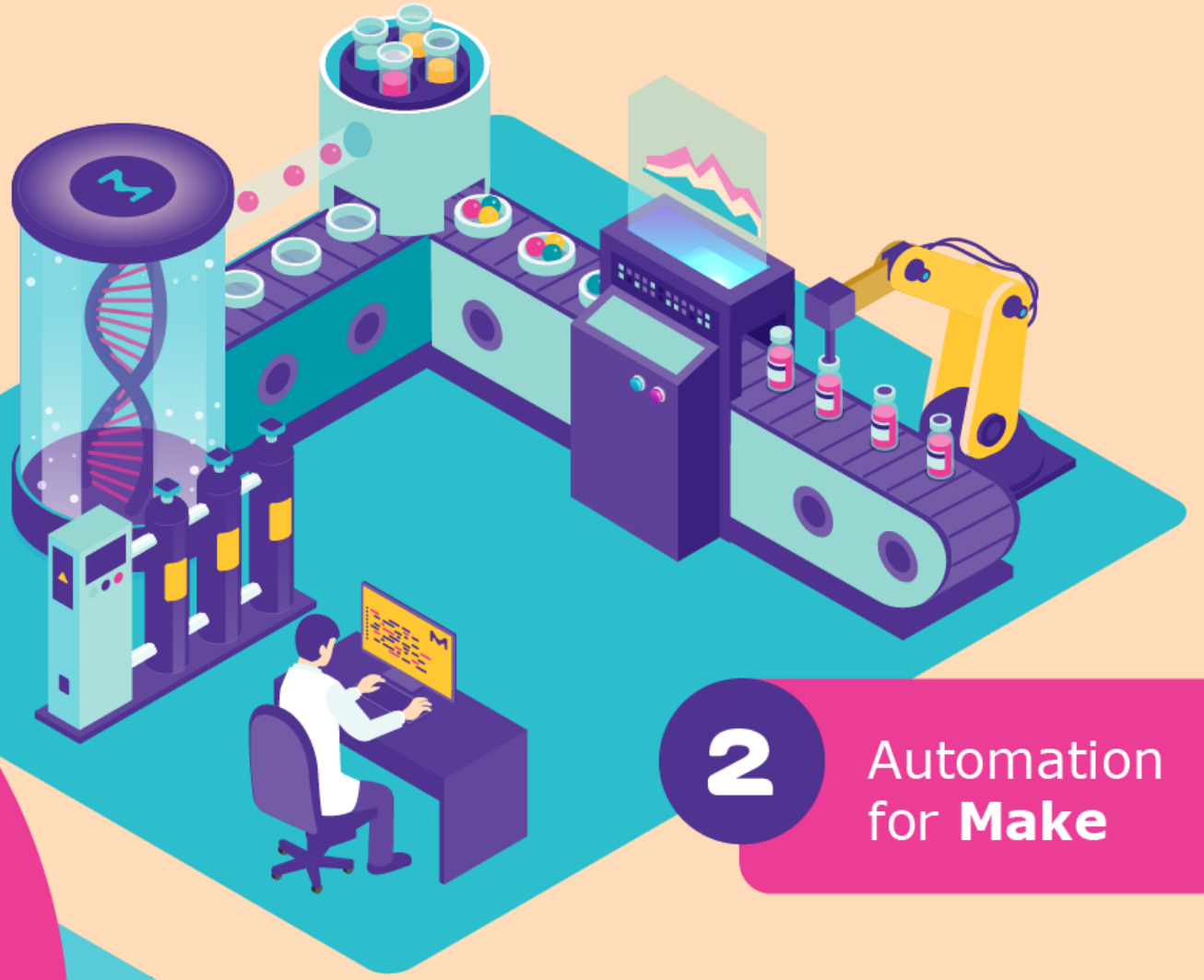
Generative and predictive models for molecule design



- Critical parameters can be derived from each of the workflow steps
- **Domaine-specific**, even product-specific **models** need to be developed **for property prediction**
- Customized machine-learning models are used to **score quality of newly-generated molecules**

Classification: Public

Automated labs and digital twins for new material discovery



MAKE

AI

2 Automation for **Make**

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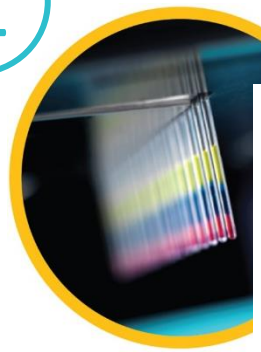
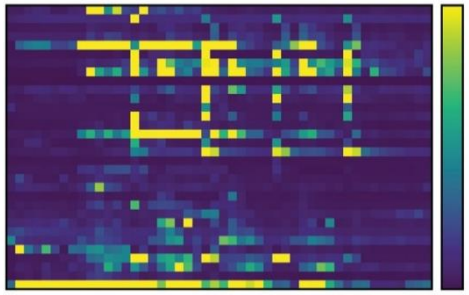
Classification: Public

Autonomous lab driven by AI, automation, and big data
Accelerating successful drug discovery

1 Miniaturization

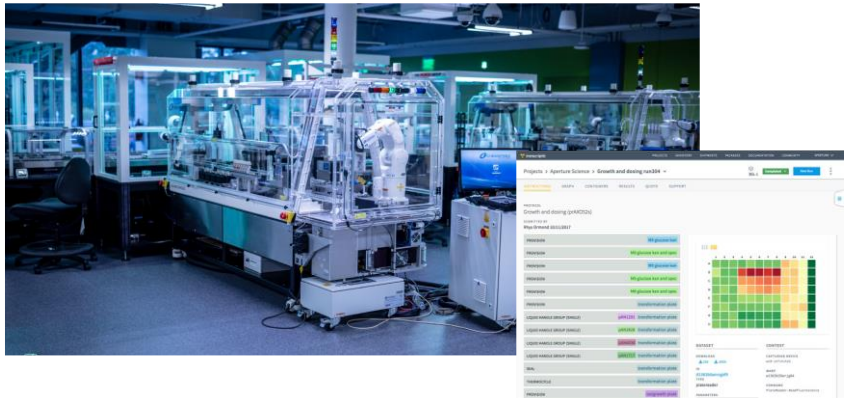


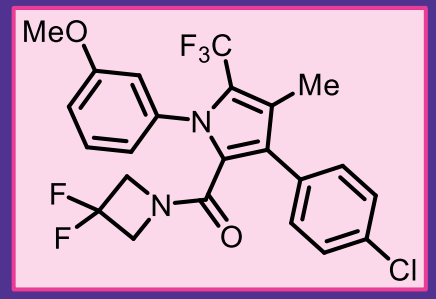
High throughput



2 Fully Automated Labs

Human-less laboratory

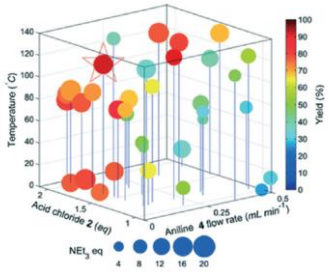


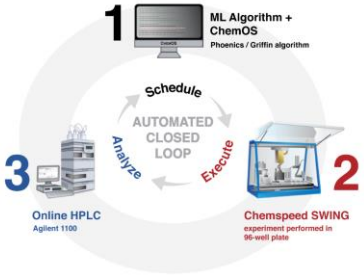


- Scale - HTS
- Faster
- Increased success

3 Closed-Loop Optimization

Computers decide the experiments





3 Bioassay **Testing**

Human Microphysiological Systems (MPS)

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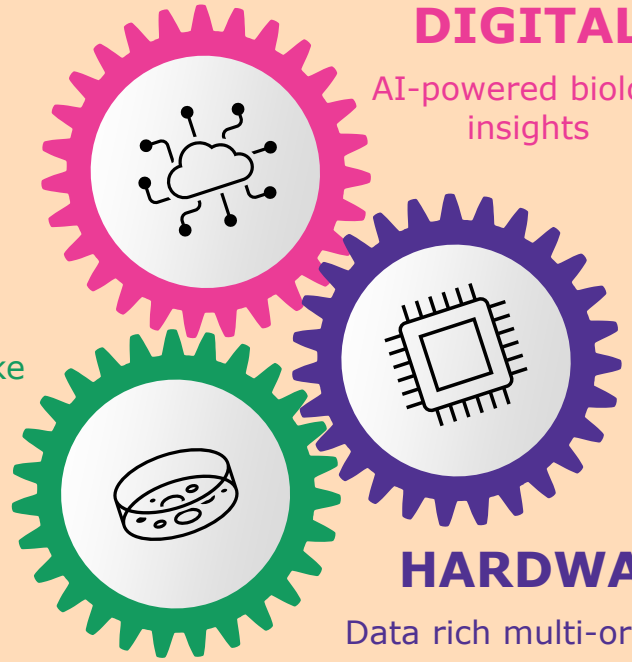
Classification: Public

Human Microphysiological Systems (MPS)

Transforming the drug development testing process



DIGITAL

AI-powered biology insights

BIOLOGY

Complex tissue-like structures

HARDWARE

Data rich multi-organ chip

A ONE Merck Program to transform drug discovery and development processes by enhancing translatability, increasing the development speed and prioritizing animal welfare.

Classification: Public

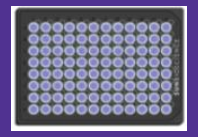
Our MPS vision

A set of connected and synergistic in-vitro & in-silico MPS capabilities

Organ-on-a-chip (OoC)

Biology merged with semiconductors to replicate human body response to drug stimuli

Assay-Ready Organoid Plates



Standard well plates lumenescence and membrane permeability testing + Microwell plates for high content imaging/screening

PBPK Modeling

Physiological based pharmacokinetic modeling and simulation (PBPK) is a computer modeling approach that incorporates blood flow and tissue composition of organs to define the PK of drugs

In-Vitro

In-Silico

PK/PD Modeling

Mathematical approach to study pharmacokinetics (PK), pharmacodynamics (PD), and their relationship

Cell Culture

2D, Spheroids

Organoids

Cells grown in 3D to form structural units that partially resemble the organ.

QSP/ML

Quantitative systems pharmacology (QSP) models the dynamic interaction between biological systems and drugs

Digital MPS

Dynamic modeling to run virtual experiments

ANALYZE

Data
Analysis

4

Integrated data sharing platform

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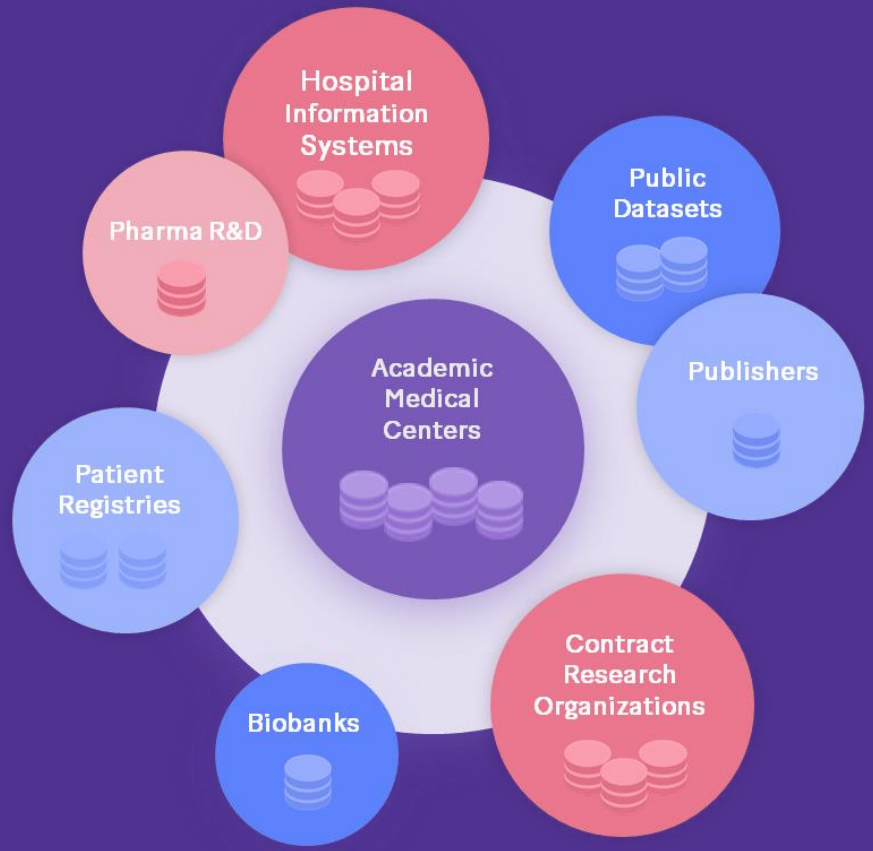
Classification: Public

Pharma have complex ecosystems

Need to break through the data-silos to improve Data quality & availability

Biomedical data is siloed across the Healthcare ecosystem



Laura Matz | Intelligent Health

Siloed data makes insights harder & slower to find and collaboration difficult

~80% of biomedical researchers' time is **spent sourcing and preparing data**[1]

>40% of large pharma companies consider **data quality** the **largest barrier** to conducting remote clinical trials[2]

Researchers want to collaborate but proliferation of available data, data silos between and within institutions, and **lack of incentives to share** have been huge barriers

[1]Primary Syntropy ethnographic research [2]PWC Health Research Institute

Building data ecosystems

through industry collaboration

Syntropy

In partnership with: Palantir

A secure & collaborative ecosystem that empowers researchers to work together across organizational boundaries to ask tough questions and solve hard problems

Rapidly bringing data sources together to:

- Drive meaningful, scalable & data-driven Clinical research
- Accelerate research, data collaboration and empower an AI OS for Healthcare

Search & File Management

Data-Driven Object Explorer

Top-down Analysis

Foundry-linked Spreadsheets

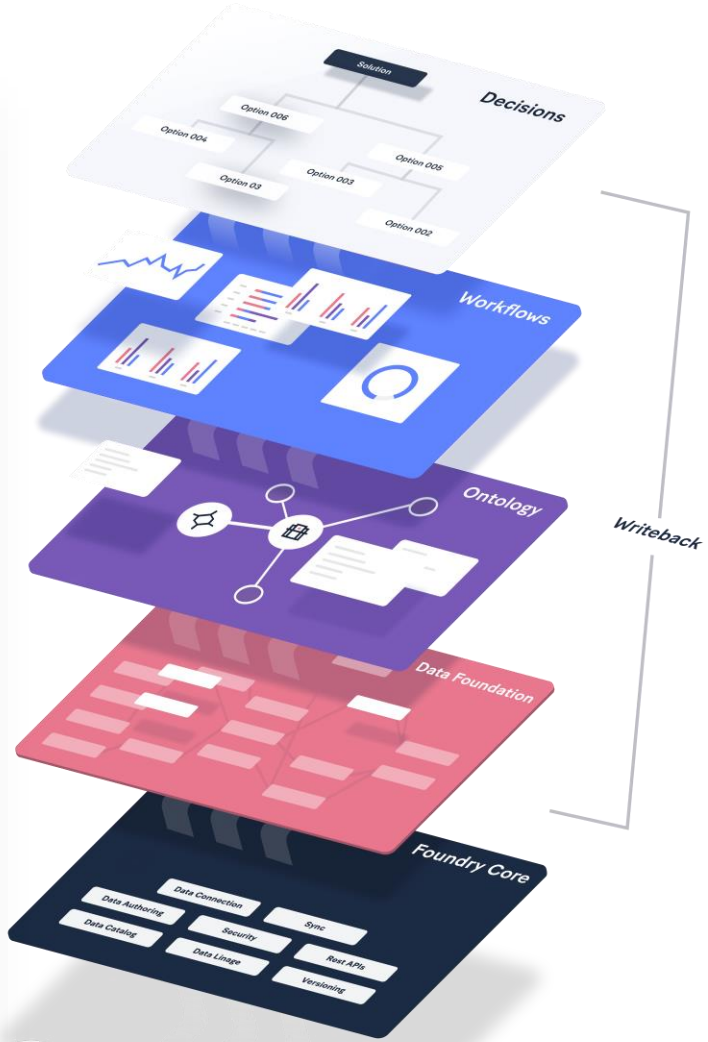
Workflow Applications

Data-Backed Reports

Time-Series Analysis

Code Workbooks

{Research question}



Images, clinical data, 'omics, wearables, etc.

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Classification: Public

UCI – MITRE Case Study

Powered by Syntropy®

- Data Integration
- Data Transformation
- Data Lineage
- Multi-Institution Collaboration
- Data Security & Privacy

Challenge

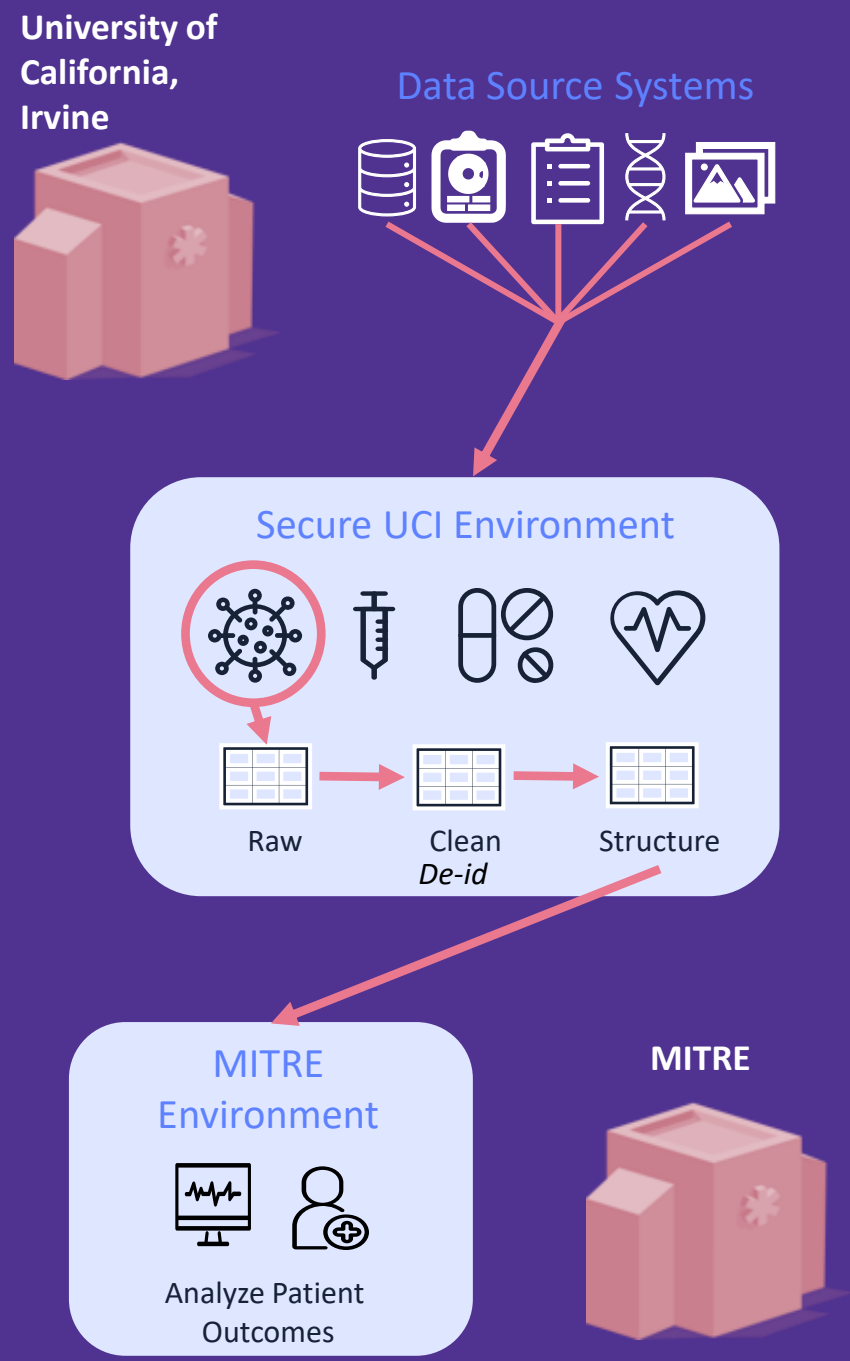
- **Integrate patient data** across the University of California, Irvine, and its co-collaborators
- **Standardize data** across the institutions based on a data schema distributed by MITRE
- **Analyze patient outcomes** for patients that received monoclonal antibody treatment for COVID-19

Solution

- Syntropy® platform:
  - Provided **data pipelines and data exchange**
  - Allowed for **scalable, robust, and flexible** mapping of UCI patient data to MITRE schema
  - Facilitated **data linking, cleaning, and validation**
- UCI standardized and submitted data to MITRE much faster and more securely

Impact

- **Fastest implementation** of data schema (~2 months faster)
- Explicit data capture through **traceability elements** baked into the workflow
- **Automated , modular data pipeline** and validation scripts
- **Zero PHI leaked**



Classification: Public

Our investment in automation for drug and material development

PRESS RELEASES /

Merck Invests in State-Of-The-Art Biotech Development Facility in Switzerland

Merck today announced an investment of € 250 million in a new facility in Corsier-sur-Vevey, Switzerland – the Merck Biotech Development Center.

SHARE

PRESS RELEASES /

Merck Introduces Modular Automation for Laboratories – A First for the Chemical Industry

Merck today announced its intention to automate the global laboratory environment of its Electronics business sector in addition to digitalizing production.

SHARE

Key takeaways

1 At Merck, our full capacity and expertise in developing molecules across three industries enables us to **accelerate innovation**.

2 Our **Bioconvergence** approach merges digital, biotech, and engineering innovations to advance human biology understanding and shape the future of precision medicine and transformative healthcare.

3 The cutting-edge **AI for Drug Discovery program** integrates AI and automation, accelerating early drug discovery while enhancing safety and cost-effectiveness.

4 **Syntropy® data ecosystem** enables a new era of scientific discovery through collaboration and the power of data, driving transformative change across the industry with unprecedented interoperability and insights.

Thank you

Let’s drive innovation together!