جامعة بغداد / كلية الصيدلة
وحدة الشؤون العلمية

Preventive

Predictive

Personalized

Participatory

P4 MEDICINE

PhD Candidate
Sahar M. Shakir

يوم الاربعاء المصادف 2022 / 3 / 2 ، الساعة العاشرة صباحا

قاعة الشهيدة د. نضال فالح ، قسم الكيمياء الصيدلانية ، كلية الصيدلة / جامعة بغداد .

The vision of ‘P4’ medicine has long been advocated by Leroy Hood & other pioneers of systems medicine.

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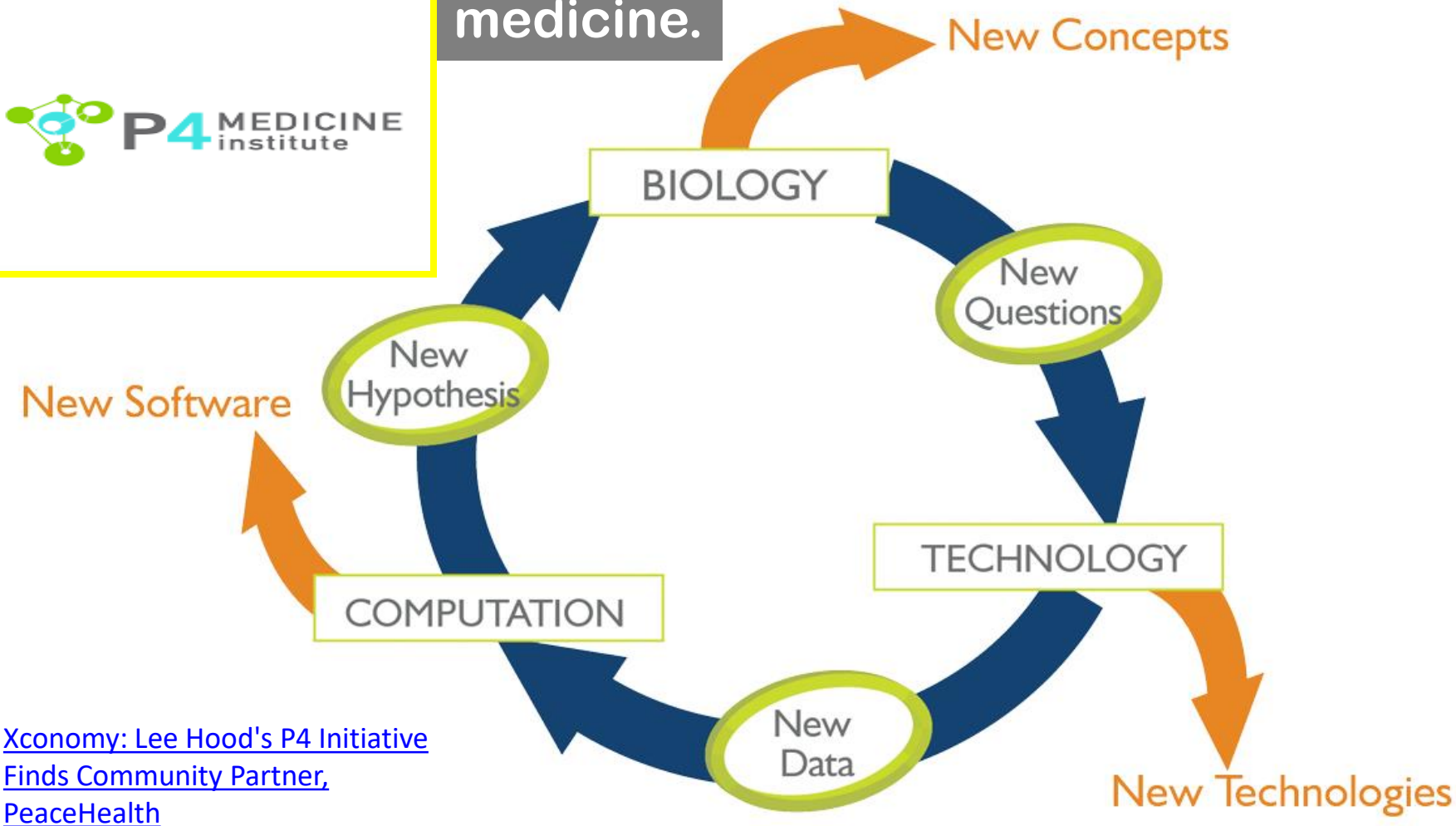
P4 MEDICINE institute



Xconomy: Lee Hood's P4 Initiative Finds Community Partner, PeaceHealth

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The major elements of **P4 medicine** vision have been largely adopted by a series of reports by
US Institute of Medicine (IOM) &
National Academy of Sciences.

These reports are:

- **A New Biology for the 21st Century**: Ensuring the United States Leads the Coming Biology Revolution. National Research Council 2009;
- **Toward Precision Medicine**: Building a Knowledge Network for Biomedical Research & a New Taxonomy of Disease. IOM November 2011;
- **Evolution of Translation Omics**. IOM March 2012;
- **Best Care at Lower Cost**: the Path to Continuously Learning Healthcare in America. IOM September 2012.

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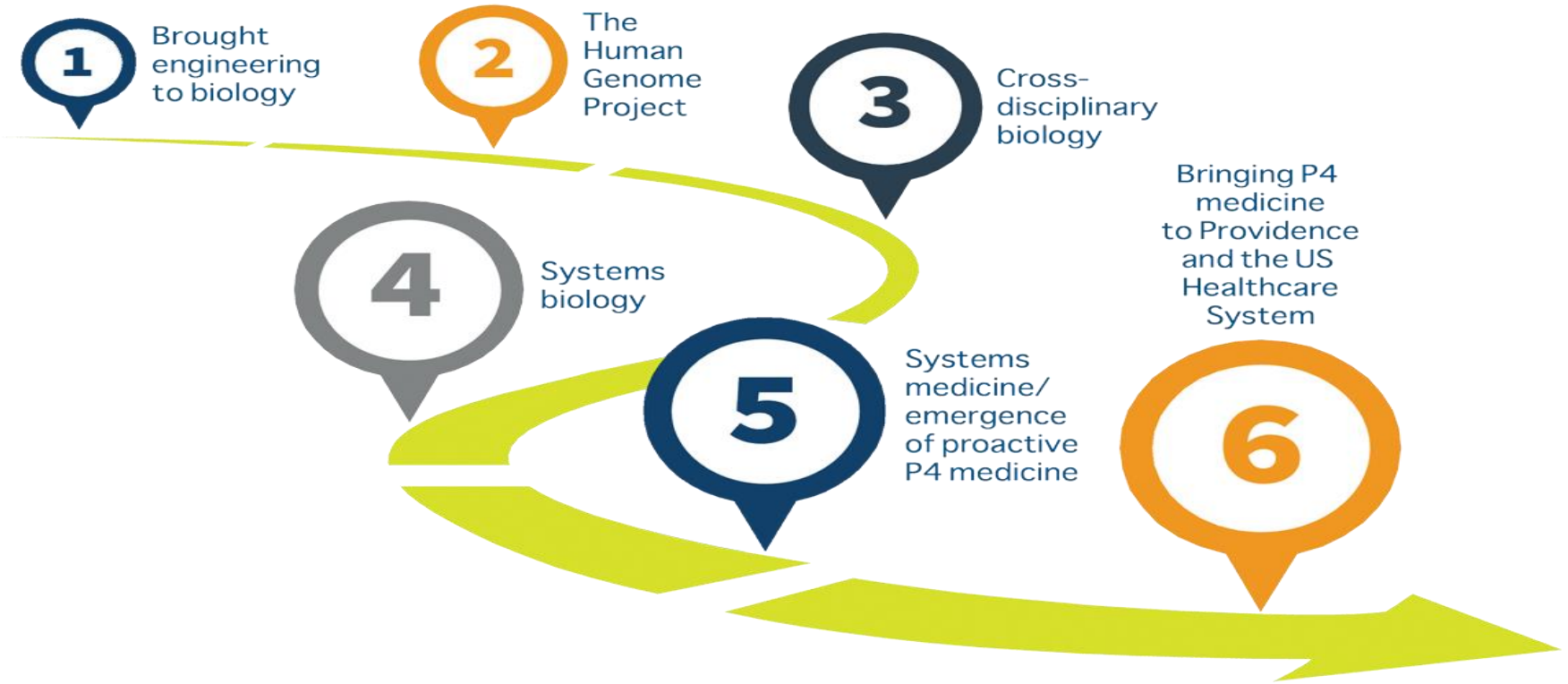
P4 medicine/healthcare & precision medicine Systems approaches to medicine at ISB from 2000–2004 led to the concept of a P4 healthcare.

The definition of **P4 medicine** arises from the convergence of 5 social & medical thrusts: it embraces the concepts of systems medicine and scientific wellness; it utilizes the striking opportunities of digital health; it capitalizes on big data & its analytics; & it takes advantage of diverse social networks for education, advocacy, and recruitment. Moreover, it also focuses on the individual assessing his/her genetic & lifestyle/environmental contributions to health with his/her own data clouds & with help from coaches or physicians make his/her own decisions about his/her health.



Six major changes in biology - from bringing engineering to biology in the 1970s to, in 2016, bringing medicine that is predictive, preventive, personalized and participatory (P4 Medicine) to the U.S. healthcare system. This change, the most recent ISB tipping point, is the result an affiliation between Institute for Systems Biology & Providence Health & Services.

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Figure 5 A photo of Leroy Hood and former President Barack Obama during a 2013 White House ceremony awarding the National Medal of Science

Precision medicine, born with Obama's State of the Union Address in 2015, employs big data (mostly from genomics) and digital health to target disease.
One of the most "successful" examples of precision medicine is the DNA sequencing of tumors to identify cancer driver mutations that might have complementary drugs—which can then be employed to attack the tumor.

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P4
The
Bio

ISB

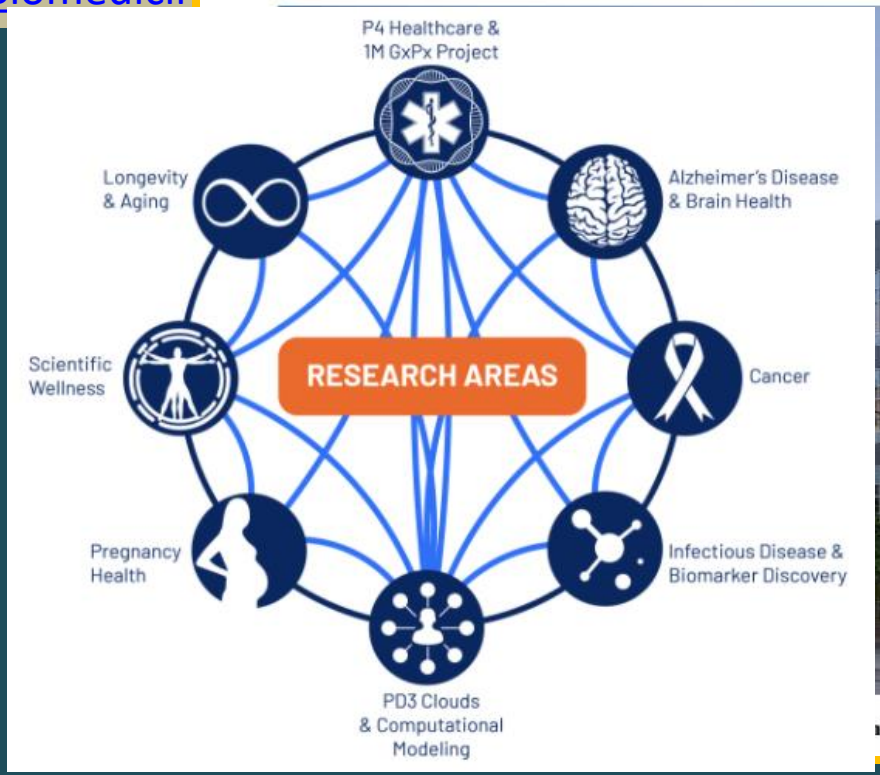
LAB HOME RESEARCH PEOPLE PUBLICAT

The Hood-Price Lab for Systems Biomedi

Taking a systems approach to transforming human health across the lifesp

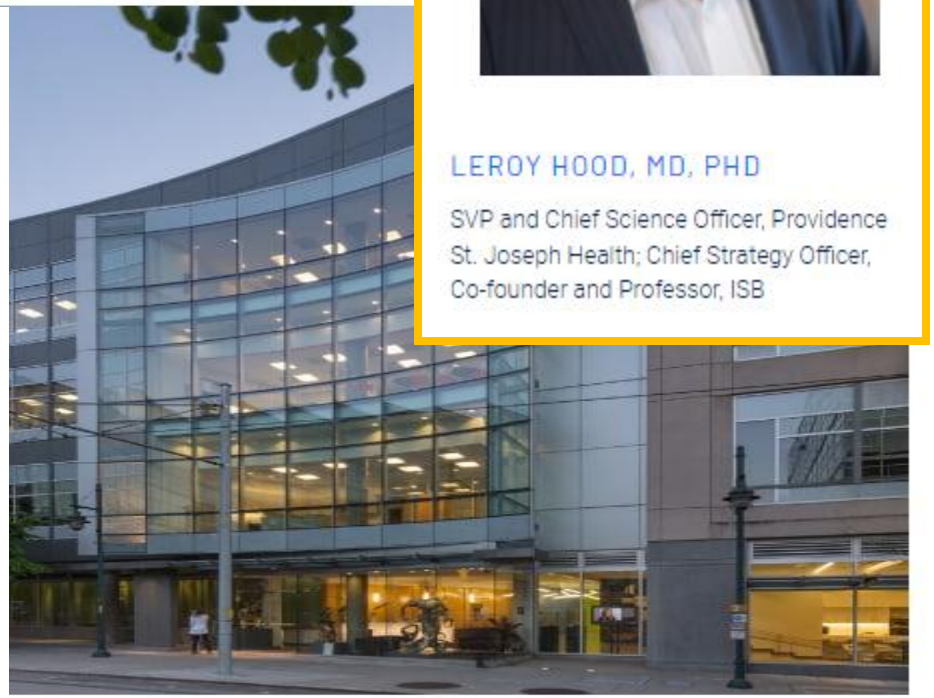
Ho
Biomedicir

Hood LE | Lessons Learned from ISB



LEROY HOOD, MD, PHD

SVP and Chief Science Officer, Providence St. Joseph Health; Chief Strategy Officer, Co-founder and Professor, ISB



he ISB building located at the South Lake Union

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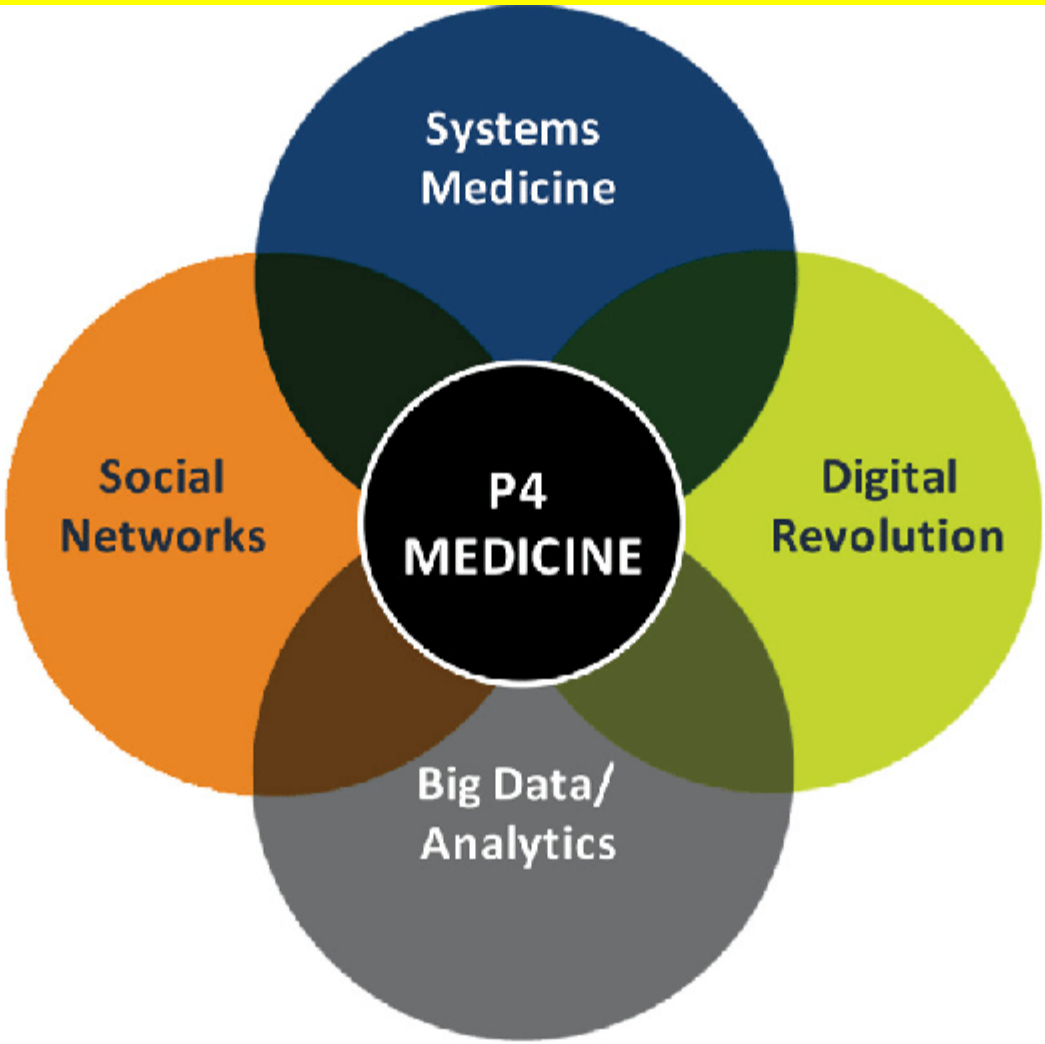

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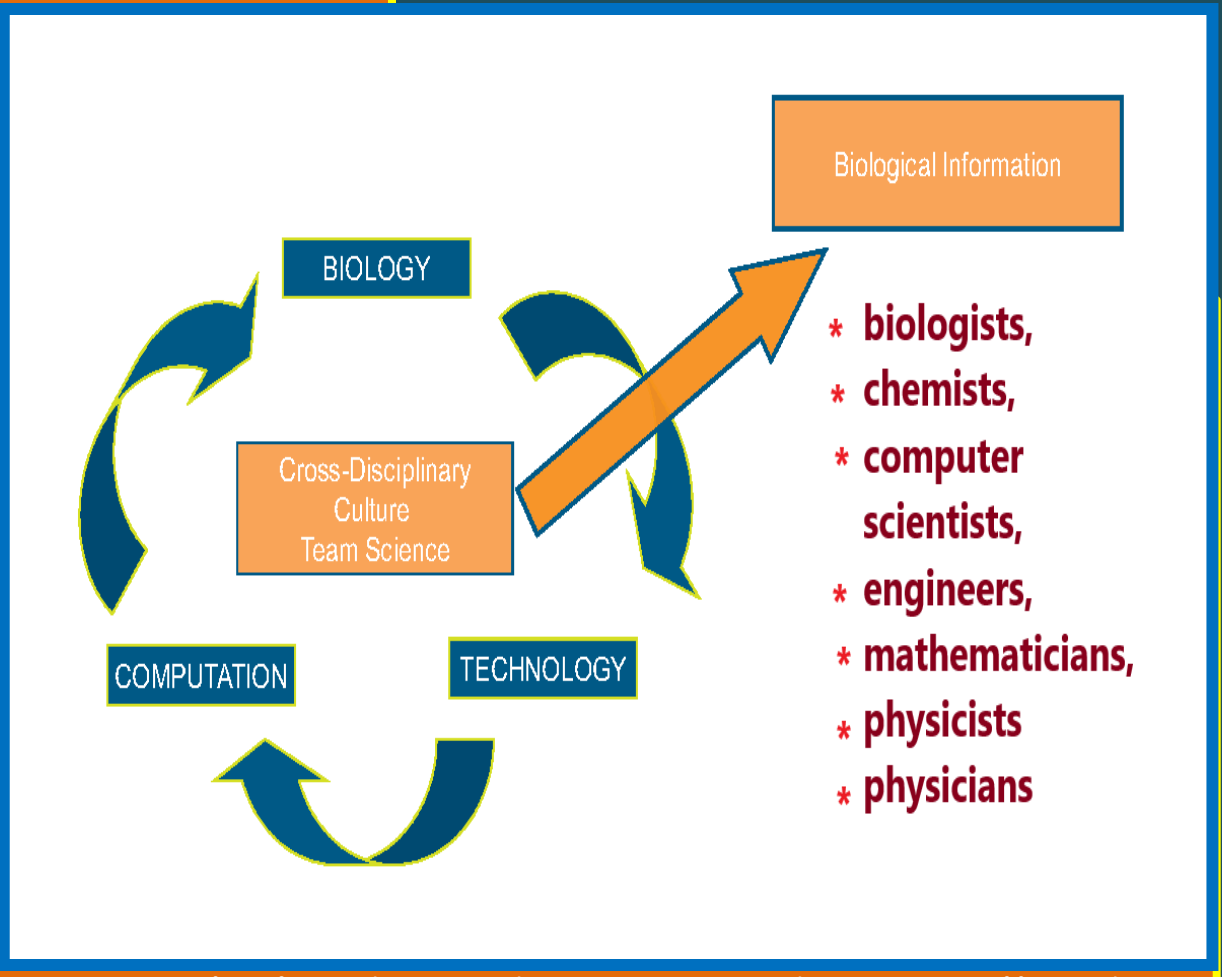
Cross-disciplinary environment all learn to speak languages of other disciplines & work together in biology-driven teams .



Democratization' of data-generation & data analysis tools; making these tools accessible to all individual scientists

So it generate data for diverse 'omic' Technologies (genomics, proteomics, metabolomics, interactomics, cellomics, among others) & a culture that encourages scientists to learn to speak languages of multiple scientific disciplines & how to work together.

In 2019, WHO established its first Department of Digital Health and Innovation (DHI) to work on digital health technologies to fulfil World Health Assembly resolution WHA/71 A71. WHO has been developing plans to accelerate the use of technologies to meet global public health needs.

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Posted on May 18, 2020 by newsdesk

Pandemic highlights e-health issues

Photo: Pixabay

f Australia's COVIDSafe app underlines the need for standards to
l out e-health services, Flinders University digital health experts say.

eightened the need for a more robust framework for analysis of
obile health applications, especially those with clinical security and
e Flinders Centre for Digital Health Research authors say in a new

WHO Digital Health virtual round table with the Private Sector

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A growing number of activated & networked patients & consumers have the ability to:

- Provide ‘big data’ essential to power innovation cycle of systems medicine;
- Improve health-related lifestyle decisions on a scale sufficient to halt rising incidence of chronic & complex diseases, such as diabetes, which presently account for more than 75% of healthcare costs in the USA.

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By combining scientific & technological power of systems medicine with active participation of networked consumers, P4 medicine will:

- Provide more cost-effective disease care;
- Reduce the incidence of disease;
- Replicate innovation cycle of systems medicine on a large scale, as both disease care & wellness support are integrated with discovery science, thereby creating what the IOM calls a "learning healthcare system"

PERSPECTIVE | VOL. 385 NO. 1, JUL 01, 2021

A Half-Century of Progress in Health: The National Academy of Medicine at 50: Advancing the Learning Health System

J.M. McGinnis, H.V. Fineberg, and V.J. Dzau | N Engl J Med 2021; 385:1-5

Recognizing that technological and methodologic advances could improve on the pace, generalizability, and costs of innovation in health and medicine, the National Academy of Medicine has helped steward the evolution of a continuously learning health system.

NEJM - Search Results

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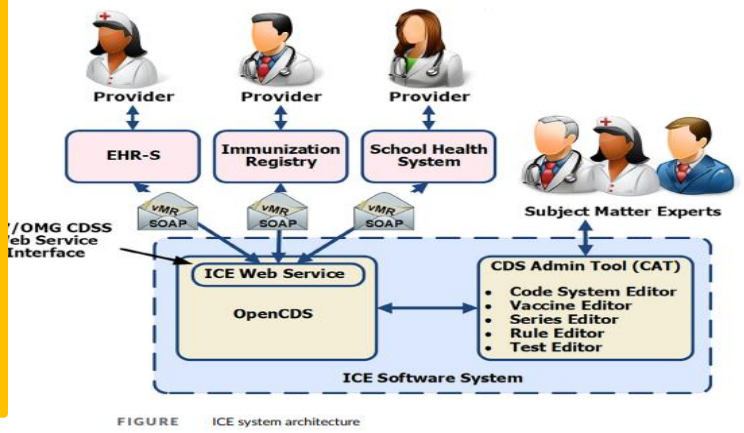
Immunization calculation engine (ICE) a free, open-source immun. forecasting eval. & software syst. supports childhood, adol-escent, & adult imm.s based on recommenda.s of Advisory Committee on Immu. Practices (ACIP)



P4 medicine is emerging from:

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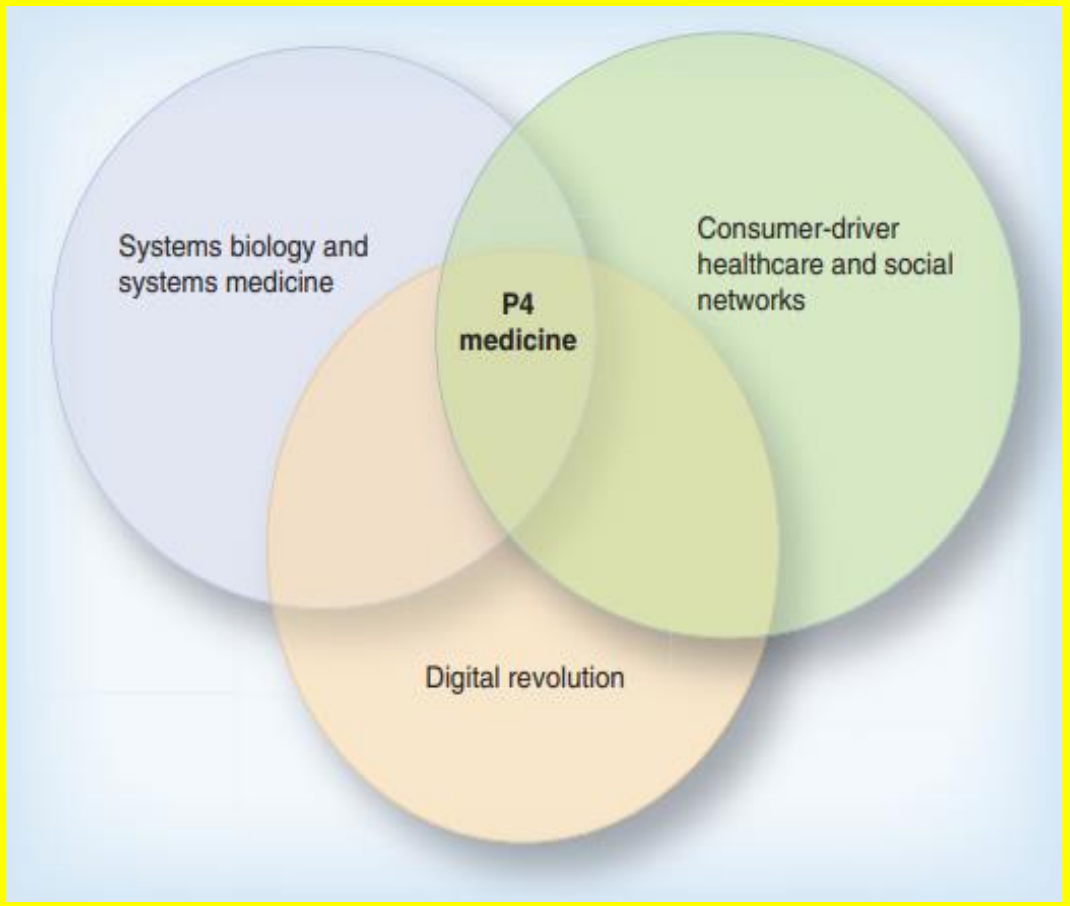
1. Increasing ability of systems biology & systems medicine to decipher the biological complexity of disease;
2. Digital revolution's radically enhanced capabilities for collecting, integrating, storing, analyzing & communicating data & information, including conventional medical histories, clinical tests & results of tools of systems medicine; *f*Consumer access to information & interest in managing their own health.



Every consumer of healthcare will be surrounded by a virtual cloud of billions of data points.

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TeleHealth

11010100
01010101
01101010
10100100

Phenome

Na143 K
3.7 BP
110/70
HCT32 BUN

Social Media

11010100
01010101
01101010
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Epigenome

11010100
01010101
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10100100

Genome

GCGTAG
ATGCGTA
GGCATGC
ATGCCAT

Transcriptome

UUAGUG
AUGCGU
CUAGGC
AUGCAU

Proteome

arg-his-pro-
gly-leu-ser-
thr-ala-trp-
tyr-val-

Transactional

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Single Cell

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iPS Cells

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Box 1. The five pillars of systems medicine.

Pillar 1

- Cutting-edge technologies for generating data regarding multiple dimensions of each person's experience of health and disease.

Pillar 2

- A digital infrastructure linking participating discovery science and clinical institutions, as well as patients/consumers.

Pillar 3

- Personalized data clouds providing information about multiple dimensions of each individual's unique dynamic experience of health and disease ranging from the molecular to the social. These data will include genetic and phenotypic characteristics, medical history, demographics and other sociometrics.

Pillar 4

- New analytic techniques and technologies from deriving actionable knowledge from the data.

Pillar 5

- Systems biology models for understanding the unique health status of each individual in terms of dynamic network states that can be manipulated by cost-effective strategies.

P4 healthcare will be implemented as data from the digital health industry,

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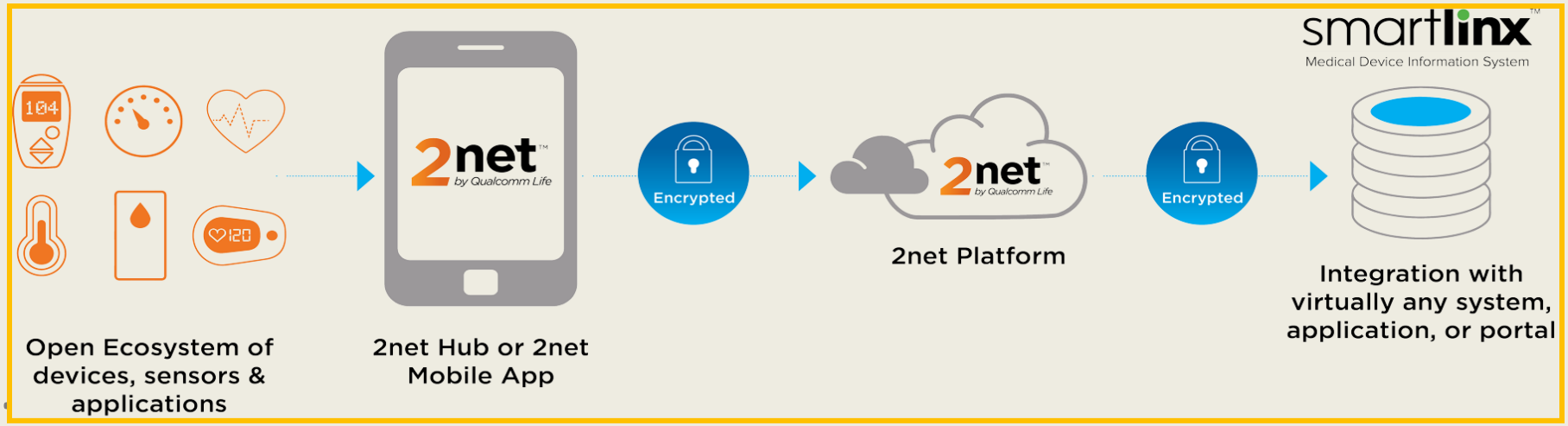
- Traditional medical records should be combined with genomic, metabolomic, transcriptomic & proteomic data, along with data about sleep, activity, diet & other lifestyle data.
- Knowledge generated by aggregating & mining these vast personalized data clouds is already beginning to transform healthcare industry.
- Qualcomm Life (CA, USA), created an open-sourced digital infrastructure called '**2Net**' capable of integrating health data from devices from multiple sources (such as digital health devices & blood data) marketed by many different companies. This privately developed utility, or others like it, will eventually be available for use by clinical & research institutions, & physician practices.



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A comparison of the current reactive, evidence-based medicine with proactive P4 medicine

Reactive medicine – evidence-based medicine	Proactive P4 medicine
Reactive-respond after a patient is sick (symptom based)	Proactive-responds before a patient is sick (based on pre-symptomatic markers)
Disease-treatment system	Wellness-maintenance system
Few measurements	Many measurements, including complete genome sequencing, high-parameter blood diagnostics, many longitudinal omics measurements
Disease-centric, with standard of care associated with population-based disease diagnosis	Individual-centric, with standard of care tailored more fully to multiple measurements on the individual
Records not highly linked	Deeply integrated data that can be mined for continued improvement of healthcare strategies
Large-scale diffusion of medical information mediated mostly through physicians alone	Social networking of patients to enhanced shared experiences and diffusion of knowledge in consultation with their physicians
Drugs tested against large populations – 10s of thousands to develop statistics for FDA	Stratification of disease populations into small groups, 50 or so, that can be effectively treated to achieve FDA approval
Science based healthcare takes place almost entirely in clinics and hospitals	Science based healthcare takes place in the home as well as the clinic as networked and activated healthcare consumers use the information made available from systems biology and wireless measuring devices to do a better job of managing their health
Discovery science and medicine are largely separate spheres of activity which communicate primarily through publication of articles in peer reviewed journals	Discovery science and the practice of medicine are integrated through digital networks and heterogeneous databases that capture data from every clinical encounter for discovery purposes and quickly and efficiently distribute information about stratified diseases and populations to physicians on an ongoing basis

How to bring P4 medicine to patients

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Challenges

– **Technological** & - **Societal**.

The latter is far more complex.

- At the **Institute for Systems Biology** in conjunction with **Ohio State Medical School**, the **P4 Medicine Institute (P4MI)** – a non-profit organization, have been created

P4MI has established a fellows program to begin delving into some of the societal challenges of P4 medicine, eventually through '**white papers**' on economics, the '**gold standard of healthcare information**', **ethics**, **regulations**, among others.

Strategic partnerships are a crucial component for bringing P4 to patients worldwide & gaining its widespread acceptance in national & international medical communities.

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Telemedicine Questionnaire

Gender: ☐ Male ☐ Female
Age: _____
Specialty: _____
Years of working experience: _____
The level of the professional role: _____
Years of using electronic health records: _____
Hospital: _____
City, Province: _____

1. Telemedicine is appropriate for your specialty during COVID-19.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

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2. You are willing to use telemedicine system during COVID-19.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

1. The lack of person-to-person contact in telemedicine can damage the doctor-patient relationship and trust.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

2. A physician's inability to examine patients will hinder clinical decision-making.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

3. During COVID-19, the use of telemedicine will increase the burden on physicians.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

4. Telemedicine makes it easier for patient data to be stolen, compromised, or hacked.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

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5. What are your major concerns regarding the use of telemedicine?
   a. Cannot communicate well with patients
   b. No assurance of patient medical safety
   c. Inability in-person physical examination
   d. Unstable telemedicine system

6. Does your hospital adopt telemedicine system?
   a. Yes b. No c. I don't know

7. How often do you use telemedicine system?
   a. ≤1/Month b. ≤ 1/Week c. >1/ Week d. No

8. If you have used the telemedicine before, please select the overall satisfaction with telemedicine system.

1	2	3	4	5	6	7
Strongly Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Strongly Satisfied

9. Have you taken any telemedicine training in your hospital?
   a. Yes b. No c. I don't know

   If you choose a, please select the overall satisfaction with telemedicine training.

1	2	3	4	5	6	7
Strongly Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Strongly Satisfied

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10. Does the telemedicine system integrate electronic medical records?
    a. Yes b. No c. I don't know

    If you choose a, please select the overall satisfaction with it.

1	2	3	4	5	6	7
Strongly Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Strongly Satisfied

11. Does the telemedicine system provide any clinical decision support tools?
    a. Yes b. No c. I don't know

    If you choose a, please select the overall satisfaction with it.

1	2	3	4	5	6	7
Strongly Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Strongly Satisfied

12. What are your major concerns regarding the use of telemedicine?

_____

_____

_____

_____

_____

Physicians' Perspectives of Telemedicine During the COVID-19 Pandemic in China: Qualitative Survey Study (nih.gov)

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13. Please provide some suggestions to promote the telemedicine.

14. Please list the main reasons why you are willing or unwilling to use telemedicine.

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Preprints (earlier versions) of this paper are available at https://preprints.jmir.org/preprint/26463, first published December 12, 2020.

Physicians' Perspectives of Telemedicine During the COVID-19 Pandemic in China: Qualitative Survey Study

Jialin Liu [1,2]; Siru Liu [3]; Tao Zheng [1]; Yongdong Bi [1]

Citation

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PMCID: 8171288

REVIEW article
Front. Med., 25 January 2022 | https://doi.org/10.3389/fmed.2021.784455

Data Integration Challenges for Machine Learning in Precision Medicine

Mireya Martínez-García[1] and Enrique Hernández-Lemus[2,3]*

[1]Clinical Research Division, National Institute of Cardiology 'Ignacio Chávez', Mexico City, Mexico
[2]Computational Genomics Division, National Institute of Genomic Medicine (INMEGEN), Mexico City, Mexico
[3]Center for Complexity Sciences, Universidad Nacional Autnoma de Mexico, Mexico City, Mexico

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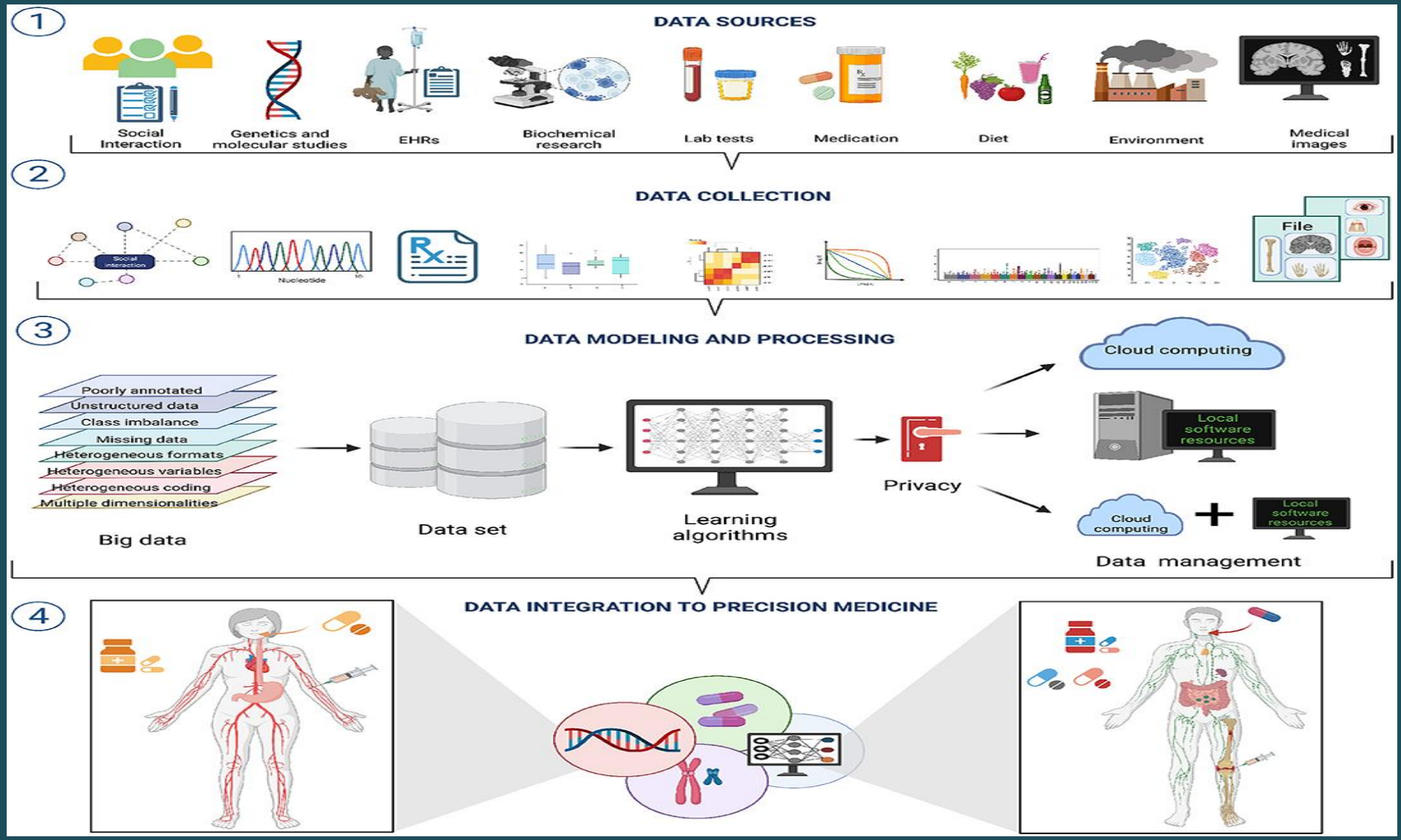

CONCLUSIONS & PERSPECTIVES

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Artificial Intelligence & Machine Learning (AI/ML) approaches have proven to be extremely relevant tools for the large scale analysis of biomedical and clinical data; central for the development of Personalized Medicine. Useful as they are, implementing AI/ML methods in the highly demanding medical applications, it is not an easy endeavor. A number of caveats, shortcomings and subtle points have to be taken into account (and in many cases, circumvented) in order to provide appropriate solutions for the individual and public health care to fully benefit from these emerging paradigms.

In this Lecture, we have discussed the extreme benefits as well as some of challenges, & drawbacks found in the applications of the methods & designs of large scale data analytics within clinical & biomedical environments.

Some relevant points:

- P4 Medicine has been recently presented as an emergent paradigm to approach healthcare in a more predictive, preventative, personalized, participatory. Precision Medicine has strong ties with data intensive approaches, as well as with machine learning & artificial intelligence.
- To deliver promise of P4 Medicine, computational learning approaches are to be nurtured by well-curated & nifty integrated data ecosystems.
- Data resources in biomedical research, clinical & healthcare environments are becoming extremely large, & are complex, unstructured & heterogeneous, hence difficult to deal with individually, even more so to be integrated into a coherent framework.
- The universe of diverse data sources needs to be collected, pre-processed, processed, modeled, & integrated to construct such coherent frameworks useful for P4 Medicine.

- For ML models to give good results their input needs to be *good* data.

Transforming existing data into optimized forms is essential.

- To develop, implement, optimize, and improve on these methods, a number of challenges needs to be overcome.

These include technical limitations, computational aspects (both software and hardware/infrastructure), mathematical and modeling issues, and even ethical, legal, and policy matters.

- We have presented and discussed some of these challenges, aiming at showing the state of the art in these different fields.
- We have introduced the need for data intensive endeavors, from the research arena to the clinical setting and the healthcare institution level to design and implement a data management plan to consider the issues that may arise and planning ahead for their solution.

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By combining scientific & technological power of systems medicine with active participation of networked consumers, P4 medicine will:

- Provide more cost-effective disease care;
- Reduce the incidence of disease;
- Replicate the innovation cycle of systems medicine on a large scale, as both disease care and wellness support are integrated with discovery science.

PAST	PRESENT	FUTURE
Intuition Medicine	Evidence-based Medicine	Precision Medicine
Signs and Symptoms	Clinical Trials	Algorithms

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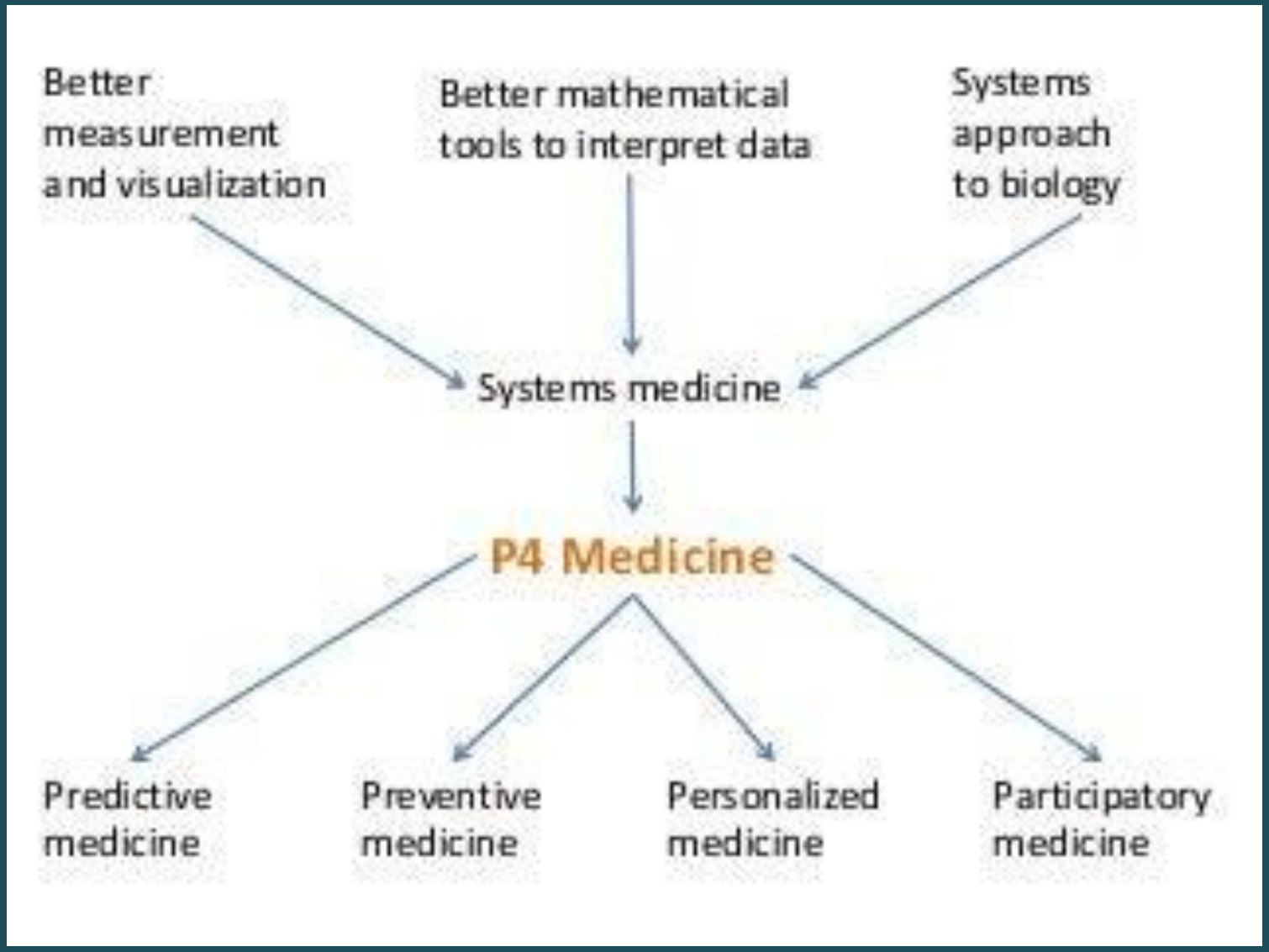

PRESIDENT OBAMA'S **PRECISION MEDICINE INITIATIVE** IS

DEVELOPING BETTER APPROACHES TO PREVENTIVE CARE AND MEDICAL TREATMENTS BY:

- **Helping patients gain access to their health information** so they can collaborate in their own care
- **Considering each individual's specifics**, like genes, environment, and lifestyle
- **Bringing new, effective medical technologies to market faster**
- **Building a research network** of 1 million or more U.S. volunteers

#PrecisionMedicine

wh.gov/PMI

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President Obama participates in a panel discussion moderated by Dr. James Hamblin of The Atlantic on the importance of PMI at the White House, February 25, 2016.

"Doctors have always recognized that every patient is unique, and doctors have always tried to tailor their treatments as best they can to individuals. You can match a blood transfusion to a blood type — that was an important discovery. What if matching a cancer cure to our genetic code was just as easy, just as standard? What if figuring out the right dose of medicine was as simple as taking our temperature?"

- President Obama, January 30, 2015

Information Protection and System Maintenance

1. **Life Cycle.** PMI organizations should implement a system development life cycle, which ensures that appropriate safeguards for PMI data remain in place from receipt or creation through disposition.
2. **Security Patching.** PMI organizations should keep systems updated with the latest security patches and should develop change control and configuration management policies to ensure that system updates are tested, reviewed, and approved prior to implementing.

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PRECISION MEDICINE | INITIATIVE | PRINCIPLES | STORIES

GO TO TOP

Guiding Principles for Protecting Privacy and Building Trust

The White House is unveiling final Privacy and Trust Principles for the Precision Medicine Initiative (PMI). The principles provide broad guidance for future PMI activities regarding: governance; transparency; participant empowerment; respect for participant preferences; data sharing, access, and use; and data quality and integrity. The principles articulate a set of core values and responsible strategies for sustaining public trust and maximizing the benefits of precision medicine.

Read the summaries below or read the whole report here

- Creating a dynamic and inclusive governance structure
- Building trust and accountability through transparency
- Respecting participant preferences
- Empowering participants through access to information.
- Ensuring responsible data sharing, access, and use
- Maintaining data quality and integrity

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P4 MEDICINE SAVING LIVES

Kareem Abdul-Jabbar

Six-time NBA Most Valuable Player, Kareem Abdul-Jabbar was diagnosed with a form of leukemia in 2008. Known to be lethal, leukemia is a cancer of the blood and bone marrow. It caused the basketball great to slow down, fall ill, and worry. A few years later, he credits precision medicine for helping him to be well

William Elder Jr.

William Elder, Jr. was diagnosed with cystic fibrosis (CF) at the age of eight, when the life expectancy for CF patients was very low. Now at 27, Bill is alive thanks to Kalydeco, a treatment of a particular form for his cystic fibrosis and a remarkable drug that treats the underlying cause of his CF, rather than the

Emily Whitehead

At age six, Emily Whitehead was the first pediatric patient to be treated with a new kind of cancer immunotherapy and was cancer free only 28 days later. “If you didn’t know what happened to her, and you saw her now, you would have no idea what she has been through,” says Emily's Mom.

Melanie Nix

Melanie Nix's family has a history of breast cancer — a history that Melanie couldn't escape when she tested positive for the BRCA gene mutations linked to breast cancer in 2008. After 16 rounds of chemotherapy and breast reconstruction surgery, she had to have both ovaries removed to further reduce risks of cancer in the future. But Melanie is now cancer free thanks to precision medicine.

Hugh and Beatrice Rienhoff

Beatrice Rienhoff's eyes were spaced wider than usual, her leg muscles were weak, and she couldn't gain weight. Her father, a trained clinical geneticist, took notice and wanted to help. After six years, he and his team of scientific volunteers identified the cause of her condition.

Genomics for Everyone

Preparing you for the revolution in healthcare

Thank you

Prepared & Presented by

Ph.D. Candidate

Sahar M. Shakir