台灣健康產業發展方向

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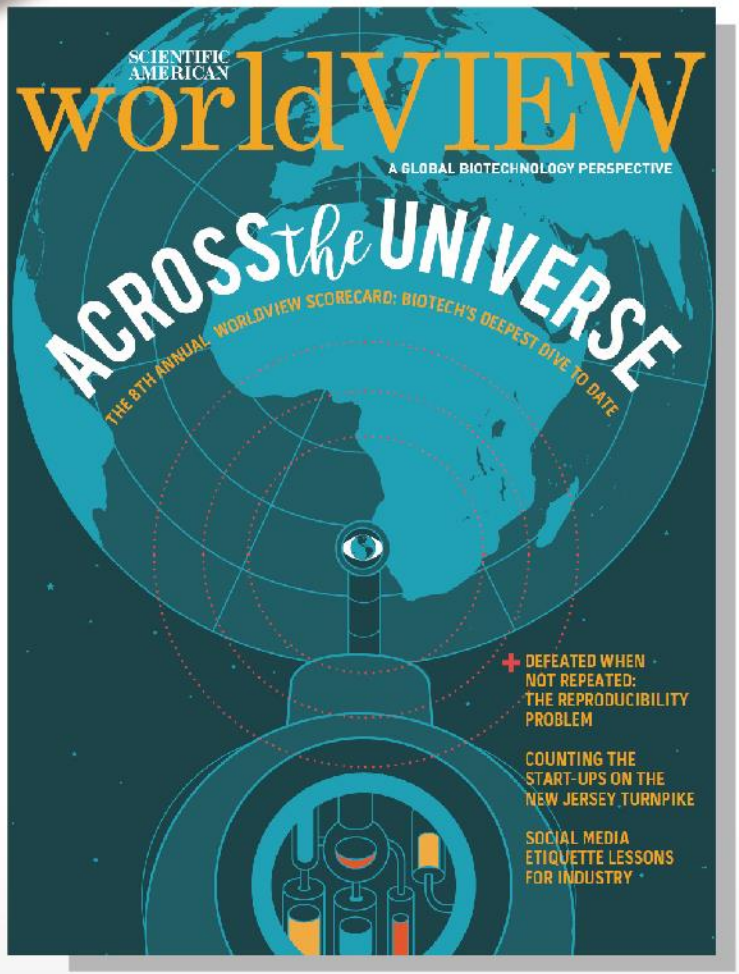
March 13, 2018

Strength of Taiwan in Biotech Development

- **Representative Population** in East Asia
- Excellent **Health Care System,** National Health Insurance: **≥ 99%**
- Strong **R&D Activities** and **Manufacturing Capabilities** in Computer Sci., Electric Engineering, Clinical Medicine, *etc.*
- **Government's Investment** and **Support**
- **Integrated** Government-Industry-Academia-Hospital, **Transparent Regulatory Environment**
- **Center of Excellence for Clinical Trials** in East Asia
  Pfizer, GSK, BI, MSD, Novartis, Eli Lilly, Roche, AZ, Bayer, etc.



2016 Scientific American

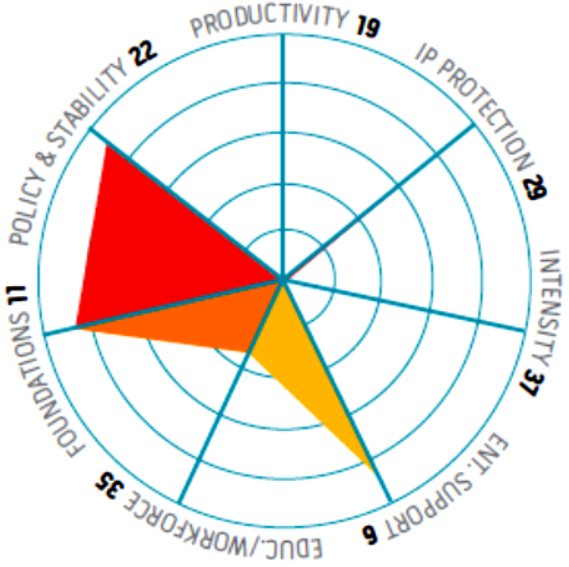
WORLDVIEW SCORECARD

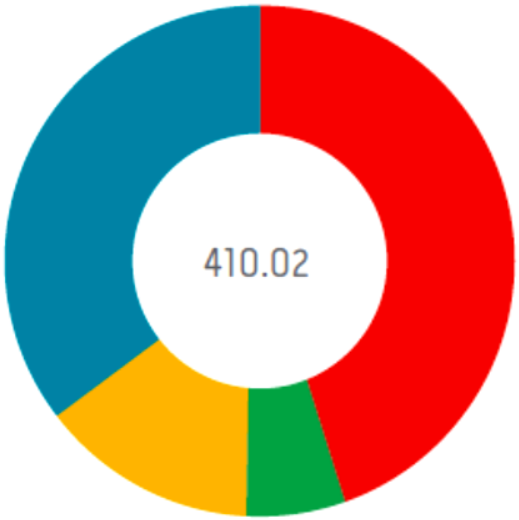
- PRODUCTIVITY
- IP PROTECTION
- INTENSITY
- ENTERPRISE SUPPORT
- EDUCATION/WORKFORCE
- FOUNDATIONS
- POLICY & STABILITY

Enhanced with a new guidebook and region-specific ratings, the 2016 Scorecard ventures deeper than ever to track down the latest in biotech innovation

Taiwan,

SAWV SC rank: 23
Population: 23,359,928
GDP: 489
R&D/GDP: 0





With an overall average of 22.4 on the SC, Taiwan's ranking of 23rd in 2016 is just about on par, and it performs even better on the *Nature Index 2015 Global,* with an 18th place overall ranking and its National Taiwan University landing in the top 100. Moreover, Taiwan advertises its biotechnology capabilities through international events, including BioTaiwan 2016. This will be the 14th annual event, and it will include presentations from companies around the world, as well as one-on-one partnering, seminars and workshops. A large exhibition is also expected, including more than 1,200 booths from 600 companies. On August 20, 2015, *Taiwan Today* reported, "A wide-ranging development plan targeting Taiwan's biotechnology-based economy is set to kick off next year, according to Premier Mao Chi-kuo." The report continued: "Focusing on agriculture, biomedicine, food, health care and medical instruments, the 10 year initiative will potentially expand the scale of the local bioeconomy to NT$4 trillion (US$123.2 billion) in 2026." With respectable scores on the SC's Foundations and Enterprise Support categories, Taiwan's commitment to innovation is clear. Like many other countries, however, Taiwan's Education/Workforce category shows room for improvement.

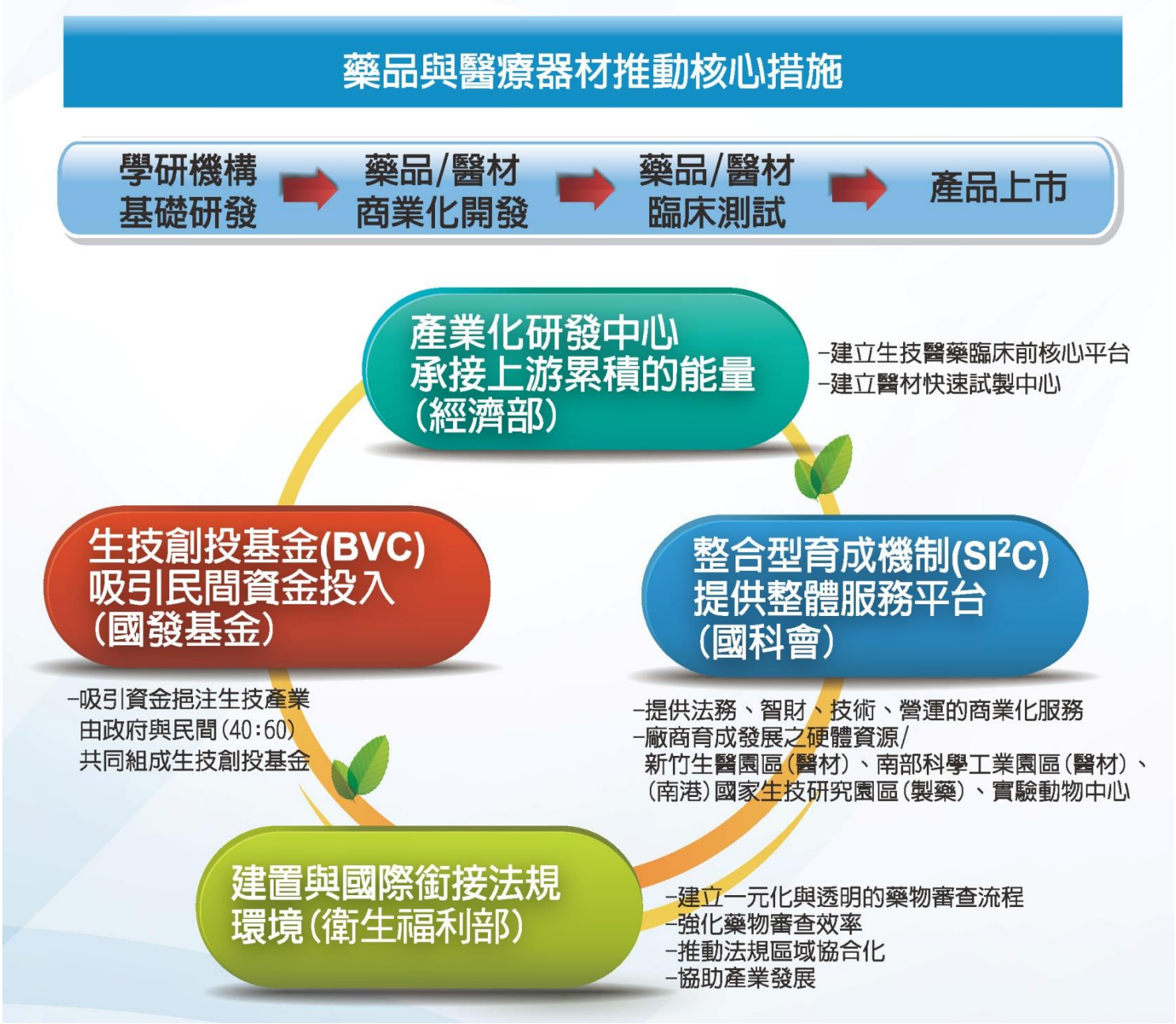
2016 Scientific American Worldview
-A Global Biotechnology Perspective

Asian Countries' Performance

Country	Global Ranking	Productivity	IP Protection	Intensity	Enterprise Support	Education/ Workforce	Foundations	Policy & Stability
Singapore	2	---	8.3	3.8	9.2	4.5	6.6	9.6
Hong Kong	11	0.0	7.1	1.6	8.6	1.6	6.7	9.0
Japan	15	0.1	9.2	0.6	4.5	3.6	7.9	8.0
Taiwan (Score/Rank)	23	0.0/19	5.8/29	0.1/37	7.0/6	2.6/35	6.9/11	7.2/22
South Korea	24	---	5.6	0.6	4.8	3.9	8.3	6.3
Malaysia	27	---	5.5	1.1	8.0	2.1	4.9	5.9
China	41	0.1	4.7	0.6	4.5	1.3	4.0	2.9
Thailand	45	---	2.3	3.0	3.4	2.7	3.0	1.8
India	49	0.0	4.3	0.8	3.5	0.2	1.6	2.0

Source: 2016 Scientific American Worldview

行政院102年~104年臺灣生技產業起飛行動方案



NEWS FEATURE

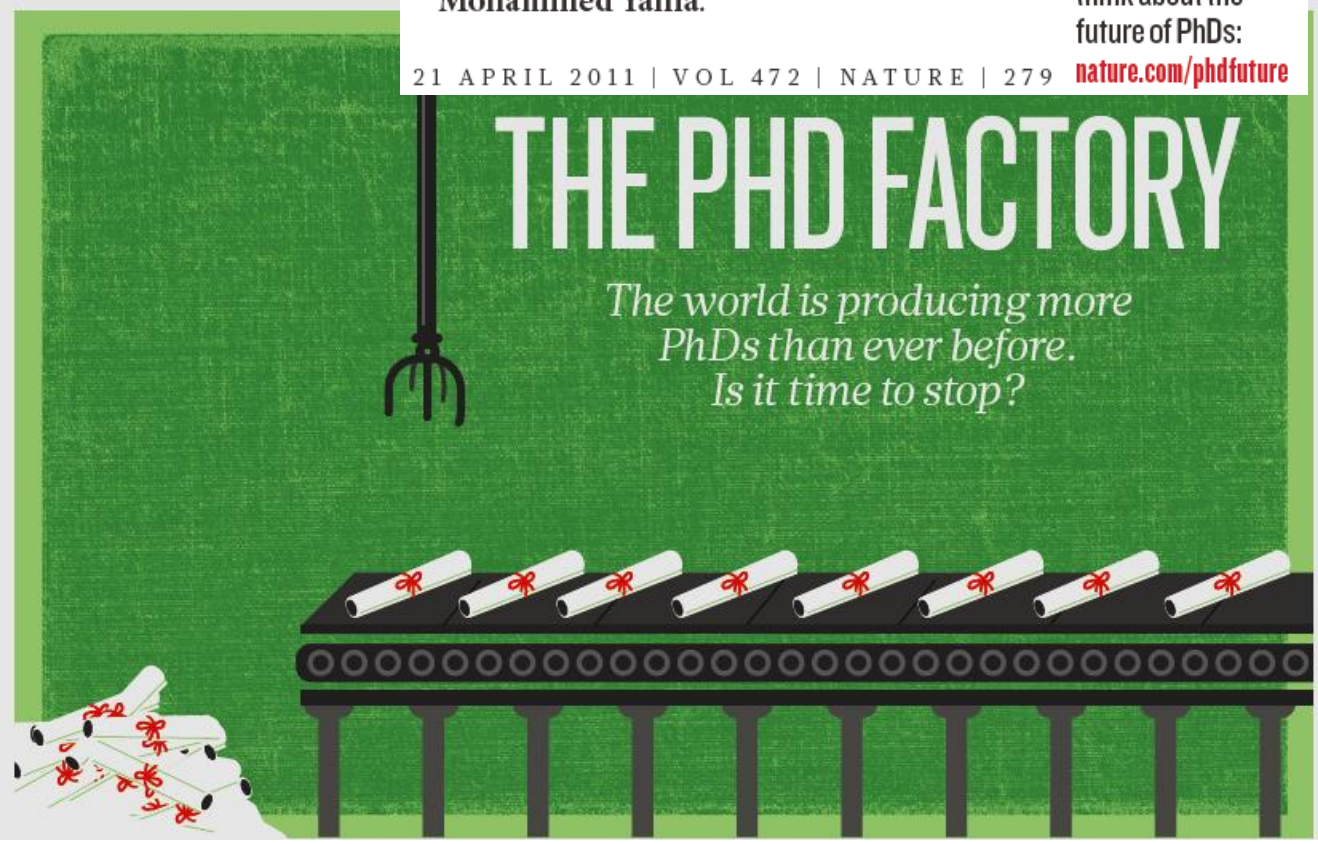
Reporting by **David Cyranoski, Natasha Gilbert, Heidi Ledford, Anjali Nayar** *and* **Mohammed Yahia.**

NATURE.COM
Tell us what you think about the future of PhDs:
nature.com/phdfuture

21 APRIL 2011 | VOL 472 | NATURE | 279

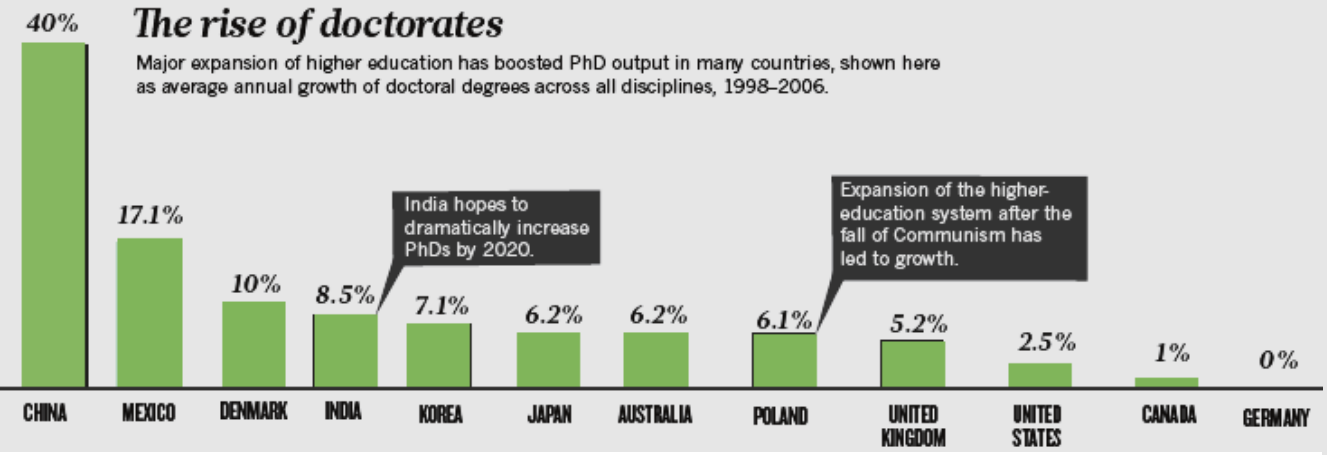
THE PHD FACTORY

The world is producing more PhDs than ever before. Is it time to stop?

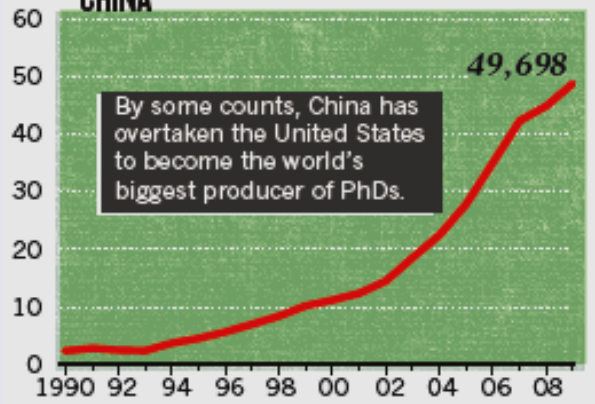


The rise of doctorates

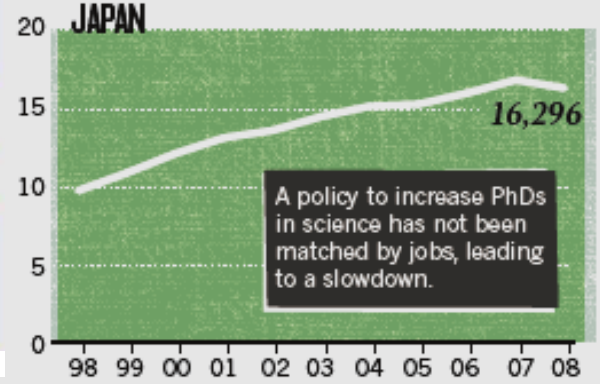
Major expansion of higher education has boosted PhD output in many countries, shown here as average annual growth of doctoral degrees across all disciplines, 1998–2006.



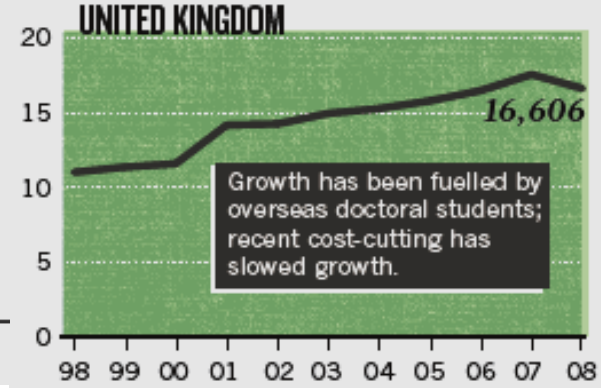
CHINA



JAPAN

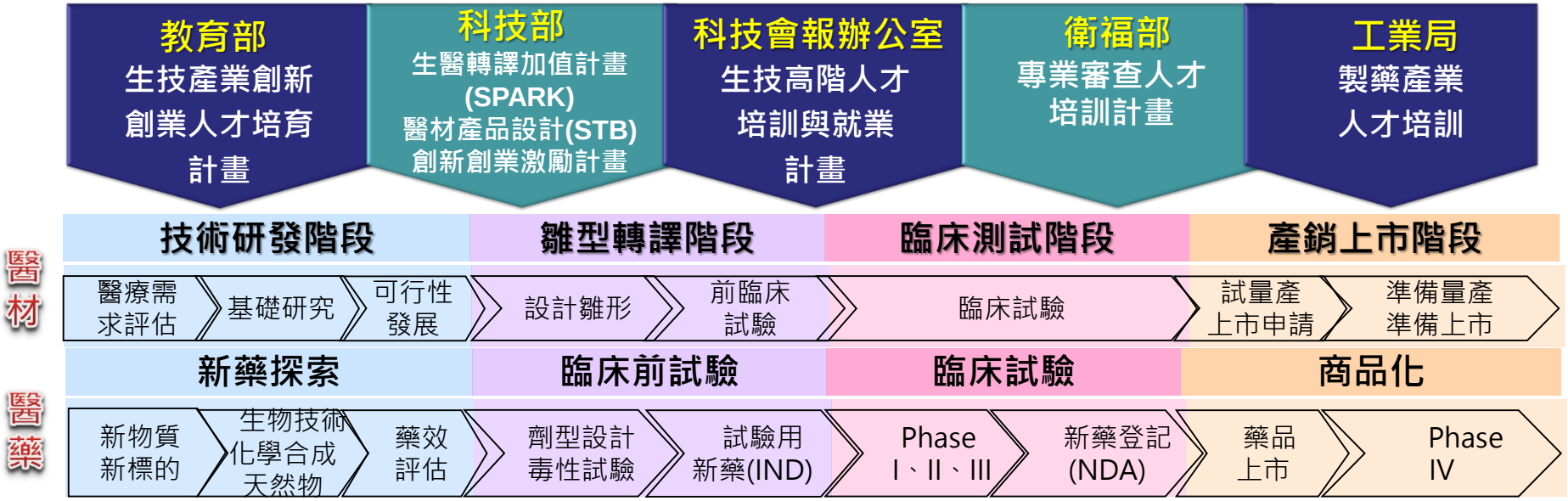


UNITED KINGDOM



Nature 2011

各部會推動生技人才培育綜整



- **從醫材或醫藥研發鏈的上游到下游的產業端，我國現行已有各相關部會的人才培育或培訓計畫。**
- **教育部**:鼓勵各大學校院開設跨領域生技課程，培育以實際應用、符合市場需求與生技創新及創業為核心之生技關鍵技術跨領域創新創業人才。屬建立我國大專院校學生具備生技產業跨領域的mindset。**(人才扎根)**
- **科技部**:透過實際案例(SPARK)或選送人員至國外訓練(STB)或給予創業的第一桶金(創新創業計畫)，導引我國生技人才朝產業應用或創新創業邁進的人才培訓。**(實務培訓)**
- **科技會報辦公室**:提供藥品、醫療器材、醫療管理等在職實戰訓練(on-the-job training)，協助博士級人才赴產業界就業，進而促進生技產業發展。**(銜接業界)**
- **衛福部**:培育藥物專業審查人才，以強化我國核心之審查能量。**(審查員精進)**
- **工業局**:邀請業界具實務經驗專家，辦理人才培訓課程，以培植我國製藥產業專業技術人才，進而提昇我國製藥界人才的水準。**(人才精進)**

SPARK計畫介紹

- 由Si²C規劃推動之SPARK-Taiwan計畫，係以美國生技產業發展聚落的搖籃-史丹福大學為合作對象，接軌**史丹福大學SPARK課程**、培訓模式及顧問專家，進行我國生醫與醫材轉譯加值的人才培訓，給以產品開發鏈上轉譯、醫療法規、智財與談判、行銷與商業規劃等重要訓練課程，並透過受訓學員團隊提出的創新前瞻轉譯加值計畫(以進行proof-of-value or proof of concept為主)，以實際案例進行跨領域人才之培訓。

台灣生技整合育成中心(Si2C)及專家顧問團

新藥/醫療器材

技術開發教練
及專責管理團隊

Real time
monitoring

培訓團隊

培訓大學 (Anchor university)

- Matching Fund (50%)，台大和成大
- 技術開發教練及管理團隊進行專責輔導
- 校內外軟硬體資源整合
- 協助輔導校外培訓團隊

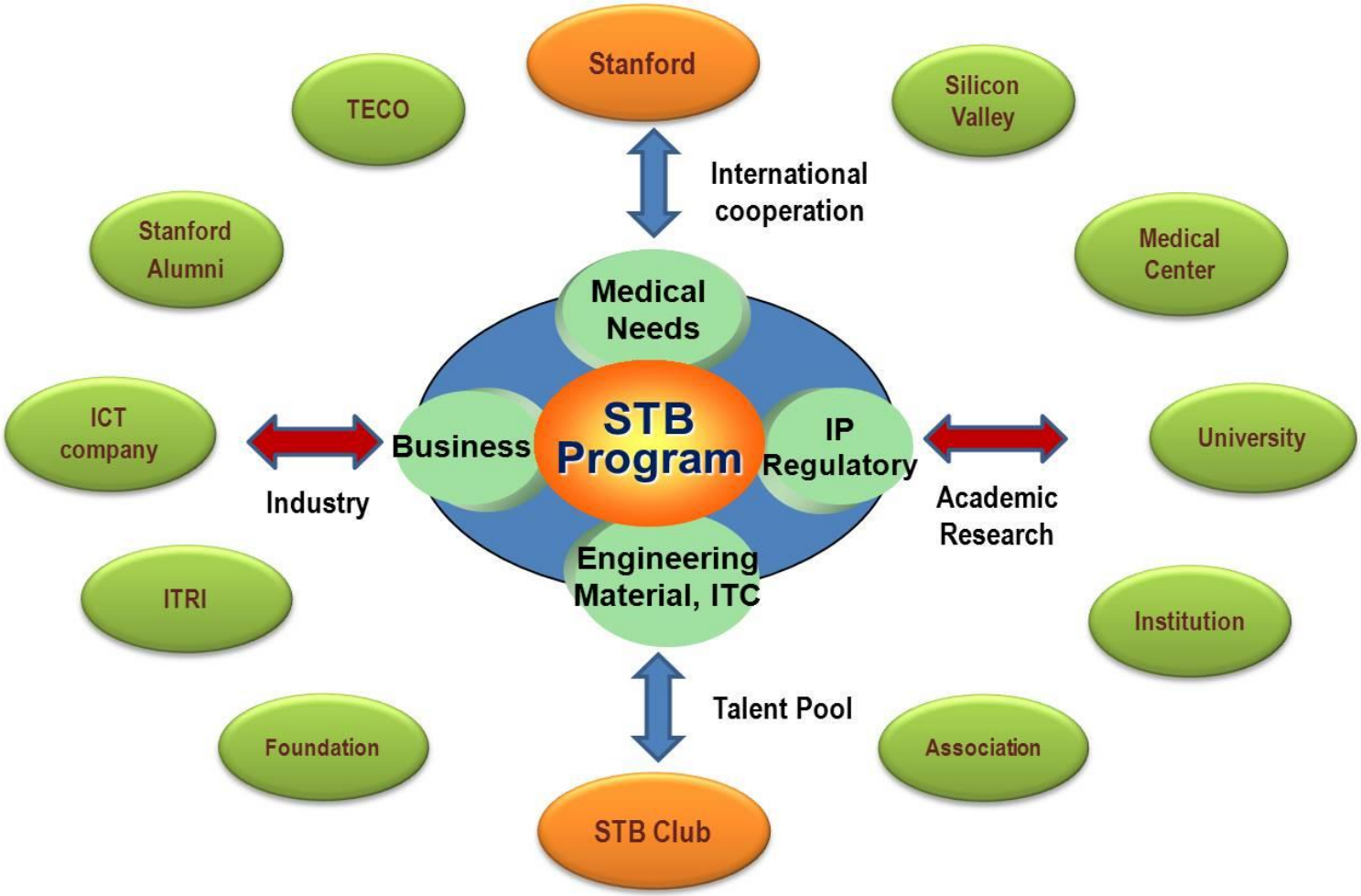
培訓團隊

- 學研成果轉譯加值(進行proof-of-value or proof of concept為主)
- 技術開發教練及管理團隊進行專責輔導
- 校內外軟硬體資源整合

資料來源：科技部

台灣-史丹福醫療器材產品設計人才培訓計畫
STANFORD-TAIWAN BIOMEDICAL FELLOWSHIP PROGRAM, STB

強化與美國史丹福大學合作，利用矽谷成熟之生態系統，培育台灣具創新性高階醫材產品設計及產業化實務能力的「跨領域種子人才」



行政院生技高階人才培訓與就業計畫

◆計畫目標

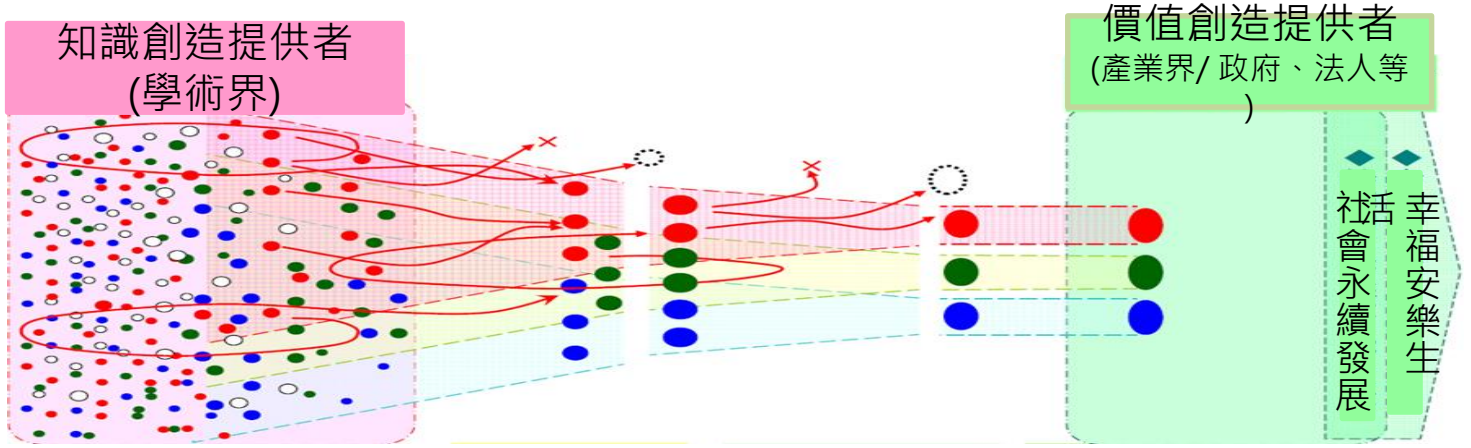
- 加速**藥品**、**醫材**、**醫管服務**的產業化推動，促進產業升級與國際化
- 生技博士到法人/學研機構「再加值」一年，能為業界聘雇或創業，縮短學用落差
- 預計**3年**、投入**3億**元、培訓**300位**符合業界需求之生技高階人才，導引進入業界

◆ 推動機制

- 透過國內重要的法人及學研機構擔任培訓單位，規劃一年期的藥品、醫療器材、醫療管理等在職實務訓練(On-the-job-training)，並提供6個月以上的產業實習機會，以累積博士級生技訓儲菁英的實務經驗和核心技能，橋接到產業就業或創業。

◆預期效益

- 帶動業界晉用博士人才，提升產業**研發能量**，增加國際市場競爭力
- 解決生技產業高階人才**供需失衡**問題，改善生技博士畢業即失業現象
- 從學研界疏導高階生技人才到產業界，創造博士**就業機會**



教育部統計生技相關領域畢業生 450~497人/年
在學博士生 3400~ 3640 人/年

經濟部工業局統計目前產業需求
博士級：140人/ 年

教育部生醫產業與新農業跨領域人才培育計畫

基礎 → 進階 → 轉譯 → 創新創業 → 就業

培育階段　　實作階段

- 生物技術科技教育改進計畫 87-90年
- 生物技術科技教育改進計畫 91-94年
- 生物及醫學科技人才培育先導型計畫 95-98年
- 轉譯醫學及農學人才培育先導型計畫 99-102年
- 生技產業創新創業人才培育計畫 103-106年
- **生醫產業與新農業跨領域人才培育計畫 107年-110年**

橋接學用落差

學校與產業間的合作，可透過法人、園區或地方政府之橋樑鏈結

生醫產業與新農業跨領域人才培育計畫

高階人才投入生醫產業與新農業創業與開發

透過符合產業需求之生醫生農課程、產業見習與實習，導引學生至產業發展

RAISE
Rebuild After PhD's Industrial Skill & Expertise
重點產業高階人才培訓與就業計畫

MOST 科技部
Ministry of Science and Technology

一、背景說明

政策依據

依據「前瞻基礎建設特別條例」之推動項目「人才培育促進就業之建設」辦理

國內現況

2015年科技部全國科技動態調查發現，博士級人才僅18%投入產業，過度集中於學界和政府部門(佔81%)

推動理念

透過法人及大學機構擔任培訓單位，提供博士級產業訓儲菁英1年期在職實務訓練(企業實習6個月以上)，媒合至產業就業或創業

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重點產業高階人才培訓與就業計畫

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Ministry of Science and Technology

二、計畫目標

計畫目標

- 110年累計至少培訓 1,000 名博士級產業訓儲菁英，進入300家企業實習機會，並媒合至少2/3就業成功或創業。

績效指標

	第一期 (106-107年)	第二期 (108年)	第三期 (109-110年)
培育博士級產業訓儲菁英	330名	330名	340名
企業實習	100家	100家	100家

預期效益

- 培訓符合產業所需高階人才，開創博士多元就業/創業管道。
- 藉由博士級產業訓儲菁英將法人及學研機構長期累積的研發成果，擴散至下游廠商應用發展，進而激勵產業創新。

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重點產業高階人才培訓與就業計畫

MOST 科技部
Ministry of Science and Technology

三、計畫架構

- 國內法人與大學擔任培訓單位
- 鏈結合作廠商提供至少6個月以上企業實習
- 完成1年期在職實務訓練後，媒合就業/創業
- 培訓期間科技部補助每人每月6萬元培訓酬金

連結法人/大學/企業能量 → 參與實務訓練 → 媒合就業創業


Core Concepts in Promotion HealthCare Management Services
Bring the World to Taiwan (Health Tourism)
EMR (Electronic Medical Record)
Cross-disciplinary Cooperation and Turn-key Exports
Big Healthcare Data Utilization
HealthCare Management Service Industry
Telecare
Other Products for Development
Branding Taiwan
Bring Taiwan to the World (HealthCare Management Service Exports)

2017 Taiwan Healthcare+ Expo
台灣醫療科技展

2017.12.07 (四) – 12.10 (日) 台北南港展覽館

前瞻醫療新技術研討會

12/7 細胞治療與幹細胞應用

12/8 精準醫療

12/8 3D列印

12/9 智慧化醫療照護

特邀國際知名演講嘉賓

- MD Andersen Cancer Center
- Mayo Clinic
- Bristol-Myers Squibb
- National University of Singapore
- Shanghai Jiao Tong University
- Beijing Tsinghua University

了解更多


Taiwan 競強!
Link the World Together with Taiwan Healthcare
2017台灣醫療科技展
Connecting,
Partnering,
and More!
Taiwan Healthcare
Expo
11.29 – 12.02 2018


Taiwan Healthcare Expo
2017 台灣醫療科技展
12/7-10
南港展覽館


Taiwan Healthcare Expo
2017 台灣醫療科技展
12/7-10
南港展覽館

Taiwan Healthcare + A Portal Leads to World-Class Medical Teams and Excellent Bio Companies in Taiwan

Medical for All

Taiwan Healthcare

Ex.

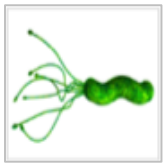
- Joint Replacement
- Artificial Reproduction
- (Living) Liver Transplantation
- Craniofacial and Microtia Surgery

Taiwan Clinical Trial Consortium (TCTC)

Disease-specific consortia involving multiple hospitals

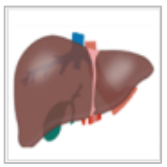
肺癌臨床試驗聯盟

Lung Cancer Consortium



胃腸疾病與幽門桿菌合作聯盟

Gastrointestinal Disease And Helicobacter Consortium



肝炎及肝癌臨床試驗聯盟

LiverNet Consortium

乳癌臨床試驗合作聯盟

Breast Cancer Consortium

高血壓相關疾病聯盟

Hypertension Associated Cardiac Disease Consortium

慢性阻塞性肺病聯盟

COPD Consortium

婦科癌症研究聯盟

GYN Oncology Group

血脂和動脈粥樣硬化聯盟

Lipid and Atherosclerosis Consortium

精神疾病臨床試驗聯盟

Mental Disorders Consortium

癌症早期臨床試驗聯盟

Oncology Phase I Consortium

小兒感染症聯盟

Pediatric Infectious Diseases Alliance

成人感染症臨床試驗聯盟

Adult Infectious Diseases

中風臨床試驗聯盟

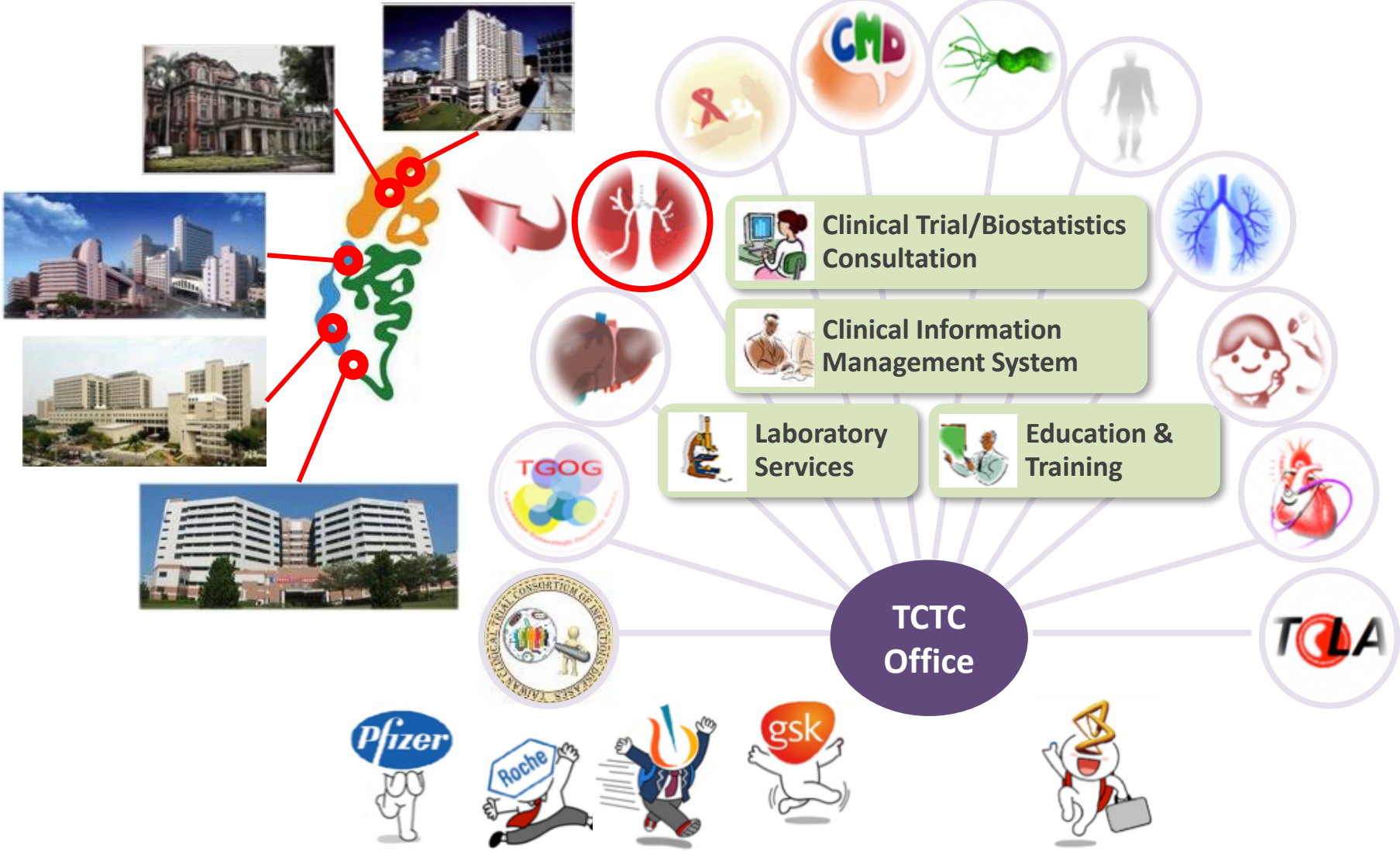
Stroke

腎臟疾病臨床試驗聯盟

Acute Kidney Injury & Renal Diseases

Taiwan Clinical Trial Consortium (TCTC): http://tc2.ntu.edu.tw/

One-stop shop for your clinical trials



Taiwan as an Asian partner for UK-/Swiss based giant pharma

The China Post

TAIWAN

GlaxoSmithKline

Wednesday, May 8, 2013 Photo 1 of 1011

GSK pharmaceutical partnership to help patients 'do more, feel better, live longer'

Officials from the National Research Program of Biopharmaceuticals (NRPB) and GlaxoSmithKline (GSK) pose in Taipei yesterday. They are, from left, Andrew H.J. Wang, co-director of the NRPB; Dr. Pan-Chyr Yang, director of the NRPB; Dr. Emilio Ledesma, vice president of GSK Vaccines Asia Pacific; and Thomas Willemsen, general manager of GSK Taiwan.

NOVARTIS

NRPB is to collaborate with Novartis on Translational Medicine.

Ongoing discussion for collaboration on open innovation with several big Pharmas, incl. Roche, Medimmmune, JPMA (Japan Pharmaceutical Manufacturing Association) and others

Includes over 20 intra-hospital clinical research projects, ranging from vaccine, rare diseases, NSCLC therapeutics, TB, quadrivalent influenza

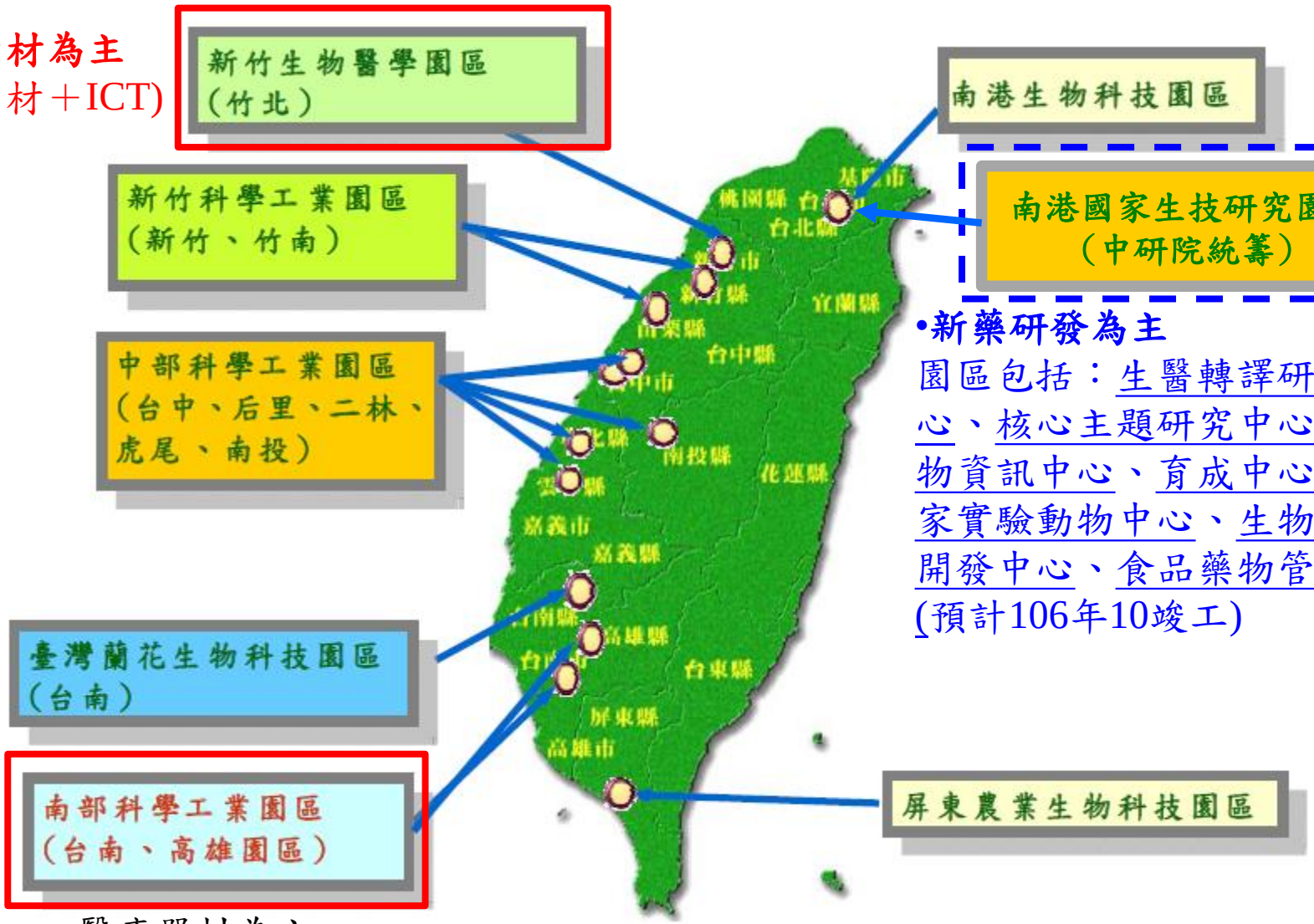
生醫產業推動方案

藥品醫材選題與整合資源、推動技術產業化及創新育成、
結合在地產業與廊帶串聯，進行南向及國際拓銷

良好選題機制、有效資源整合、積極招商引資

創造友善法規環境、發展前瞻技術智財、培育跨域高階人才

生技聚落規劃


•醫療器材為主
(醫療器材＋ICT)
新竹生物醫學園區
(竹北)
新竹科學工業園區
(新竹、竹南)
中部科學工業園區
(台中、后里、二林、
虎尾、南投)
臺灣蘭花生物科技園區
(台南)
南部科學工業園區
(台南、高雄園區)
•醫療器材為主
(骨科、牙科材料)
南港生物科技園區
南港國家生技研究園區
(中研院統籌)
•新藥研發為主
園區包括：生醫轉譯研究中心、核心主題研究中心、生物資訊中心、育成中心、國家實驗動物中心、生物技術開發中心、食品藥物管理局
(預計106年10竣工)
屏東農業生物科技園區
桃園縣
台北縣
宜蘭縣
台中縣
南投縣
花蓮縣
嘉義市
嘉義縣
高雄縣
台東縣
屏東縣
高雄市

台灣生技產業園區概況

- 新竹科學園區
- 竹北生醫園區

59家生技公司

重點領域：

醫療設備，體外檢測，生物製劑製造

- 中部科學園區

33家生技公司

重點領域：

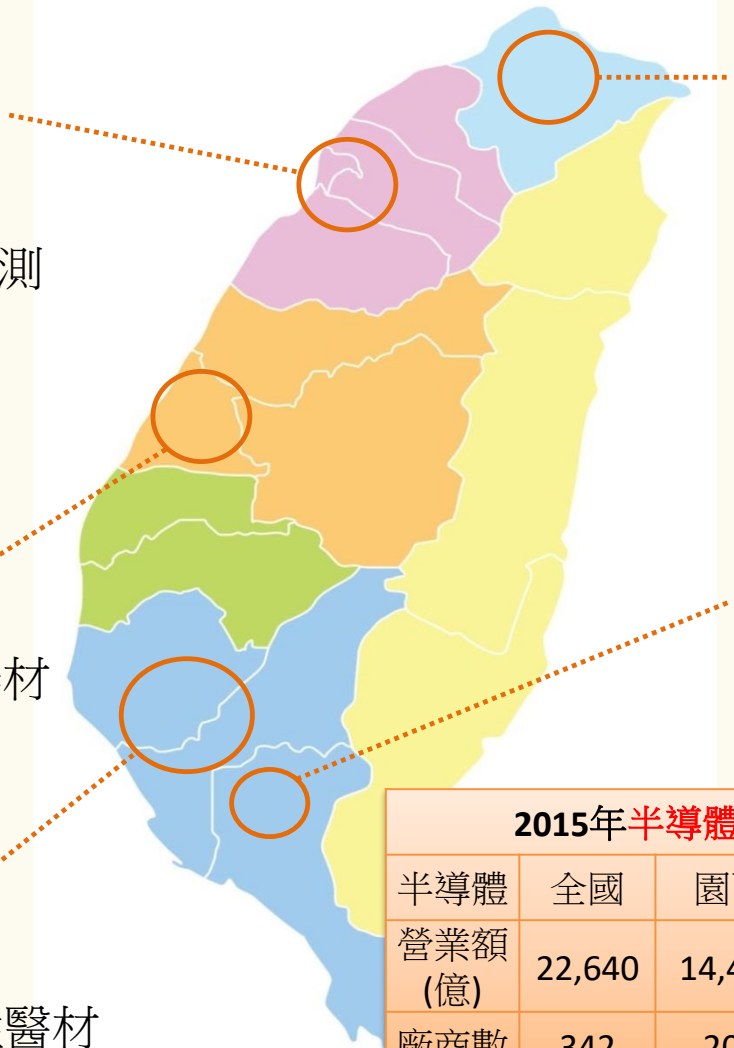
藥物製造，醫療器材

- 南部科學園區

61家生技公司

重點領域：

原料藥，植入物性醫材，微創手術器械



- 南港國家生技研究園區
- 南港生技園區
- 台北內湖科技園區
- 新北產業園區

178家生技公司

重點領域：

新藥及新醫療器材研發

- 屏東農業生技園區

99家生技公司

重點領域：

功能性食品，現代中藥，動物疫苗，動物育種

2015年半導體產業				2015年生技產業			
半導體	全國	園區	佔比	生技產業	全國	園區	佔比
營業額(億)	22,640	14,472	64%	營業額(億)	2,986	191	6%
廠商數	342	206	60%	廠商數	1,871	153	8%

園區生技產業廠商104年營業額191億元，較96年65億元，成長**196%**。

圖檔來源http://ak.takes.ntpc.edu.tw/teach/100/4%E4%B8%8A-Writer/%E7%AF%84%E4%BE%8B/%E5%9C%96%E5%BA%AB/07-%E5%8F%B0%E7%81%A3%E5%9C%B0%E5%9C%96.jpg

新竹生物醫學園區
Hsinchu Biomedical Science Park (HBSP)

(新竹生醫園區鳥瞰圖)

HBSP Hospital

2020

Biomedical R&D Centers
Incubation Center

第二生技大樓

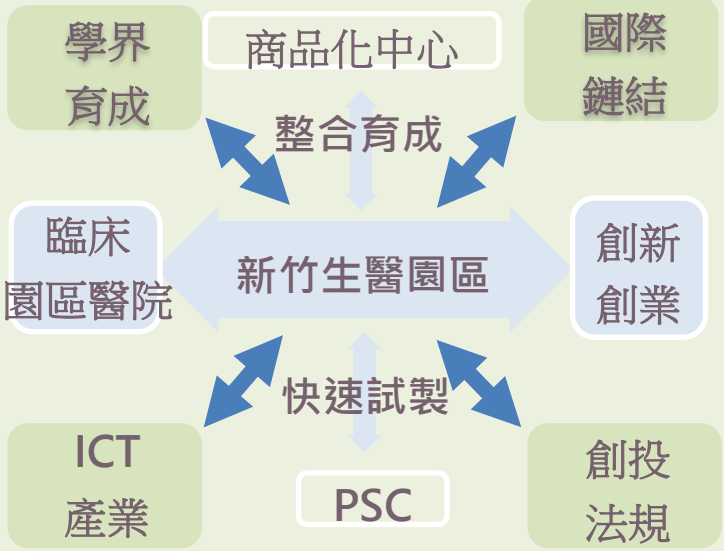
Biotech Building

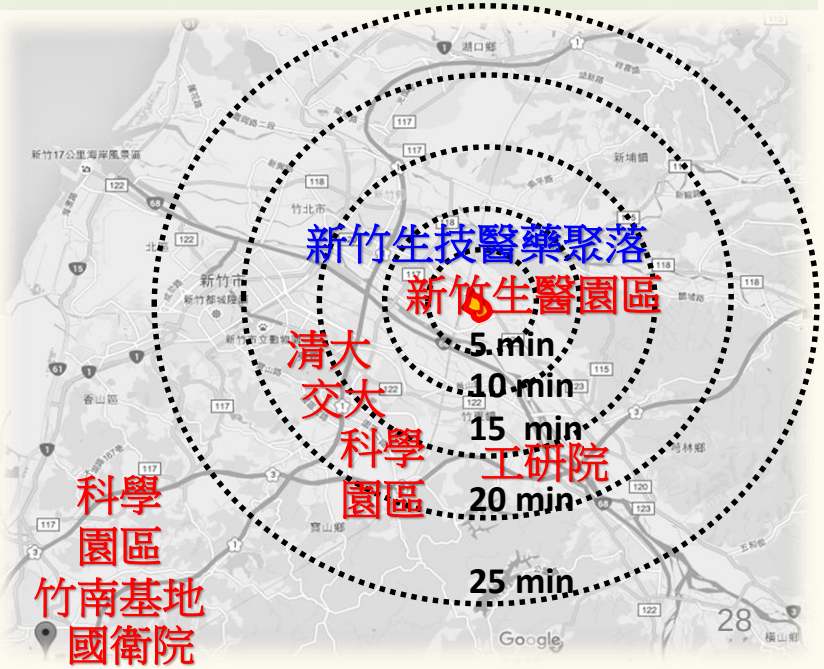
- 園區之規劃用地共約38.1公頃
- 資通訊、生技、醫療跨領域創新技術價值與產業化平台
- 扮演生物醫學產業化與臨床試驗重鎮的角色

新竹生技醫藥聚落

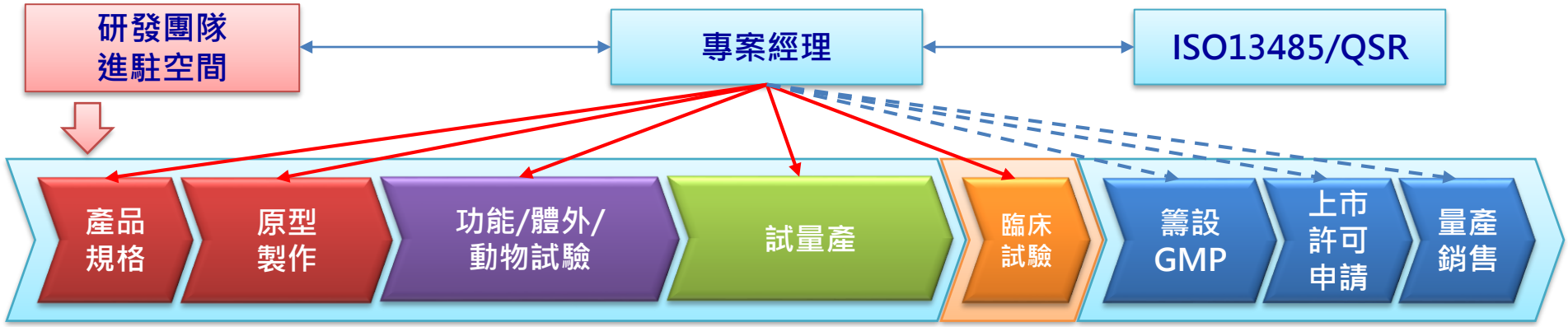
策略：建構以新竹生醫園區為核心，結合學研及產業之創新醫材聚落

措施：
- 建置台大竹北園區醫院：整合臨床需求、產品開發與臨床試驗
- 設置醫材商品化中心：整合資源，招商引資，加速BIO/ICT產業發展
- 建置快速試製服務平台：商品化輔導育成，依循ISO13485快速推出產品
- 引入TFDA/CDE進駐諮詢，建立快速審查: 引導創新產品法規驗證與整備
- 遴選國際醫材團隊進駐：提升國內醫材產業視野，鏈結國際醫材產業





醫材開發流程圖



共通核心實驗室

生醫光電實驗室
系統構裝實驗室
生醫晶片實驗室

藥物傳輸實驗室
體外診斷實驗室
生醫材料實驗室

產品檢測驗證

物理特性驗證
電性相容驗證
生物相容驗證

臨床前測試實驗室

GMP/GTP實驗室

-生醫光電影像
-生醫元件晶片
-生醫光電影像
-體外診斷醫材
-生醫材料

臨床研究

新創公司

產品移轉

技術移轉

BP

TFDA, CFDA, CE, FDA

軟體服務平台（DHF/DHR/DMR/EP/STED）

專利檢索、分析、佈局

醫材法規

機構繪圖、BOM

設計文件管制系統

一站式服務能量(醫材加速器)

- 生醫影像實驗室(MRI/CT/US/C-ARM)
- 積層製造實驗室(3D列印/金屬/高分子)
- 生醫晶片實驗室(表面修飾、晶片封裝)
- 體外診斷實驗室(生物試劑、系統驗證)

- 電性安規驗證(IEC60601/IEC61010)
- 生物相容性驗證(ISO10993)
- 物理特性驗證(ASTM/TAF3291)
- 臨床前試驗(IACUC/AAALAC)

- 品質系統(ISO13485/QSR/DMR/DHF)
- 軟體確校(ISO62304)
- 風險確校(ISO14971)
- 專利、法規、繪圖

檢測驗證實驗室

- 醫材產品規格設計
  -提供正確之驗證程序、驗證數據
- 第三方建置聯合實驗室

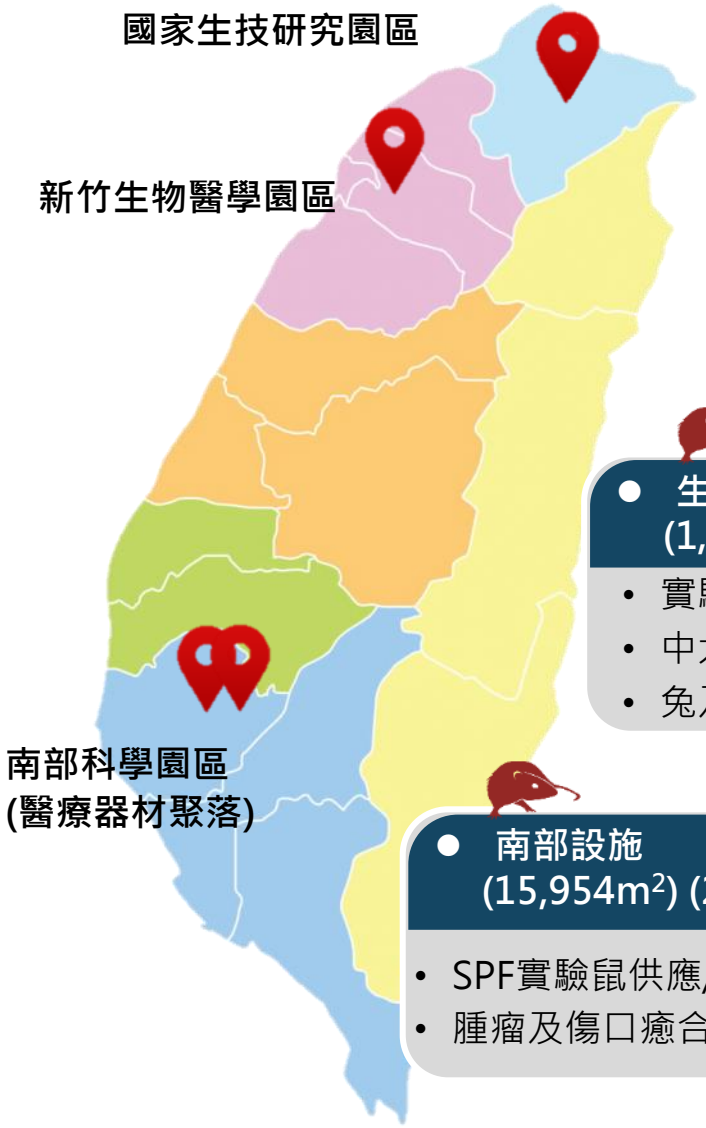
TAF
Testing Laboratory
3291

滅菌實驗室(竹北)

AST 台灣艾思特 科技股份有限公司
ADVANCED STERILIZATION TECHNOLOGY

CBC 中國生化科技股份有限公司
CHINA BIOTECH CORPORATION

國家動物中心服務據點



- **台北中心 (總部)**
  (25,200 m²) (2017)
  - SPF實驗動物供應/ 種原庫主庫
  - 品管及診斷實驗室
  - 疾病模式及藥品功效試驗（免疫、腫瘤、神經退化性疾病、代謝）

- **生醫臨床前測試實驗室**
  (1,000m²) (2016)
  - 實驗豬手術平台（心血管、肝腎、腦）
  - 中大動物腫瘤模式
  - 兔及天竺鼠之生物相容性試驗

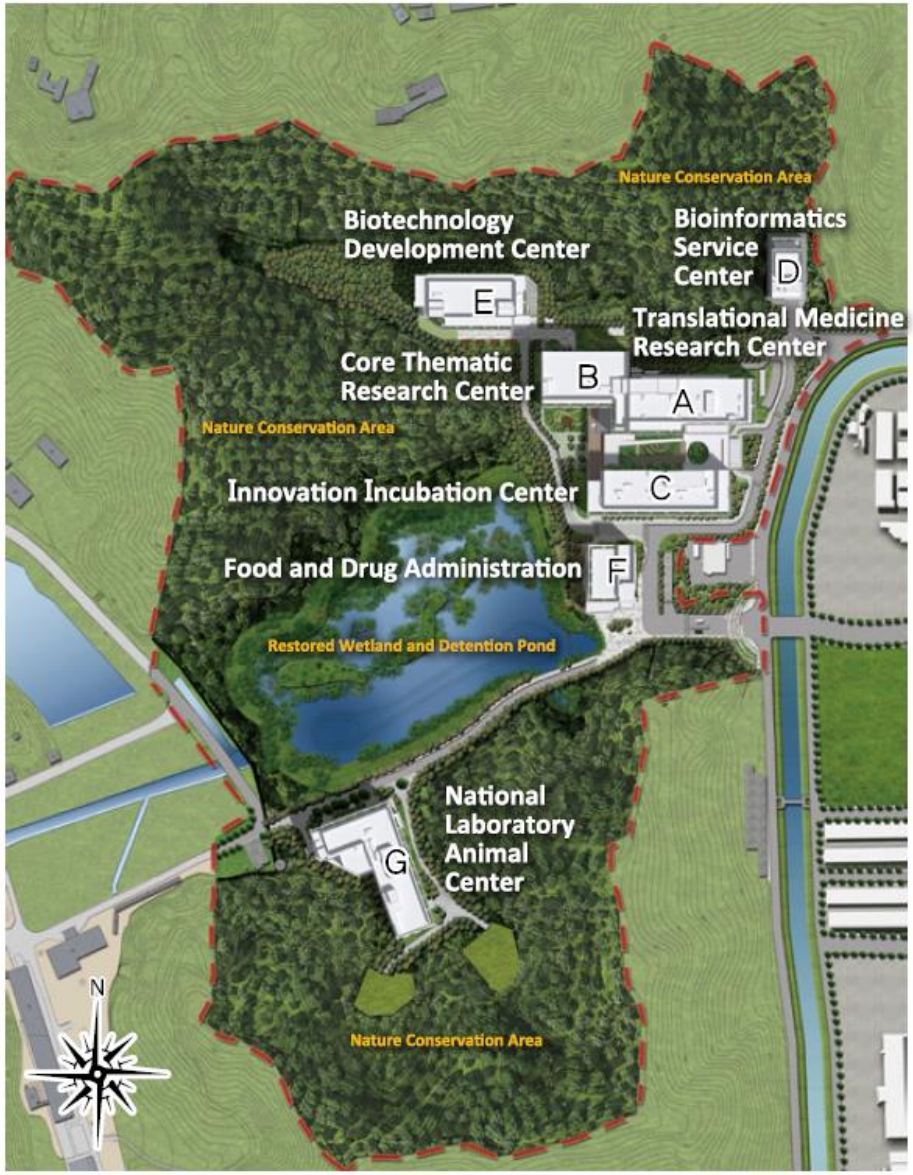
- **南部設施**
  (15,954m²) (2008)
  - SPF實驗鼠供應/ 種原庫分庫
  - 腫瘤及傷口癒合試驗

- **臨床前手術及照護設施**
  (1,000m²) (2015)
  - 骨科、齒科植入試驗（實驗兔、犬、豬）
  - 實驗豬傷口癒合及敷料試驗
  - 內視鏡教學及設備驗證

台北南港·國際級生技產業廊帶

資料來源: 台北生技電子報第三期

國家生技研究園區是以研發為主的國家型研究 研究中心及生物資訊中心，以利將基礎研究銜接至動物及臨床試驗階段；另設置育成中心便於讓進駐廠商育成早期研發成果。此外與園區研發密切相關的國家實驗動物中心(NLAC)、生物技術開發中心(DCB)、衛生福利部食品藥物管理署(TFDA)、台灣生技整合育成中心(Si2C)、生策會及生策研究中心等亦將共同進駐，提供生技醫藥產業由新藥探索階段至臨床試驗階段所需的相關資源。



台北南港·國際級生技產業廊帶

臺北市生技產業聚落計畫

補足國家生技研究園區在生技產業發展價值鏈臨床試驗「臨床試驗」階段之缺口，整合南港忠孝營區(原址)暨西側市有地、僑泰興麵粉廠工業區都市計畫變更回饋土地、南港轉運站東側第三種商業區(特)等可利用基地，發展生技產業聚落中心。忠孝營區基地已提供生技企業臨床試驗研發實驗室(wet lab)，小型試量產工廠(pilot plant)為主；僑泰麵粉廠及商三特等2基地，則規劃提供生技企業暨其他支援性服務產業之辦公空間(dry lab)使用。

南港可成為台灣生技產業驅動核心
預計提供7000名就業人口
帶動生技產業產值500億元/年

資料來源: 台北生技電子報第三期

南港新藥研發聚落-綜合規劃

統合園區、大學、醫學中心、臨床試驗聯盟(TCTC)形成區域生態系

基礎研究 中研院	新藥探索 臨床前開發 國家生技研究園區	新藥查驗 (IND) 衛福部食藥署	臨床前試驗 及試量產 忠孝營區	新藥核准 上市(NDA) 衛福部食藥署	產品上市 行銷 南軟內湖竹北園區

Toward Precision Medicine:

Building a Knowledge Network for Biomedical Research and a New Taxonomy of Disease

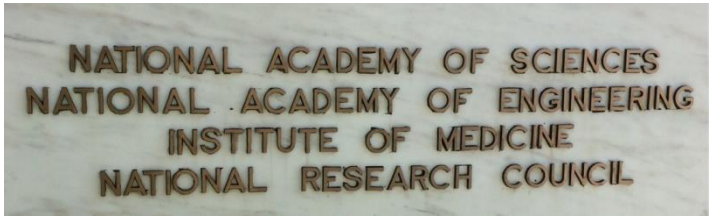
2011

Committee on A Framework for Developing a New Taxonomy of Disease

Board on Life Sciences

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES



REPORT TO THE PRESIDENT

BIG DATA AND PRIVACY: A TECHNOLOGICAL PERSPECTIVE

John P. Holdren
Assistant to the President for
Science and Technology
Director, Office of Science and Technology
Policy

2.2.1 Healthcare: personalized medicine

Not all patients who have a particular disease are alike, nor do they respond identically to treatment. Researchers will soon be able to draw on millions of health records (including analog data such as scans in addition to digital data), vast amounts of genomic information, extensive data on successful and unsuccessful clinical trials, hospital records, and so forth. In some cases they will be able to discern that among the diverse manifestations of the disease, a subset of the patients have a collection of traits that together form a variant that responds to a particular treatment regime.

2.2.2 Healthcare: detection of symptoms by mobile devices

Many baby boomers wonder how they might detect Alzheimer's disease in themselves. What would be better to observe their behavior than the mobile device that connects them to a personal assistant in the cloud (e.g., Siri or OK Google), helps them navigate, reminds them what words mean, remembers to do things, recalls conversations, measures gait, and otherwise is in a position to detect gradual declines on traditional and novel medical indicators that might be imperceptible even to their spouses?

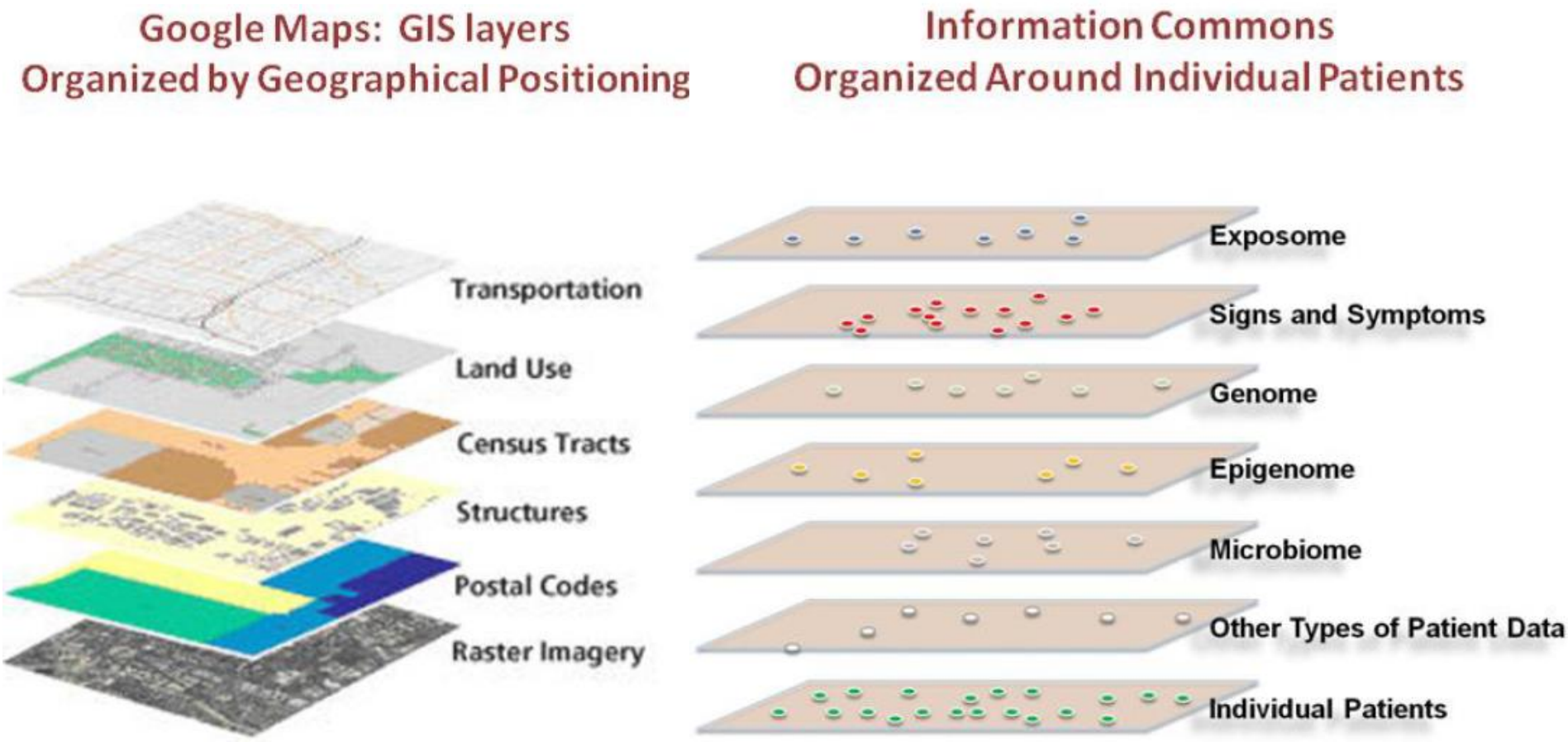


Figure 1-2: The proposed, individual-centric Information Commons (right panel) is somewhat analogous to a layered Geographical Information System (left panel). In both cases, the bottom layer defines the organization of all the overlays. However, in a GIS, any vertical line through the layers connects related snippets of information since all the layers are organized by geographical position. In contrast, data in each of the higher layers of the Information Commons will overlay on the patient layer in complex ways (e.g., patients with similar microbiomes and symptoms may have very different genome sequences). Source: FPA 2011 (left panel).

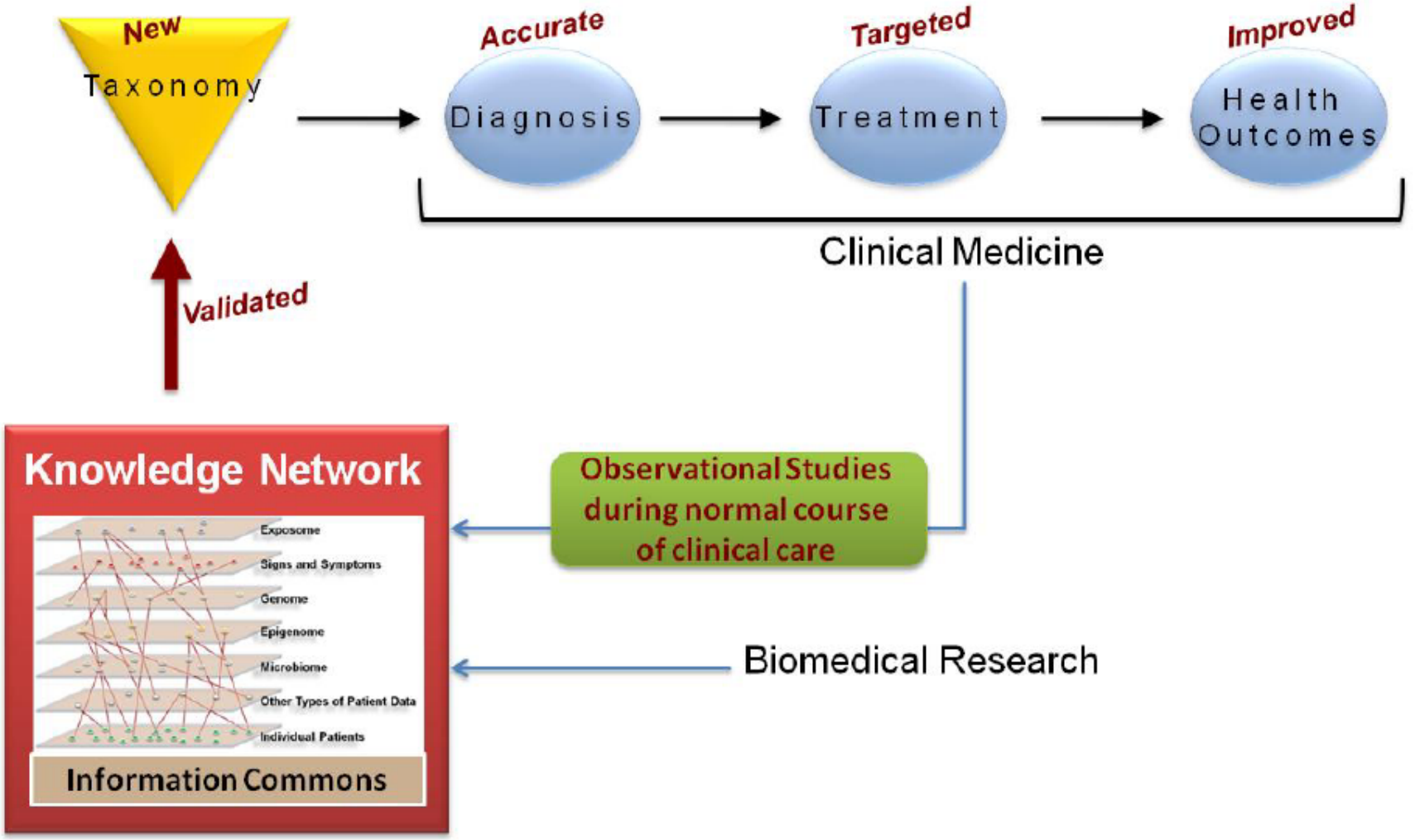


Figure 1-3: An individual-centric Information Commons, in combination with all extant biological knowledge, will inform a Knowledge Network of Disease, which will capture the exceedingly complex causal influences and pathogenic mechanisms that determine an individual's health. The Knowledge Network of Disease would allow researchers hypothesize new intralayer cluster and interlayer connections. Validated findings that emerge from the Knowledge Network, such as those which define new diseases or subtypes of diseases that are clinically relevant (e.g., which have implications for patient prognosis or therapy) would be incorporated into the New Taxonomy to improve diagnosis and treatment.

Biology Has Become a Data-Intensive Science

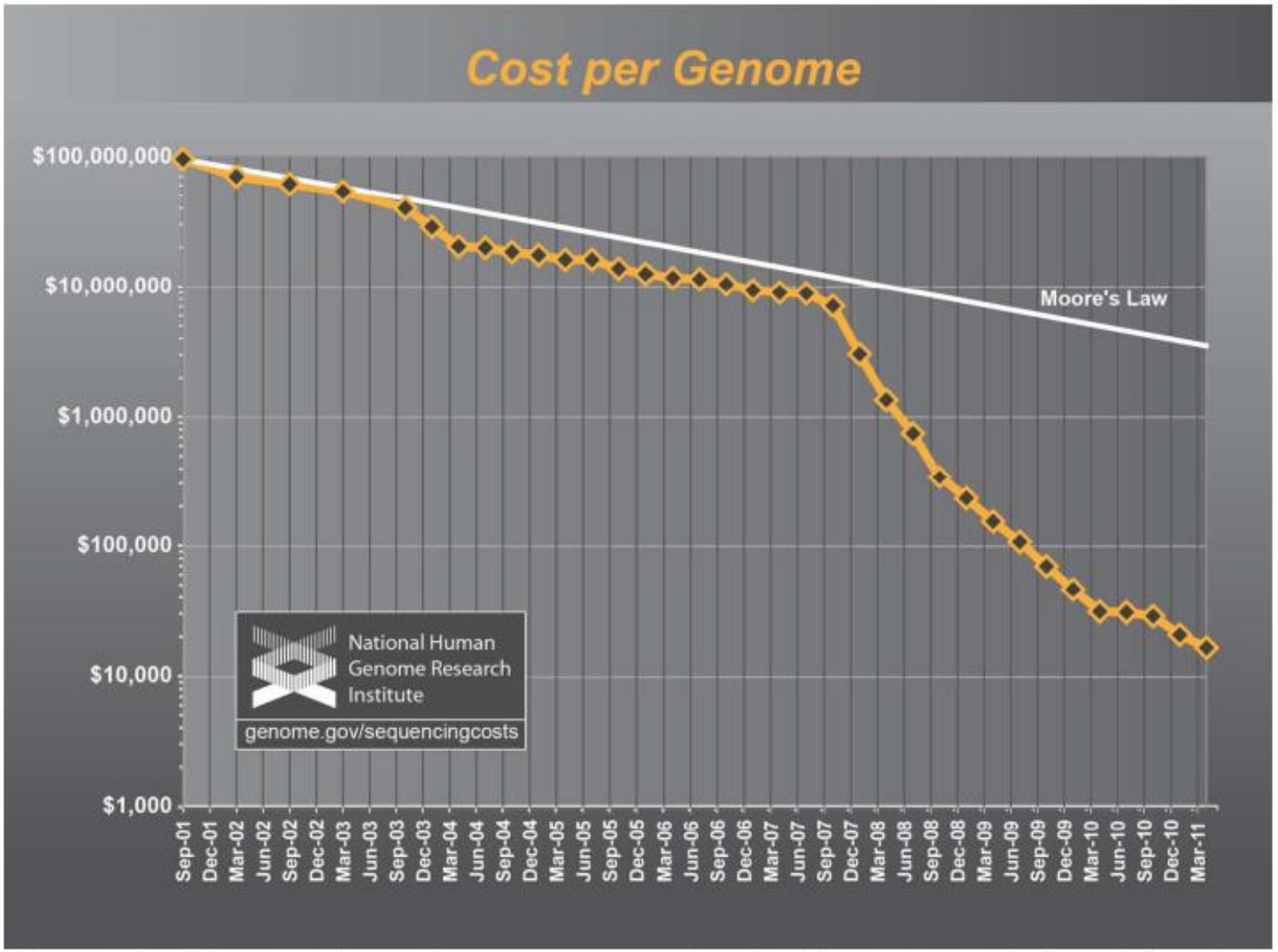


Figure 2-1: The cost of complete genome sequencing is falling faster than Moore's Law. The cost is still dropping rapidly, with a "$1000 genome" becoming a realistic target within a few years. Source: Wetterstrand 2011.

Cancer Research: Lung Cancer

at NTU Center of Genomic Medicine

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 4, 2007 VOL. 356 NO. 1

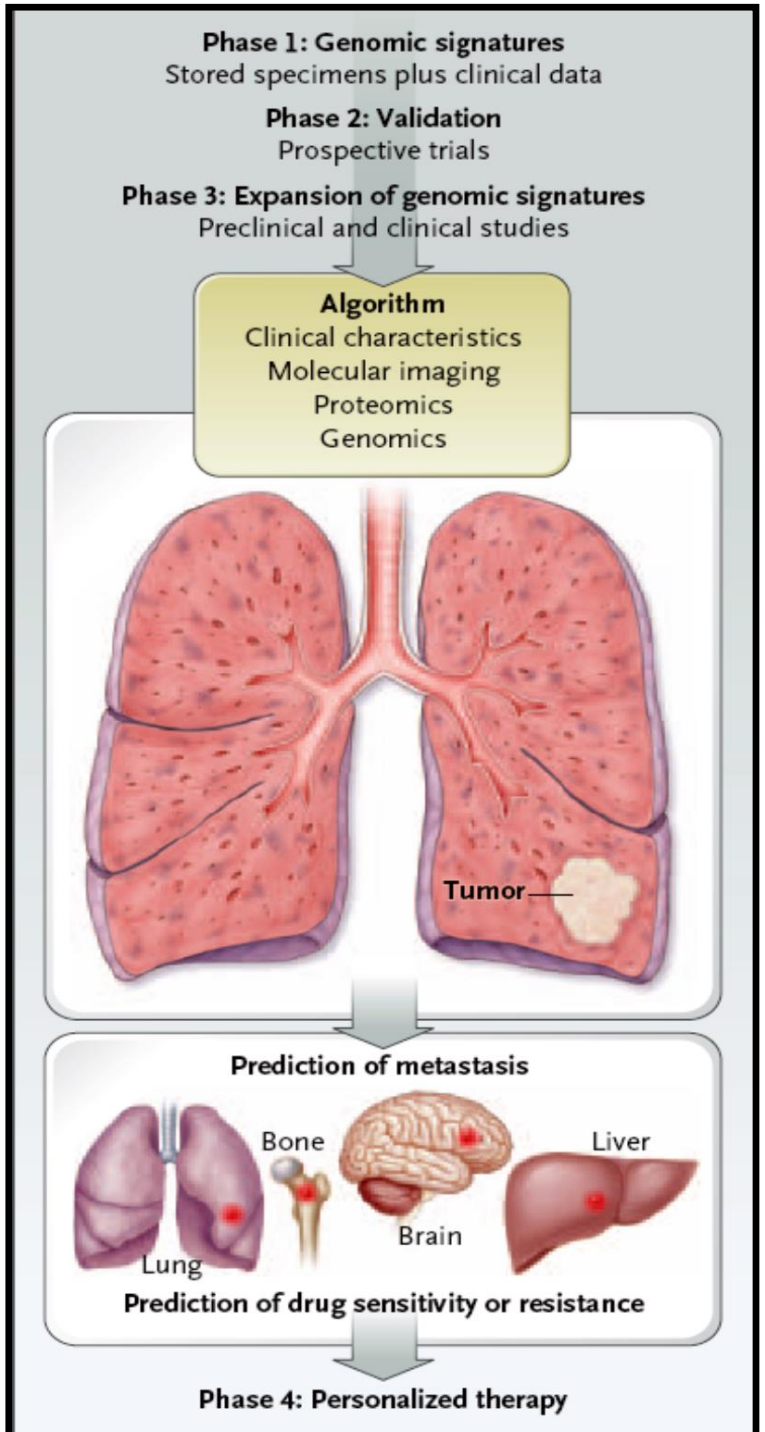
A Five-Gene Signature and Clinical Outcome in Non–Small-Cell Lung Cancer

Hsuan-Yu Chen, M.Sc., Sung-Liang Yu, Ph.D., Chun-Houh Chen, Ph.D., Gee-Chen Chang, M.D., Ph.D., Chih-Yi Chen, M.D., Ang Yuan, M.D., Ph.D., Chiou-Ling Cheng, M.Sc., Chien-Hsun Wang, M.Sc., Harn-Jing Terng, Ph.D., Shu-Fang Kao, M.Sc., Wing-Kai Chan, M.D., Han-Ni Li, M.Sc., Chun-Chi Liu, M.Sc., Sher Singh, Ph.D., Wei J. Chen, M.D., Sc.D., Jeremy J.W. Chen, Ph.D., and Pan-Chyr Yang, M.D., Ph.D.

EDITORIAL

Molecular Signatures of Lung Cancer — Toward Personalized Therapy

Roy S. Herbst, M.D., Ph.D., and Scott M. Lippman, M.D.



The Opportunity to Integrate Data-Intensive Biology with Medicine

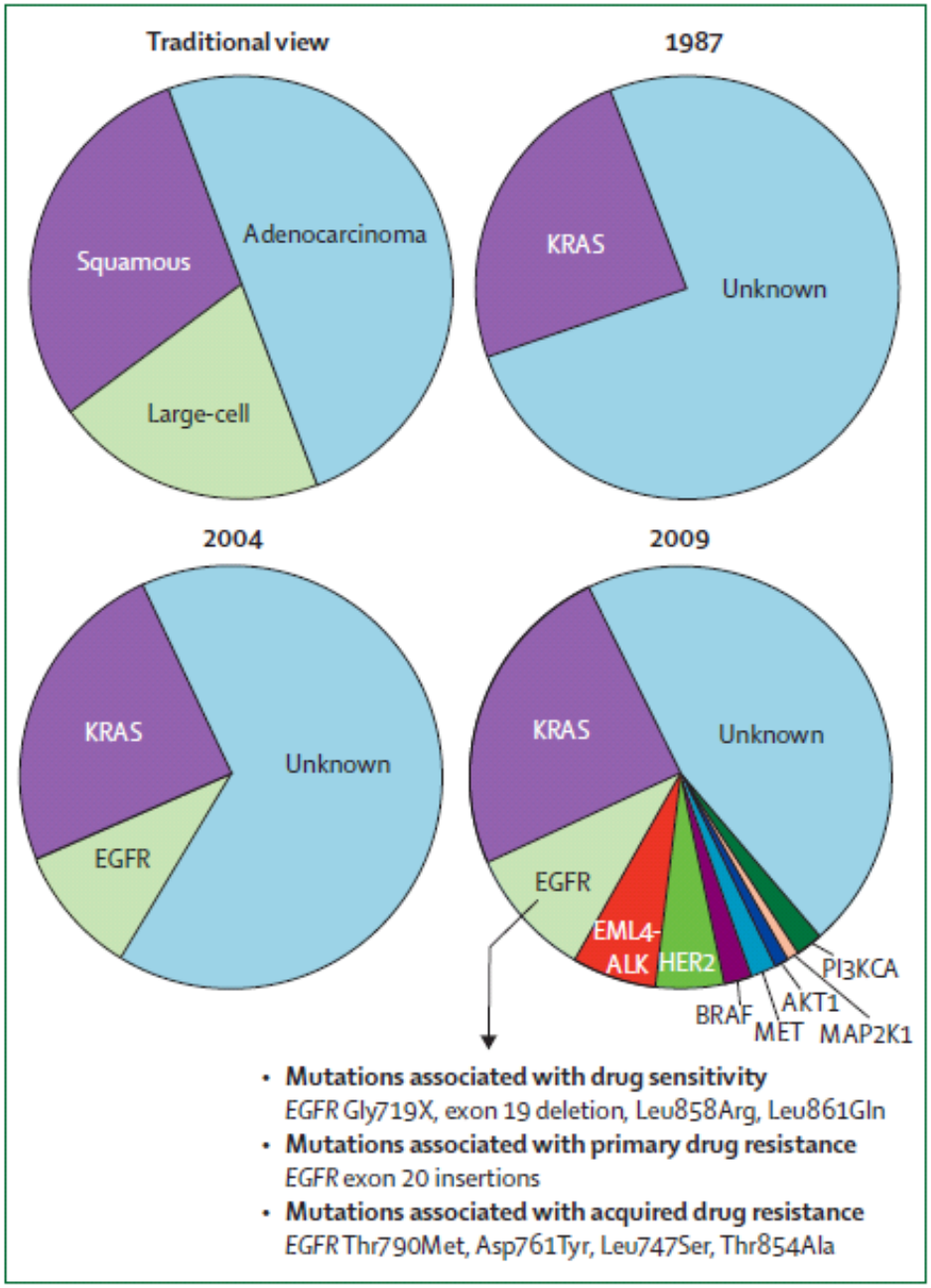


Figure 2-2: Knowledge of non-small-cell lung cancer has evolved substantially in recent decades.

The traditional characterization of lung cancers based on histology has been replaced over the past 20 years by classifications based on driver mutations. In 1987, this classification was rudimentary as only one driver mutation had been identified, KRAS. However, the sophistication of this system for molecular classification has improved with the advent of more genetic information and the identification of many more driver mutations. Similar approaches could improve the diagnosis, classification, and treatment of many other diseases.

Source: Pao and Girard 2011

2018

Precision cancer medicine and immunology in China

Xu-Chao Zhang[1,2] and Yi-Long Wu[1*]

[1]Guangdong Lung Cancer Institute and [2]Medical Research Center, Guangdong General Hospital and Guangdong Academy of Medical Sciences, Guangzhou, China

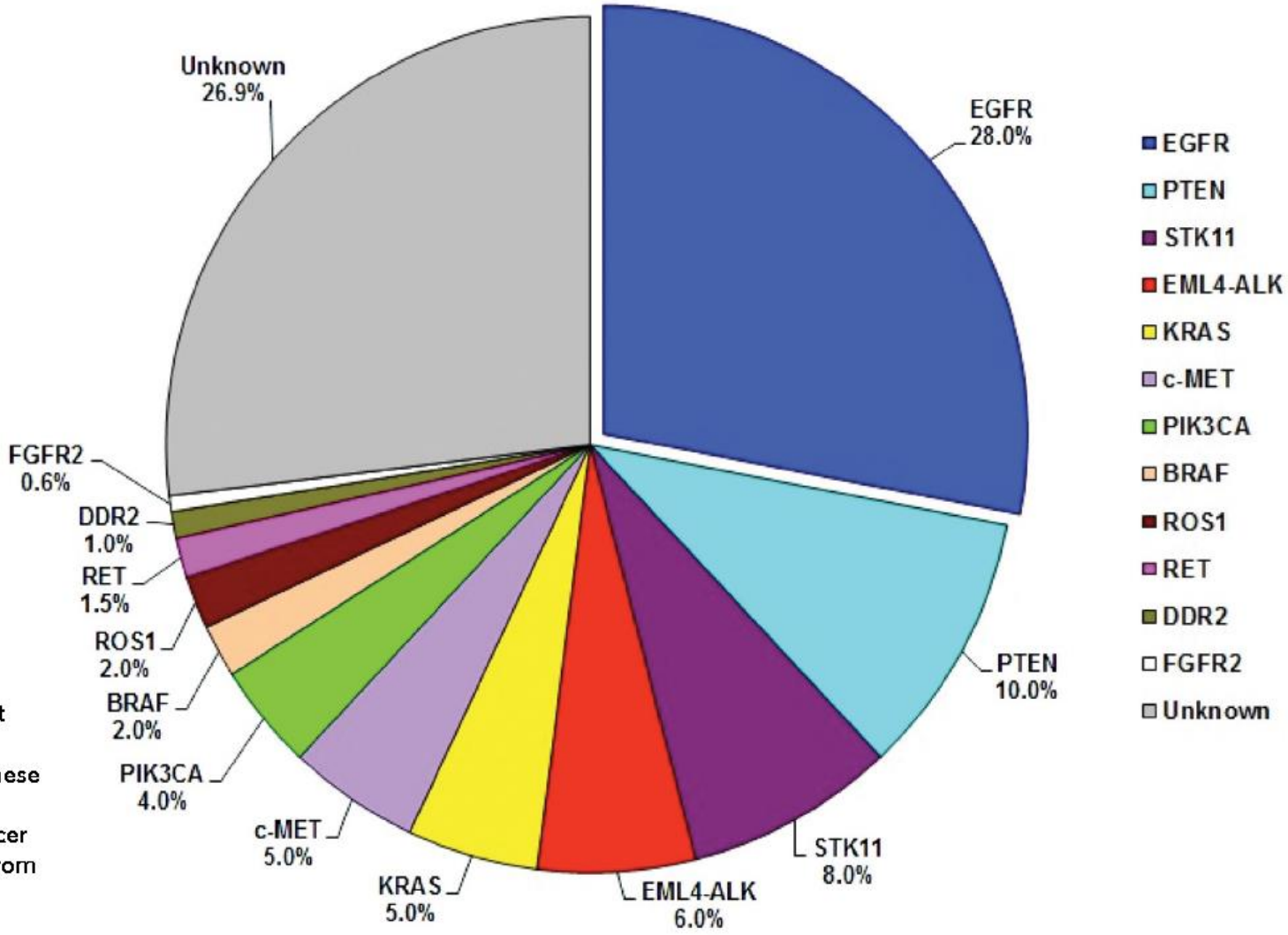


FIGURE 1. Pie chart of the driver gene distribution in Chinese patients with non-small cell lung cancer (NSCLC) (revised from Guangdong Lung Cancer Institute).

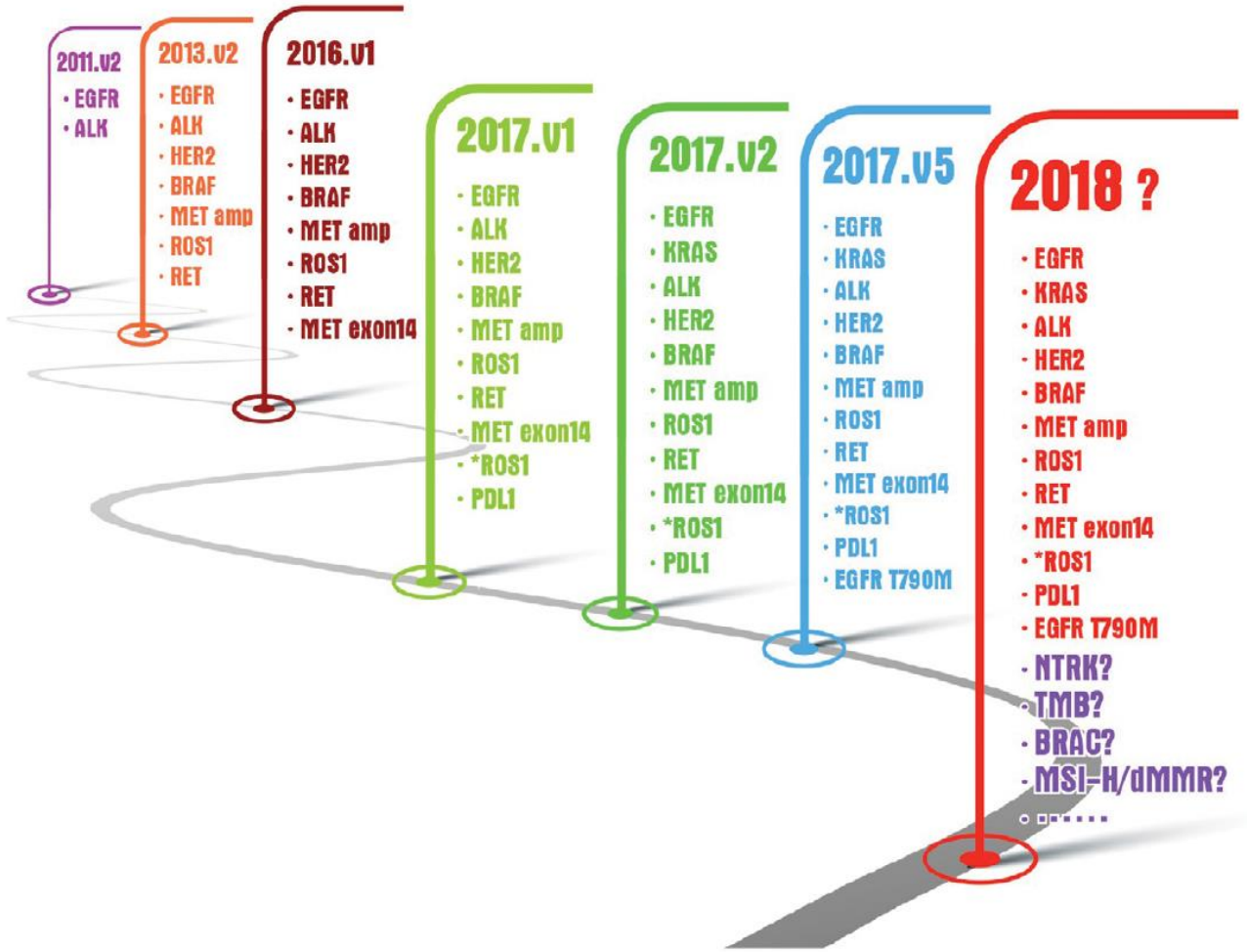
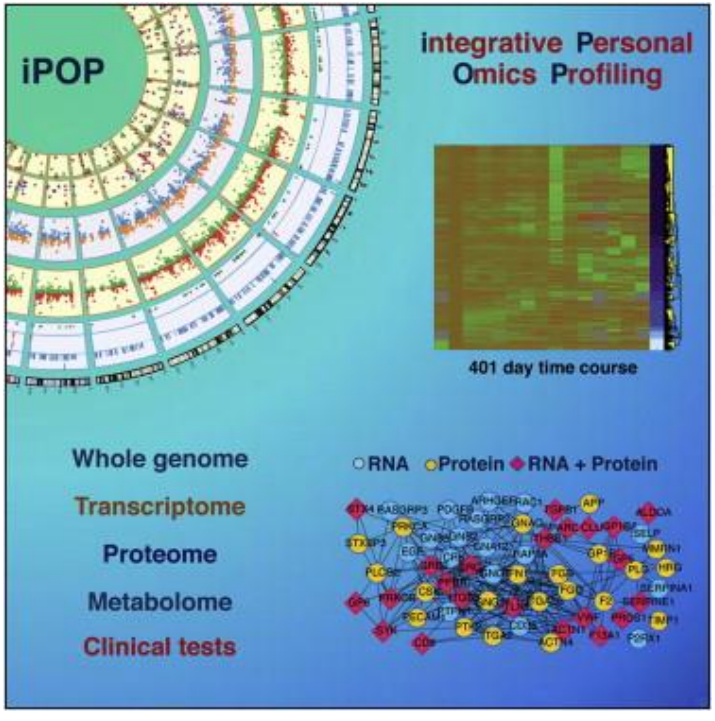
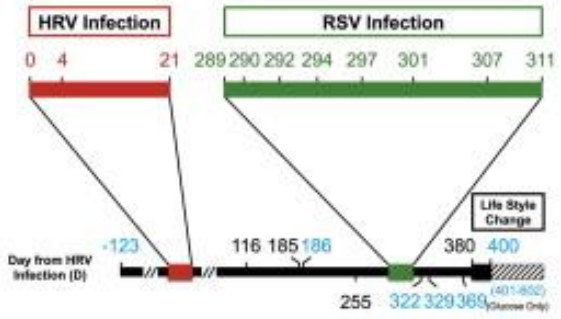


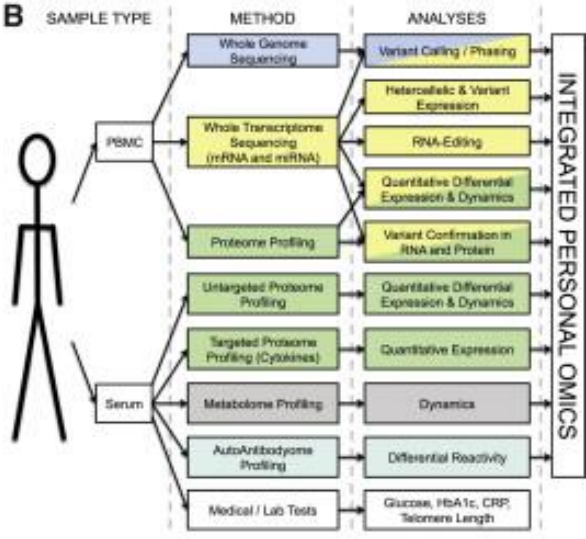
FIGURE 2. The timeline of recommendations from the National Comprehensive Cancer Network for genes detected in non-small cell lung cancer.

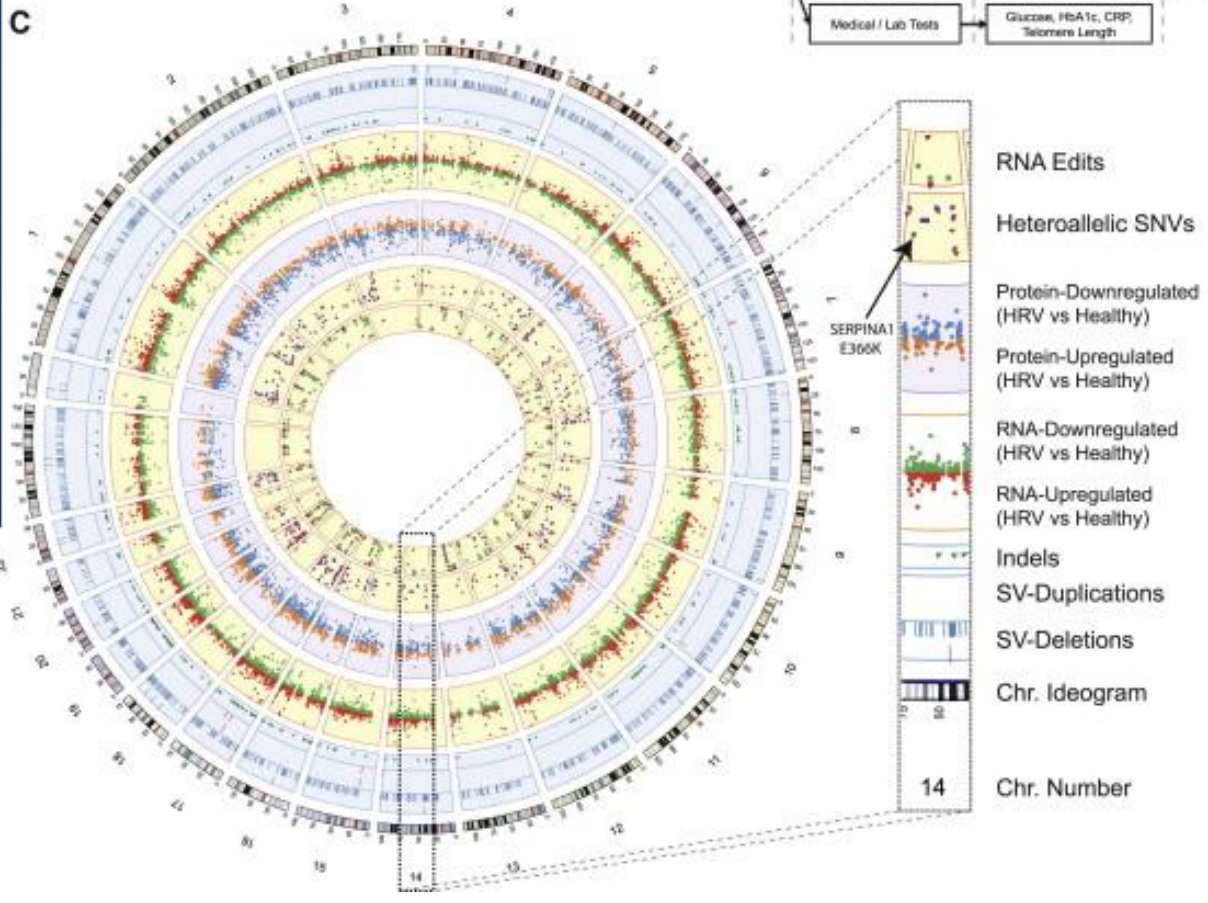
Cell *148*, 1293–1307, March 16, 2012

Personal Omics Profiling Reveals Dynamic Molecular and Medical Phenotypes









NATURE BIOTECHNOLOGY | NEWS AND VIEWS

Omics gets personal

Laura DeFrancesco

Nature Biotechnology **30**, 332 (2012)
Published online 10 April 2012

Precision medicine and cancer immunology in China

From big data to knowledge in precision medicine

Large Population-Based Cohort Study

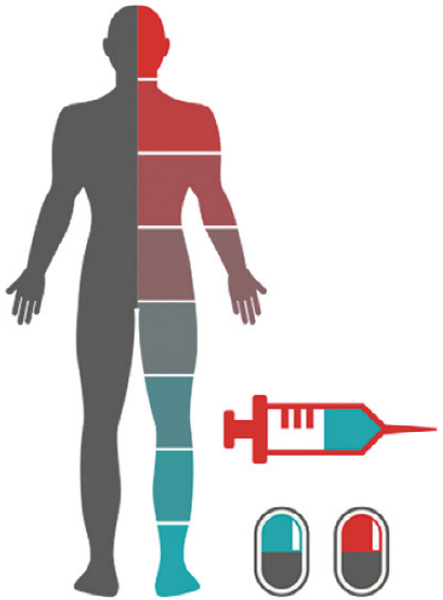
Data Acquisition

Multi-omics
genomics
transcriptomics
proteomics
epigenomics
metabolomics
metagenomics
exposomics

Electronic Medical Records
medical history
family history
biochemical testing
imaging
diagnosis and treatment
follow-up

Wearable Devices Data
heart rate
blood pressure
weight
body temperature
sleep information
sports activities

Data Acquisition

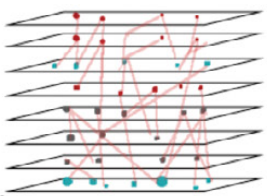


Clinical Decision and Health Management

Data Storage

Data

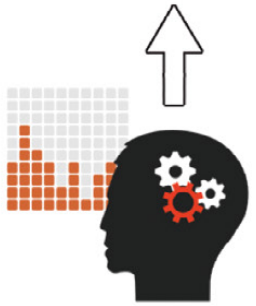
Bioinformatics Analysis



phenotypes
genotypes
gene expression
protein expression
DNA/histone modifications
metabolites composition
microbial diversity
exposure assessment

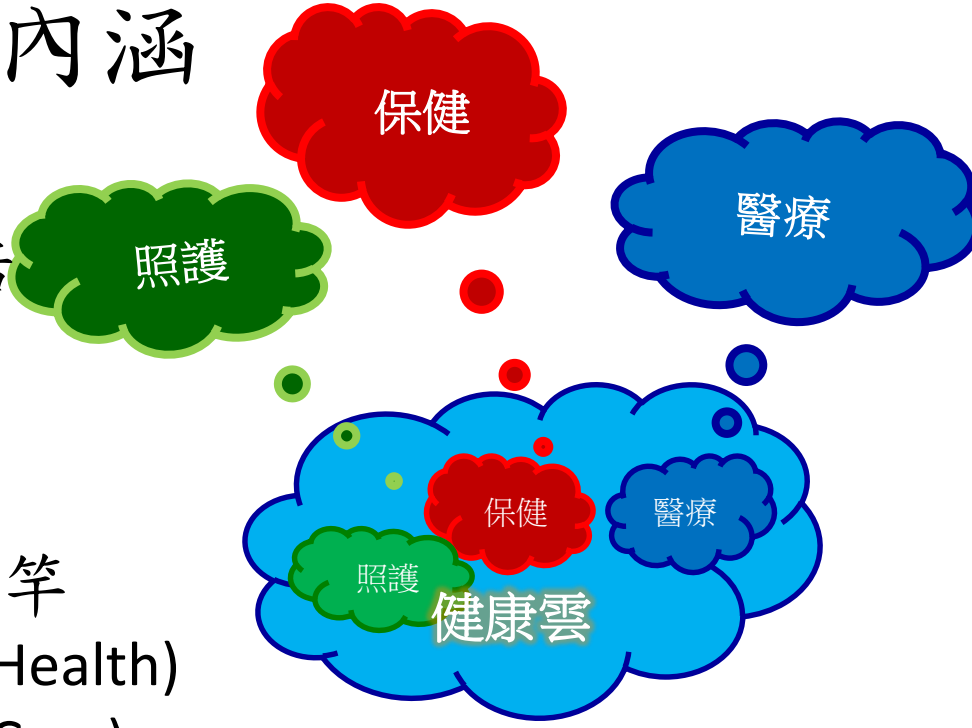
Information

Knowledge Extraction



Knowledge

健康雲的內涵



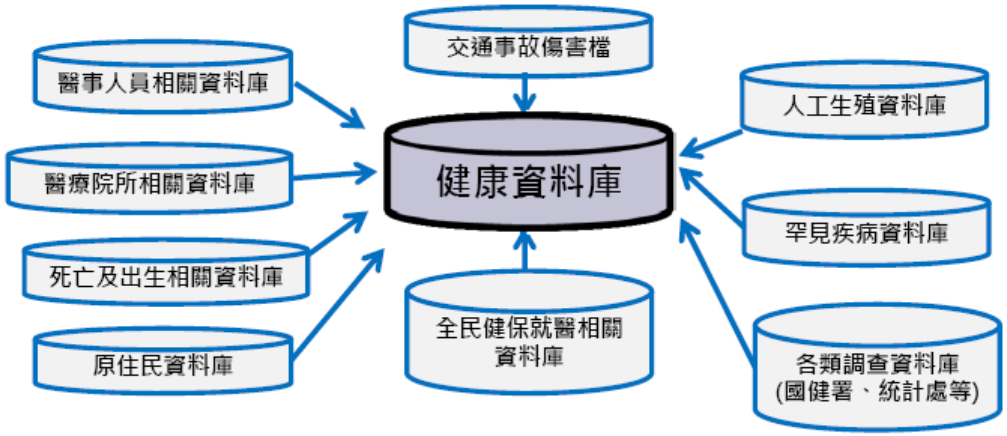
- 塑造全方位的健康優質生活
  - 平時：全時保健
  - 病時：個人化醫療
  - 年長：長期照護
- 塑造 ICT 智慧應用的國際標竿
  - 保健雲 =>優質健康 (Better Health)
  - 照護雲 =>照護提升 (Better Care)
  - 醫療雲 =>短期：資源最有效運用 (Lower Cost)
    長期：個人化醫療 (Personalized Medicine)
  - 健康雲 =>政府福利、產業發展並重的永續經營 (Sustainability)

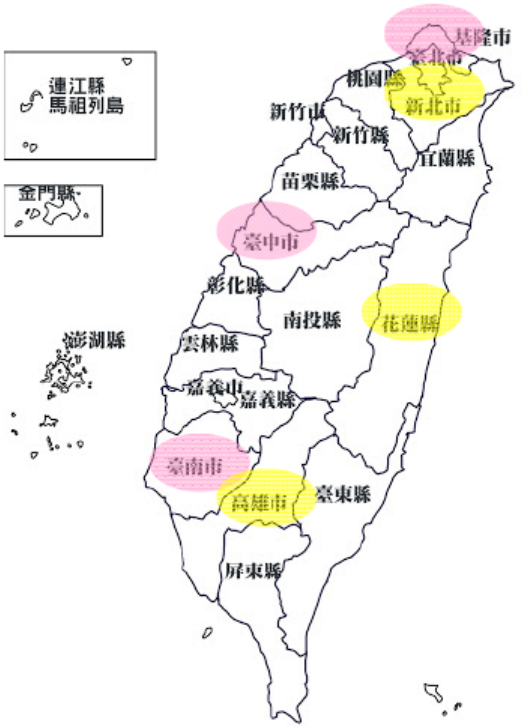
→未來醫學希望能做到P4醫學，也就是預防醫學（Preventive）、預測醫學（Predictive）、個人化醫學（Personalized）、參與醫學（Participatory）。

健康資料加值應用雲端化服務-執行現況

Ministry of Health and Welfare

- 健康資料加值應用協作中心分布
  - ➢已成立：台北車站協作中心、中國醫大、台北醫大、台灣大學、成功大學、 高雄醫大
  - ➢規劃中：陽明大學、長庚大學、慈濟大學
- 擴充健康資料庫資料檔種類 ※每年約25億筆資料





- 研發 R線上統計分析暨導引系統
- 建置指標查詢服務系統

健保資料庫運用： 鳳梨 vs. 鳳梨酥

?

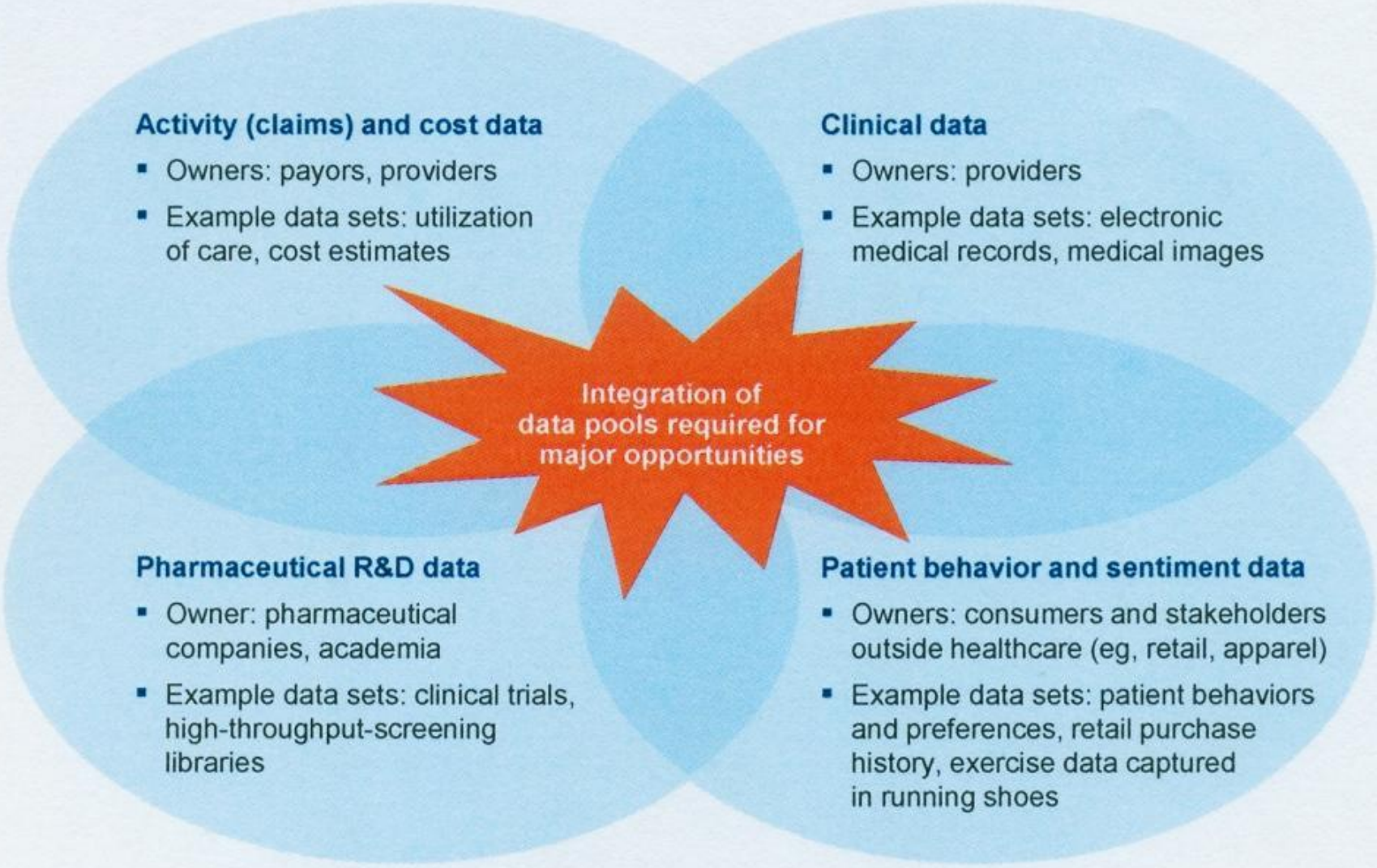
McKinsey,
Jan. 2013

Center for US Health System Reform
Business Technology Office

The 'big data' revolution in healthcare

Accelerating value and innovation

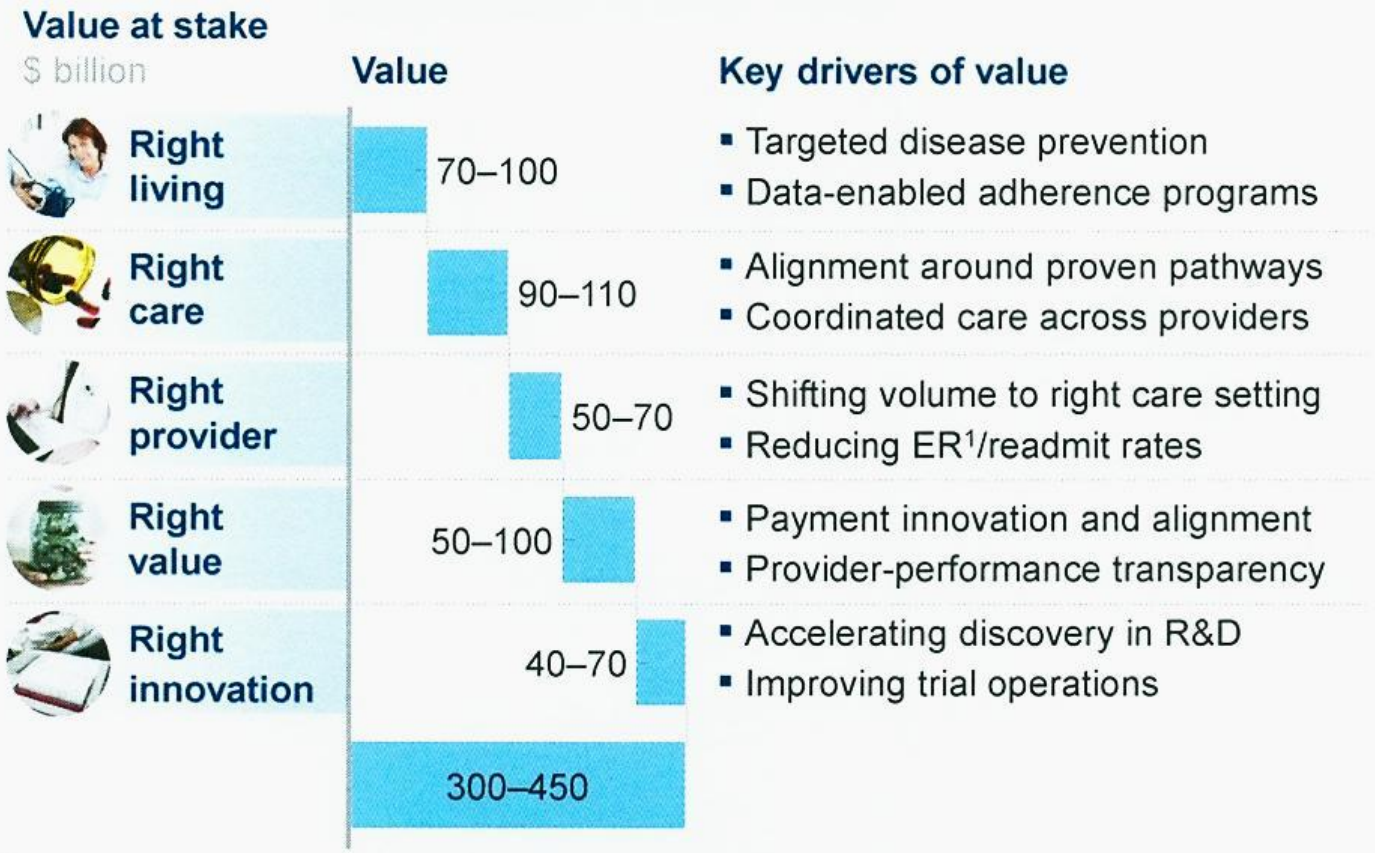
Exhibit 2: Primary data pools are at the heart of the big-data revolution in healthcare.



Source: McKinsey Global Institute analysis

The value of big data in health care = $300-450 billion

Exhibit 4: Applying early successes at scale could reduce US healthcare costs by $300 billion to $450 billion.



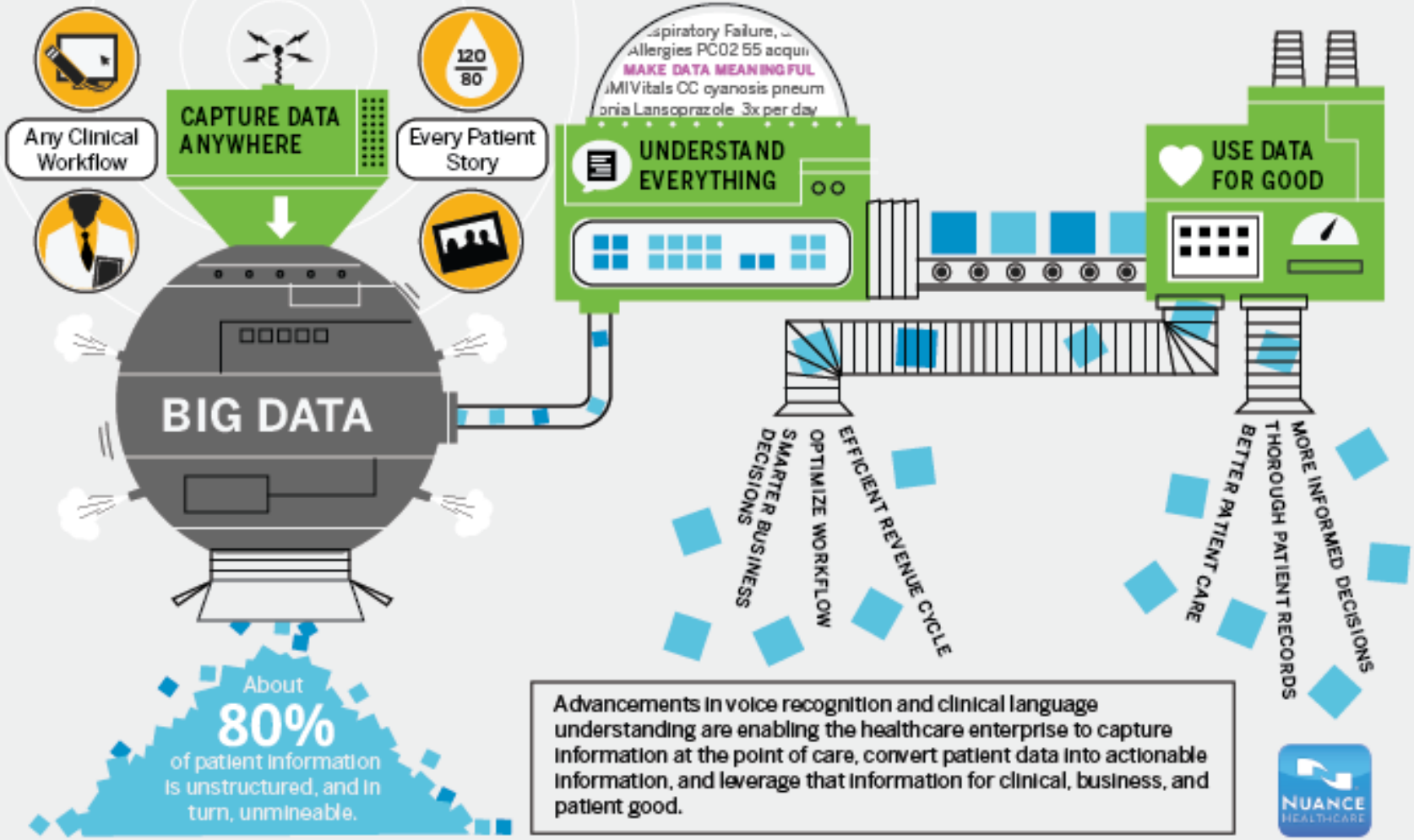
1 Emergency room.

Source: American Diabetes Association; American Hospital Association; HealthPartners Research Foundation; McKinsey Global Institute; National Bureau of Economic Research; US Census Bureau

HEALTHCARE'S DATA CONUNDRUM

FROM DISPARATE DATA TO MEANINGFUL INFORMATION

We can empower healthcare organizations, providers and payers to unify the capture, analysis, and use of data to drive smarter care and business.



www.nuance.com/for-healthcare

6 Keys to the Future of Big Data in Healthcare Marketing

Big data is forecast to make a big difference in the future of healthcare, according to a recent report by the **Ewing Marion Kauffman Foundation**. (April 19, 2012)

1. **Figure Out How to Organize and Use Big Data**
2. **Develop Technology That Taps Into Big Data**
3. **Use Big Data for Better Decision Support**
4. **Turn To Big Data to Ease the Flow of Information**
5. **Use Big Data to Increase the Quality of Care and Decrease Costs**
6. **Develop More Mobile Apps and Social Media That Capitalize on Big Data**

Data is rapidly becoming the foundation for a Smarter Planet

Watson Healthcare Products – 1H 2013

Watson Clinical Insights Advisor

Therapy Designer

Assists with efficient trials and reduces time to market with new cancer therapies

Accelerate Research and Insights

Watson Diagnosis & Treatment Advisor

Oncologists

Assists in identifying individualized treatment options for patients diagnosed with cancer

Improve Diagnosis and Treatments

Watson Care Review and Authorization Advisor

Nurses

Streamlines manual review processes between a physician and health plans

Improve Decisions and Outcomes

Top 10 AI Applications

Robot-Assisted Surgery**

$40B

Virtual Nursing Assistants

$20B

Administrative Workflow Assistance

$18B

Fraud Detection

$17B

Dosage Error Reduction

$16B

Connected Machines

$14B

Clinical Trial Participant Identifier

$13B

Preliminary Diagnosis

$5B

Automated Image Diagnosis

$3B

Cybersecurity

$2B

Acknowledgement

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National Development Fund, Executive Yuan


DOIT 經濟部技術處
Ministry of Economic Affairs

財團法人生物技術開發中心
Development Center for Biotechnology