

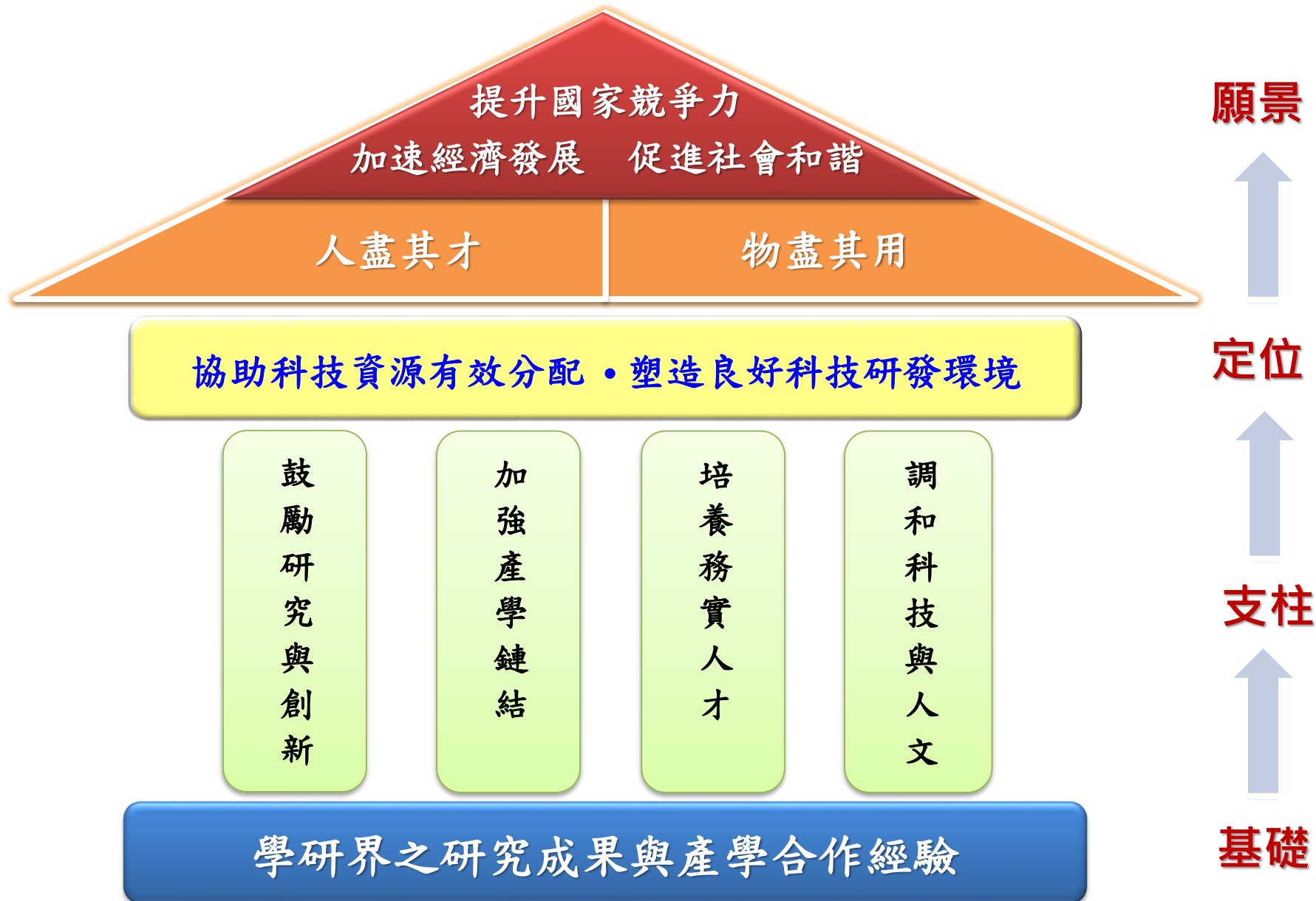
# 科技未來發展方向

錢宗良

科技部

**April-15-2016**

# 科技部整體施政架構



# Strength of Taiwan in Biotech Development

- **Representative Population** in East Asia
- Improved Cross-Strait Relationship
- Competitive, Strong **R&D Activities** and **Manufacturing Capabilities** in Computer Sci., Electric Engineering, Biotech, Clinical Medicine, *etc.*
- **Integrated** Government-Industry-Academia-Hospital, **Transparent Regulatory Environment**
- Excellent **Health Care System**, National Health Insurance: **≥ 98%**
- **Center of Excellence for Clinical Trials** in East Asia  
*R&D for Pfizer, GSK, BI, MSD, Novartis, Eli Lilly, Roche, AZ, Bayer, etc.*
- **Government's Investment and Support**

SCIENTIFIC  
AMERICAN

# worldVIEW

A GLOBAL BIOTECHNOLOGY PERSPECTIVE

2013

## SEARCHING FOR THE NEXT WAVE

SPECIAL REPORT

RIPPLES OF INNOVATION  
FROM UNEXPECTED PLACES



THE 4<sup>TH</sup>  
ANNUAL  
WORLDVIEW  
SCORECARD  
NATIONS GO FOR THE  
BIOTECH GOLD

**MARATHON MEN:**  
3 ENDURING LIFE  
SCIENCE LEADERS

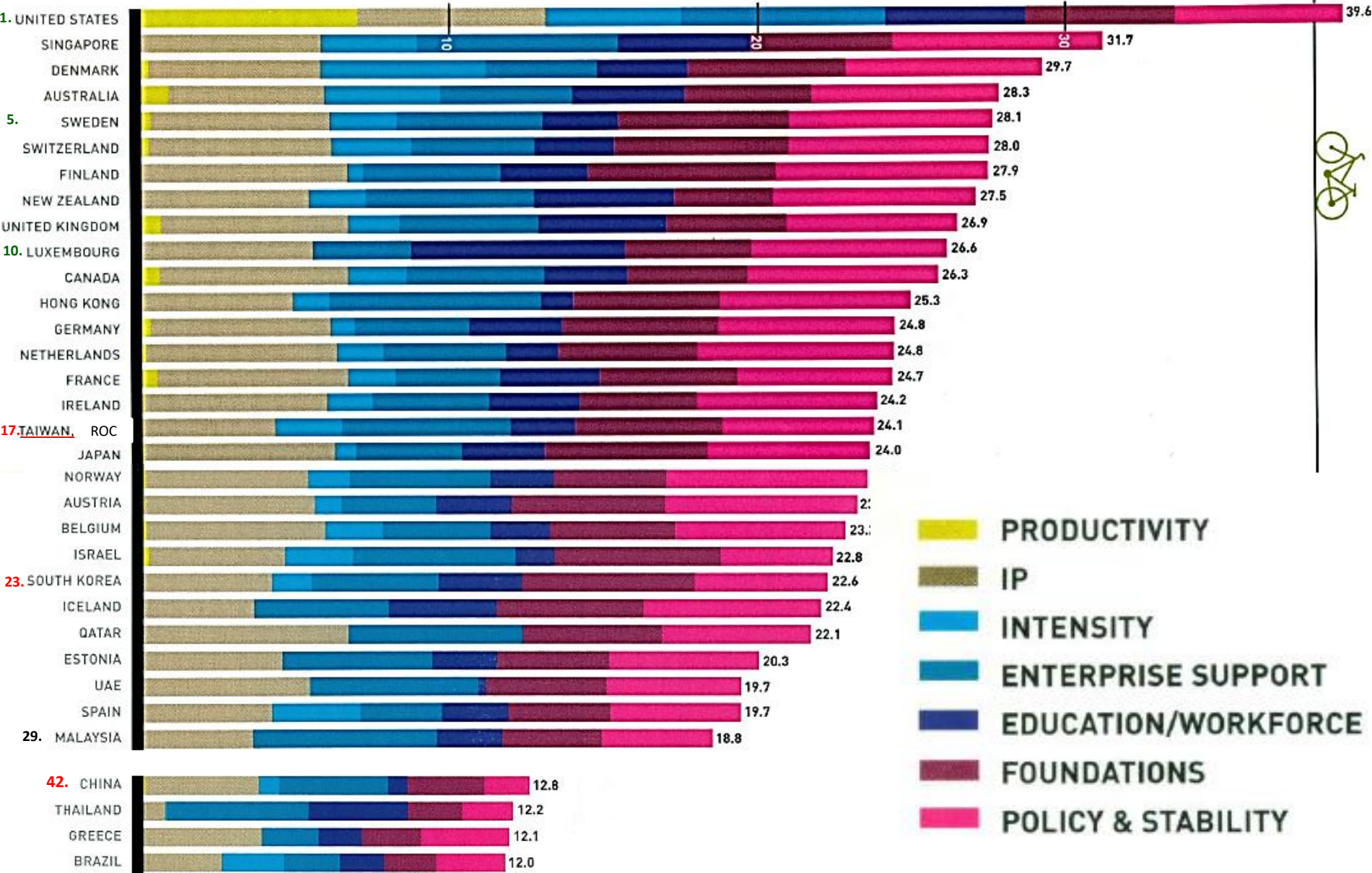
**DROWNING IN DATA?**  
FLOOD CONTROL  
FOR THE FUTURE

1. IP
2. INTENSITY
3. ENTERPRISE SUPPORT
4. EDUCATION/  
WORKFORCE
5. FOUNDATIONS
6. POLICY &  
STABILITY

# 2014 SCIENTIFIC AMERICAN WORLDVIEW OVERALL SCORES

PRODUCTIVITY GIVES THE US AN EXTRA PUSH

Taiwan is # 17



## 2015 Taiwan Total Ranking # 25

- |                        |      |
|------------------------|------|
| 1. Productivity        | # 23 |
| 2. IP                  | # 29 |
| 3. Intensity           | # 31 |
| 4. Enterprise Support  | # 8  |
| 5. Education/Workforce | # 33 |
| 6. Foundation          | # 12 |
| 7. Policy & Stability  | # 24 |

# SEVEN YEARS OF BIOTECH TRACKING BY RANK

*Our growing database reveals ongoing competition at many levels*

## Taiwan's Ranking:

2012 # 21

2013 # 26

2014 # 17

2015 # 25

Average # 22.3

change since last year (neg. values = improvement)



COUNTRY	2009	2010	2011	2012	2013	2014	2015	AVG.	
UNITED STATES	1	1	1	1	1	1	1	1.0	0
DENMARK	3	5	2	2	2	3	2	2.7	-1
NEW ZEALAND	7	18	18	9	10	8	3	10.4	-5
AUSTRALIA	10	17	5	10	7	4	4	8.1	0
SINGAPORE	2	2	8	3	5	2	5	3.9	3
FINLAND	8	6	7	4	4	7	6	6.0	-1
SWITZERLAND	6	10	6	6	3	6	7	6.3	1
SWEDEN	4	4	3	5	6	5	8	5.0	3
UNITED KINGDOM	12	14	9	11	9	9	9	10.4	0
CANADA	11	3	4	7	8	11	10	7.7	-1
HONG KONG			17	13	20	12	11	14.6	-1
GERMANY	16	16	16	16	14	13	12	14.7	-1
IRELAND	14	13	14	8	11	16	13	12.7	-3
NETHERLANDS	19	12	12	17	12	14	14	14.3	0
FRANCE	18	8	10	12	13	15	15	13.0	0
JAPAN	13	9	11	18	18	18	16	14.7	-2
NORWAY	17	21	21	19	22	19	17	19.4	-2
ISRAEL	5	7	13	14	15	22	18	13.4	-4
AUSTRIA	21	20	20	20	17	20	19	19.6	-1
LUXEMBOURG		25	29	25	19	10	20	21.3	10
BELGIUM	20	15	15	15	16	21	21	17.6	0
QATAR					42	25	22	29.7	-3
SOUTH KOREA	15	19	19	22	24	23	23	20.7	0
ICELAND	9	11	22	23	23	24	24	19.4	0
TAIWAN,				21	26	17	25	22.3	8

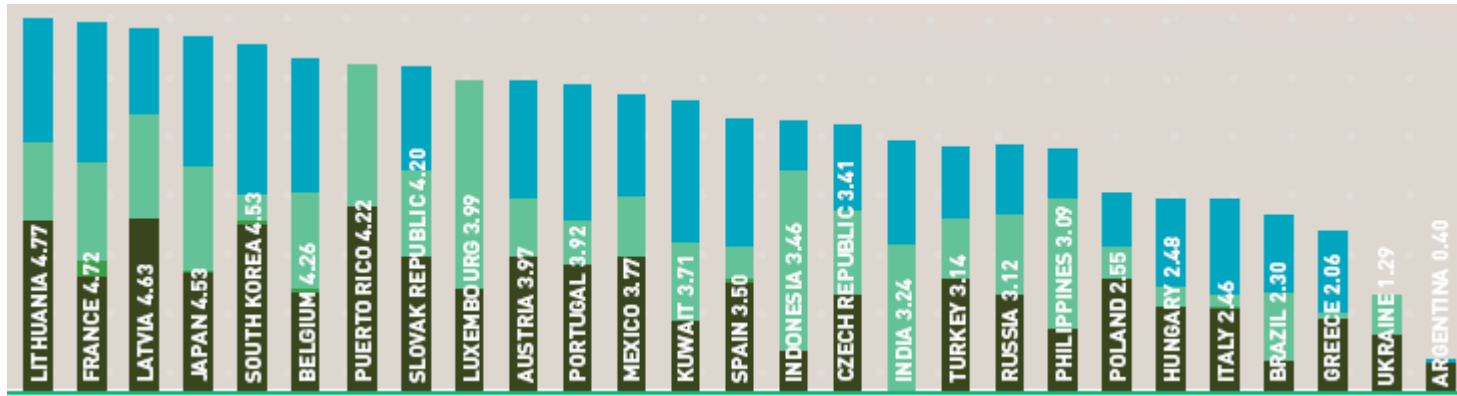
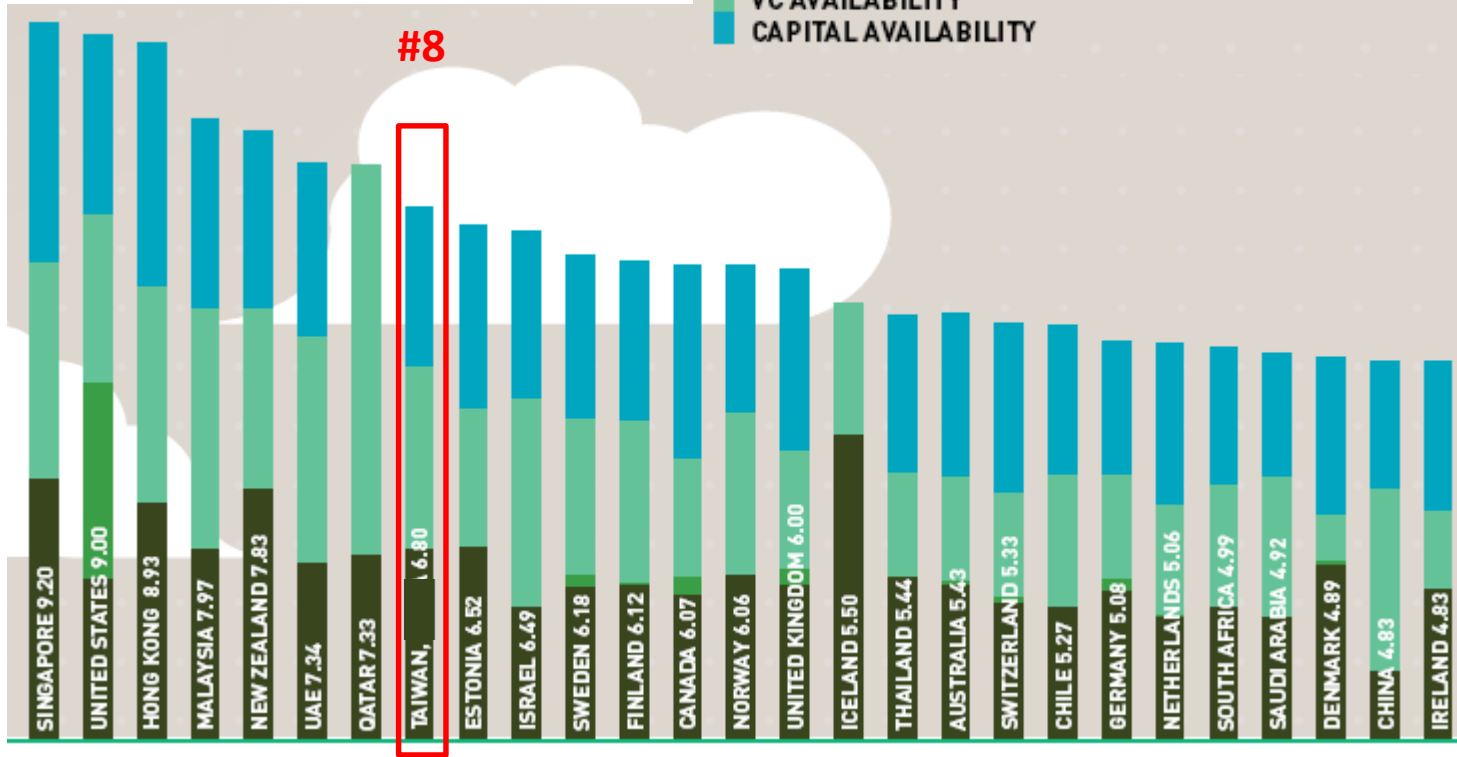
# SCORECARD CATEGORY #5: ENTERPRISE SUPPORT

*A trio tussles for the top spot*

Taiwan #8

## ENTERPRISE SUPPORT

- BUSINESS-FRIENDLY ENVIRONMENT (higher = better)
- BIOTECH VC, 2007 (US\$MM)
- VC AVAILABILITY
- CAPITAL AVAILABILITY

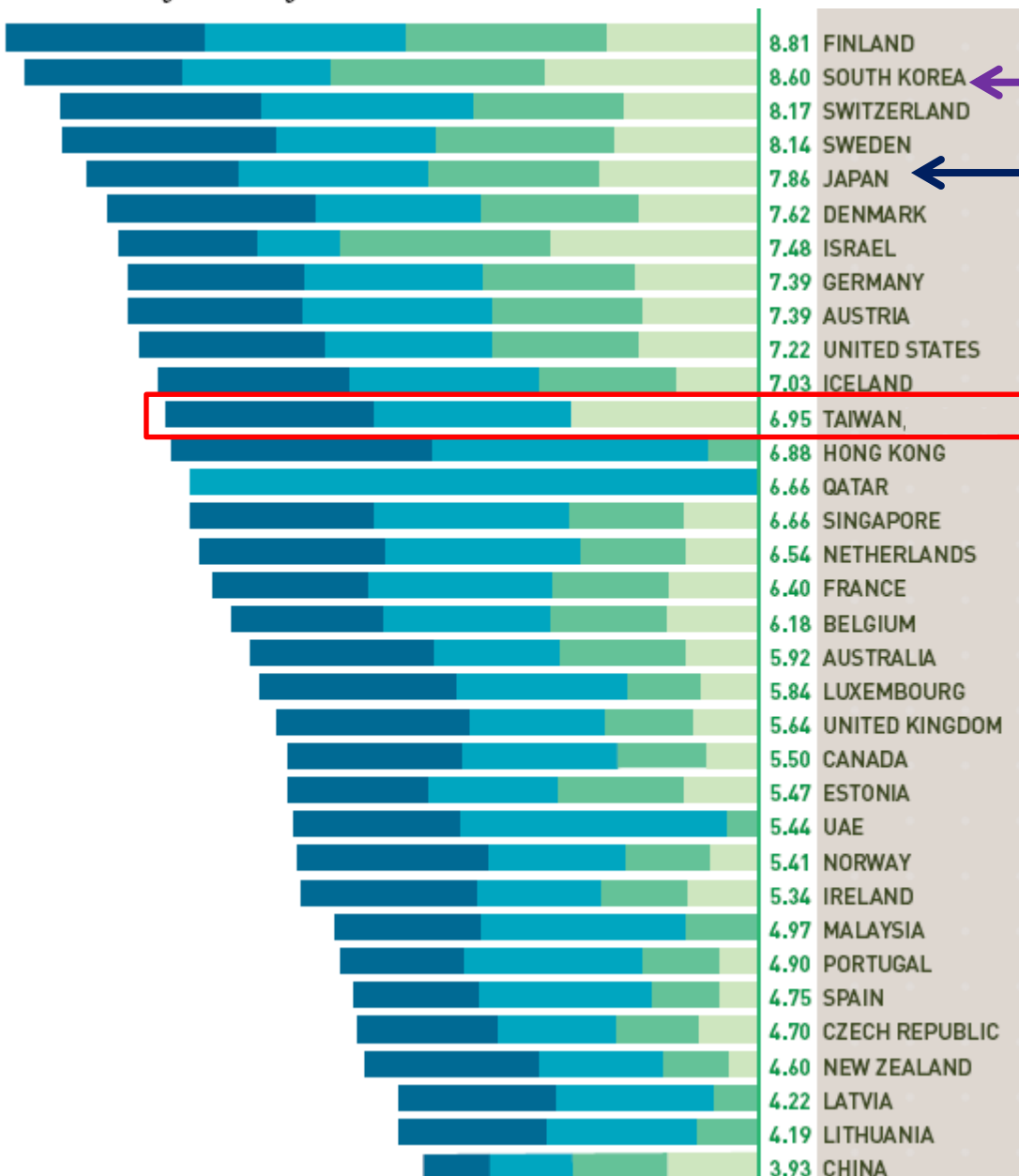




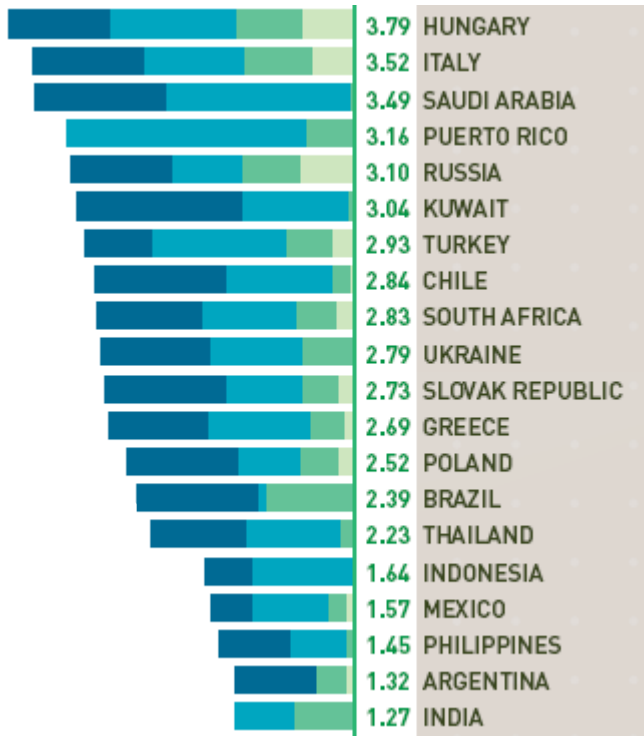
SCORECARD  
CATEGORY #6:  
**FOUNDATIONS**  
*Finland finishes first*

**Taiwan #12**

- BUSINESS EXPENDITURES ON R&D (% of GDP)
- GOVERNMENT SUPPORT OF R&D (% of GDP)
- INFRASTRUCTURE QUALITY (roads, ports, electricity, etc.)
- ENTREPRENEURSHIP & OPPORTUNITY



**#12**



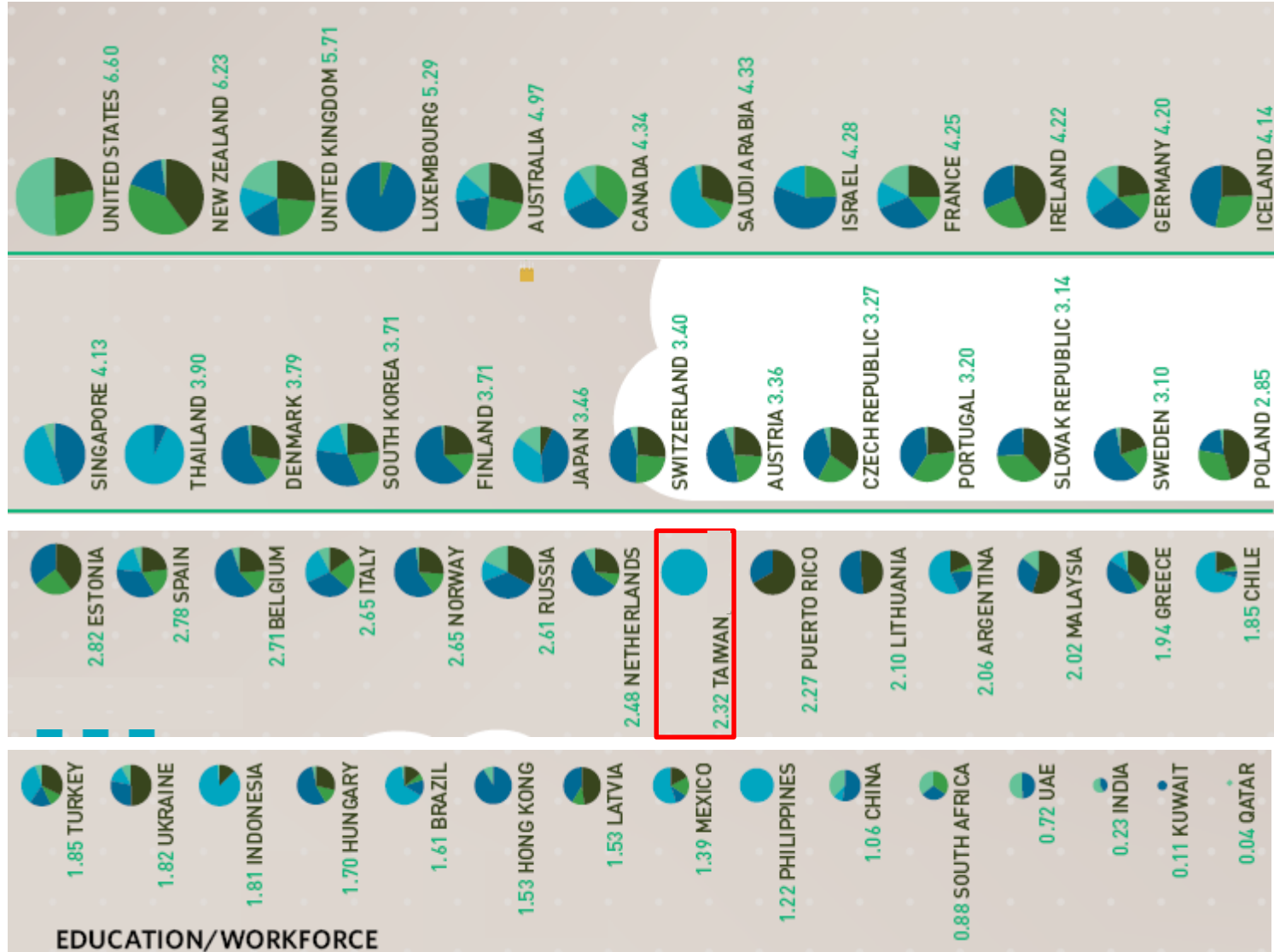
# SCORECARD CATEGORY #4: EDUCATION/WORKFORCE

High-tech innovation demands a highly educated workforce

Taiwan #33

## EDUCATION/WORKFORCE

- POST-SECONDARY SCIENCE GRADUATES / CAPITA
- PHD GRADUATES IN LIFE SCIENCES PER MILLION POPULATION
- R&D PERSONNEL PER THOUSAND EMPLOYMENT
- TALENT RETENTION (reciprocal of brain drain)
- BRAIN GAIN (share of global students studying outside their country)



EDUCATION/WORKFORCE

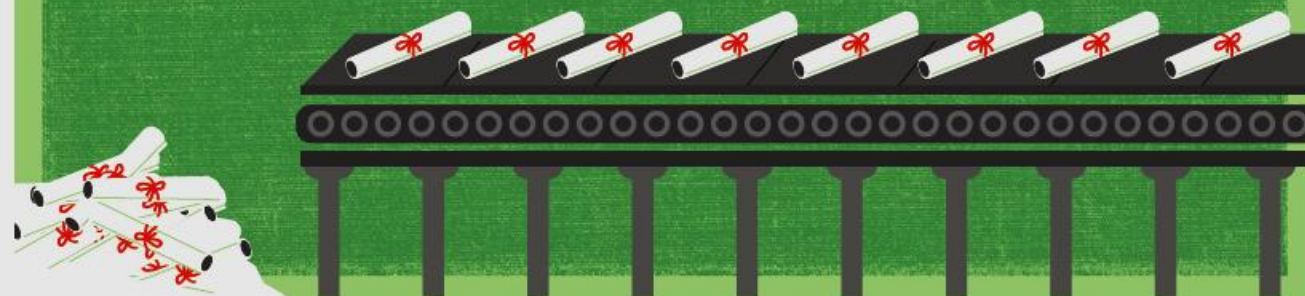
Reporting by David Cyranoski, Natasha Gilbert, Heidi Ledford, Anjali Nayar and Mohammed Yahia.

**NATURE.COM**  
Tell us what you think about the future of PhDs:  
[nature.com/phdfuture](http://nature.com/phdfuture)

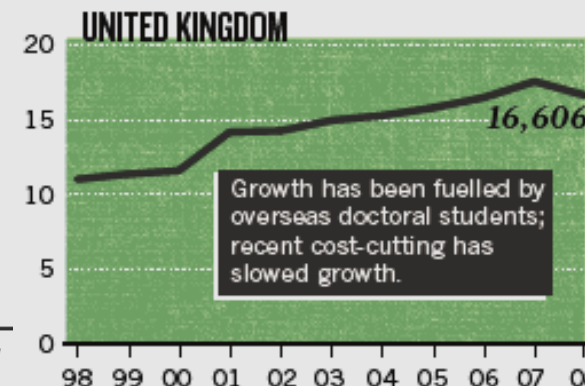
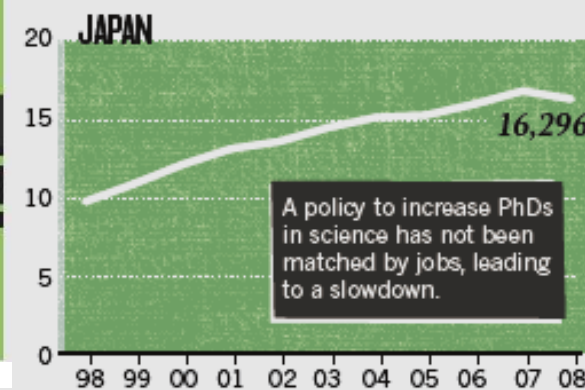
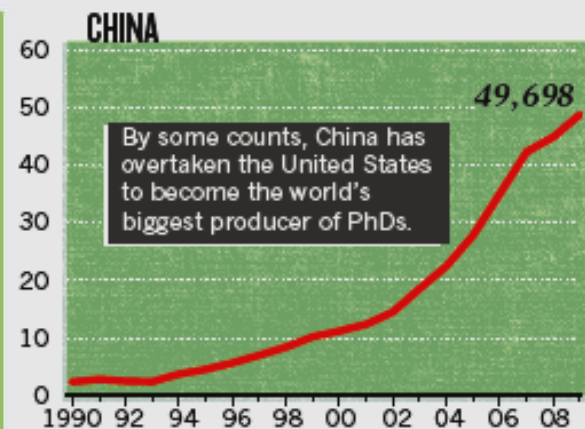
21 APRIL 2011 | VOL 472 | NATURE | 279

# THE PHD FACTORY

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

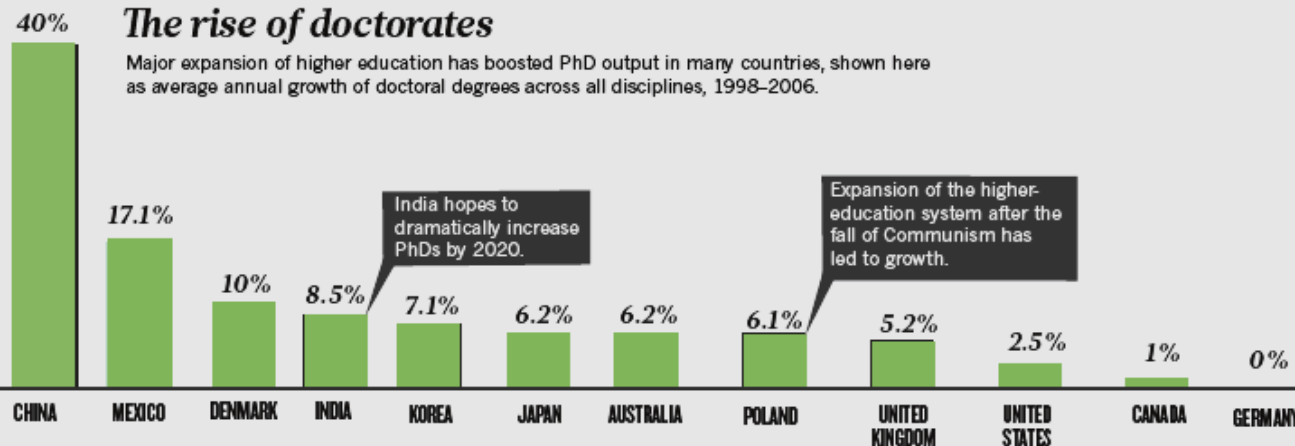


## Nature 2011

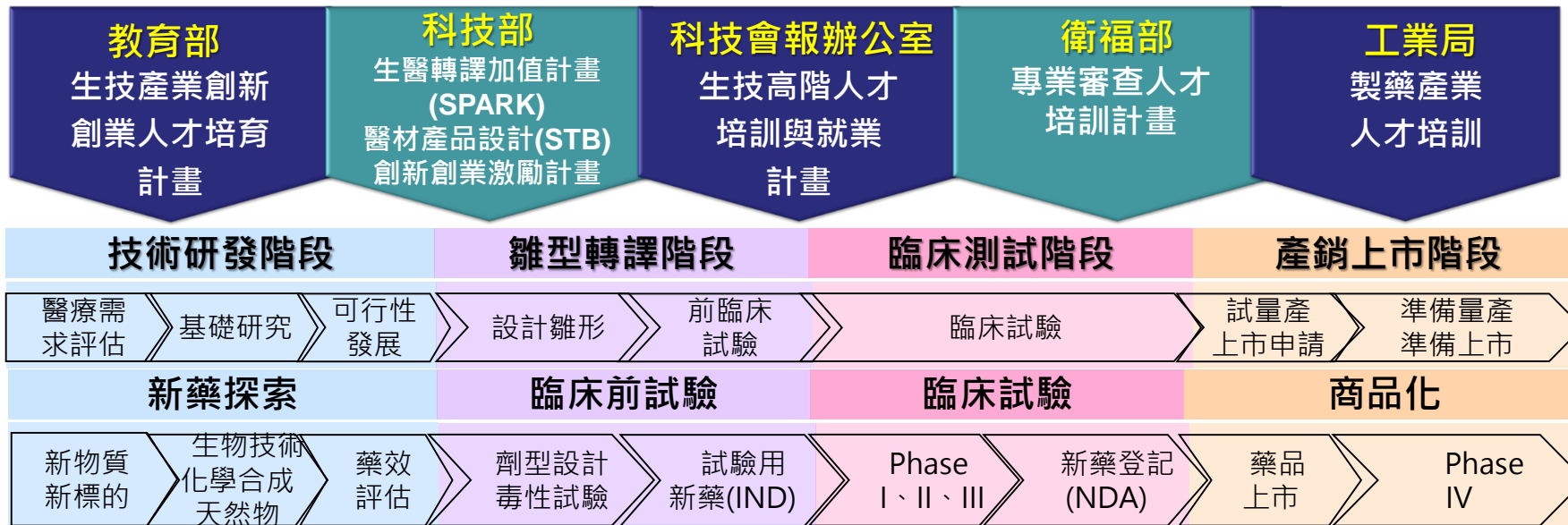


### The rise of doctorates

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.



# 各部會推動生技人才培育綜整



醫材

醫藥

- ◆ 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)

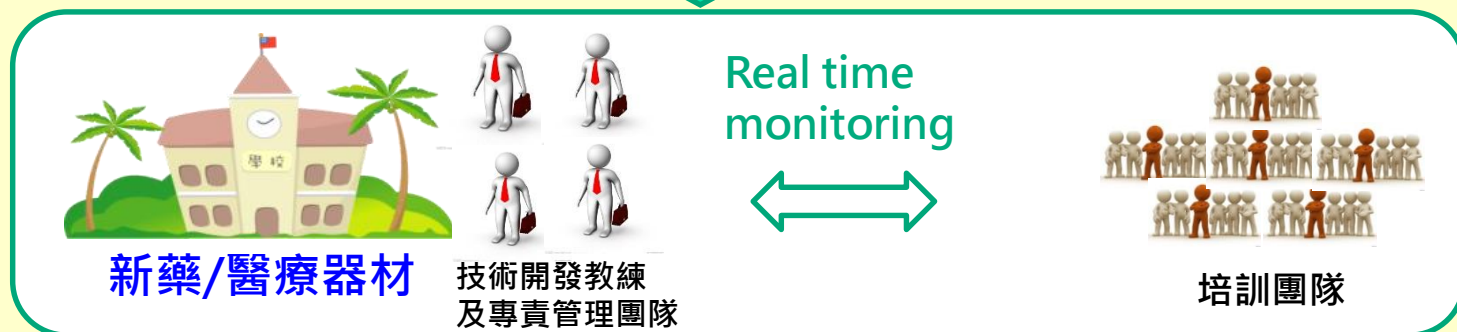
# 科技部負責之生技人才相關計畫

1. 推動生醫與醫材轉譯增值人才培訓計畫 (SPARK-Taiwan)
2. 推動醫療器材跨領域人才培訓計畫 (STB)

# SPARK計畫介紹

- 由Si<sup>2</sup>C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增值的人才培訓，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增值計畫(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



### 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

- 學研成果轉譯增值(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



# SPARK 總體成效



## (二) 與Anchor university連結，擴散SPARK Taiwan目標與精神

AU	第一期 (102年度)	第二期 (103年度)	第三期 (104年度；執行中)	歷年總 培訓團 隊數
總配合款	2,100萬	6,300萬	7,025萬	
台大	10	26 (6)	22 (11)	41
成大	6	14 (2)	13 (7)	24
陽明	-	12	10 (6)	16
北醫	-	10	9 (6)	13
中國醫	-	12	10	22
清大	-	-	7	7
總計團隊數	16	74	71	123
總計培訓人數	69	263(25)	273(108)	472



## 亮點說明 - SPARK

### 102-103年期 (第一~二期) 團隊量化成果:

- ✓ 共補助5家區域型培訓大學，累計培訓82個團隊，共計**307**位培訓團隊成員投入研發產品化訓練，其中**29%**為臨床人員。

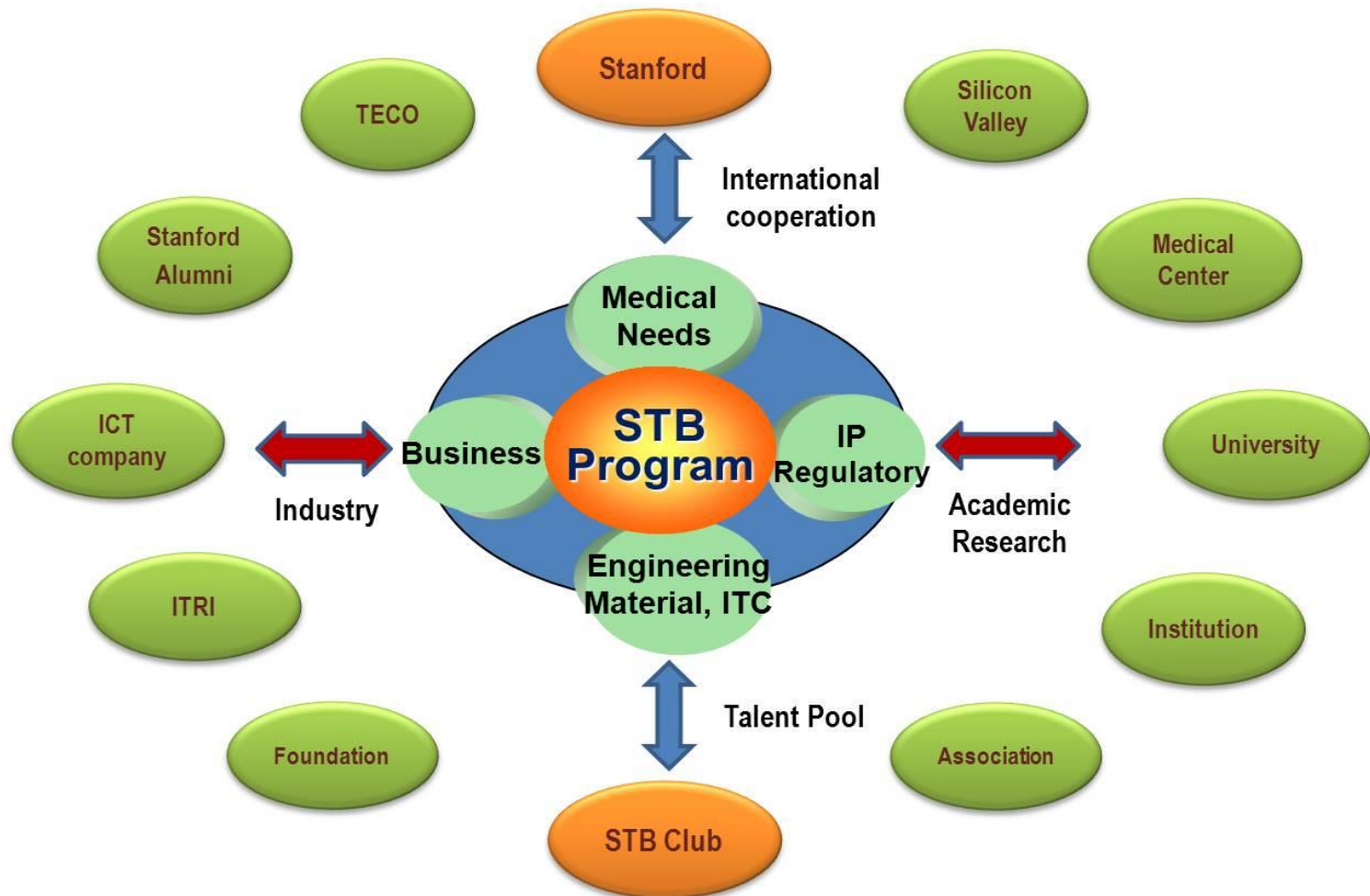






# 台灣-史丹福醫療器材產品設計人才培訓計畫 Stanford-Taiwan Biomedical Fellowship Program, STB

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」





# 總體成效 - STB



## ▶ 醫療器材人才培育計畫

### Stanford培訓計畫

- ✓ 超過500位申請者，選出40位STB學者
- ✓ 33位學員結訓→10家新創公司，累計實收資本額超過5億元

### STB 國內培訓課程 (2009-2012)

- ✓ 119名跨領域醫工人才
- ✓ 34組醫材概念創意
- ✓ 4家新創公司，累計實收資本額超過1億元

## ▶ 醫療創業支援平台

### STB eNET/

### 生醫人培FB

國際創新醫療器材技術與產品發展現況與趨勢資訊分享平台

- ✓ [www.stb.org.tw](http://www.stb.org.tw)
- ✓ [FB Page](#)



### STB交流媒合



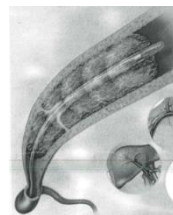
- ✓ STB大師論壇2場
- ✓ STB創業小聚1場
- ✓ 業師諮詢 16案次



### 創新醫材育成

創意概念輔導加值

- ✓ 4案通過輔導
- ✓ 2案引介申請育苗或天使計畫
- ✓ 2案轉入明年輔導



# 生技高階人才培訓與就業計畫

## ◆計畫目標

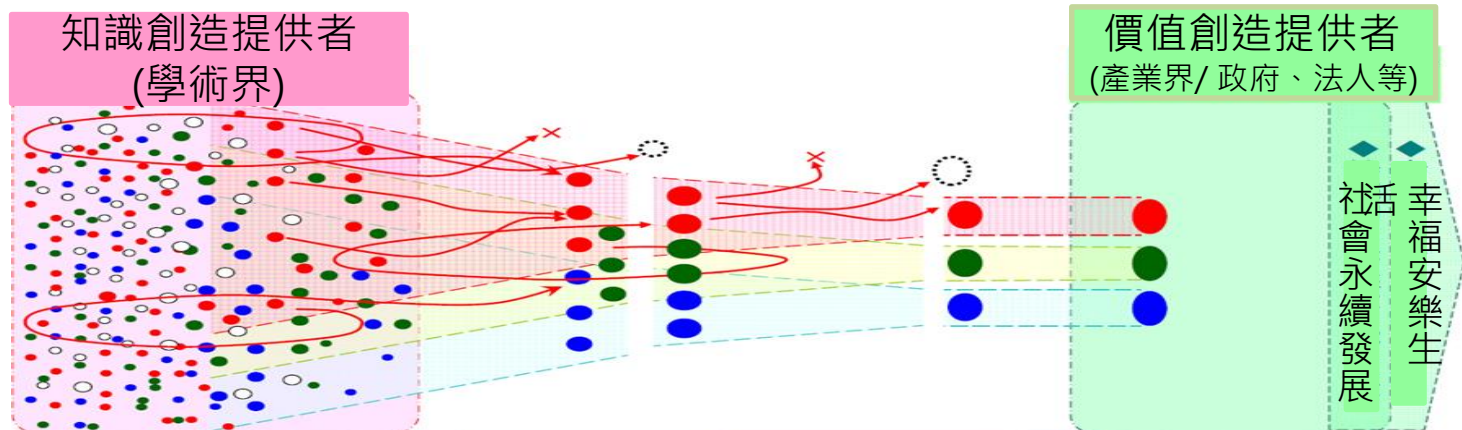
- 加速藥品、醫材、醫管服務的產業化推動，促進產業升級與國際化
- 生技博士到法人/學研機構「再加值」一年，能為業界聘雇或創業，縮短學用落差
- 預計3年、投入3億元、培訓300位符合業界需求之生技高階人才，導引進入業界

## ◆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練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

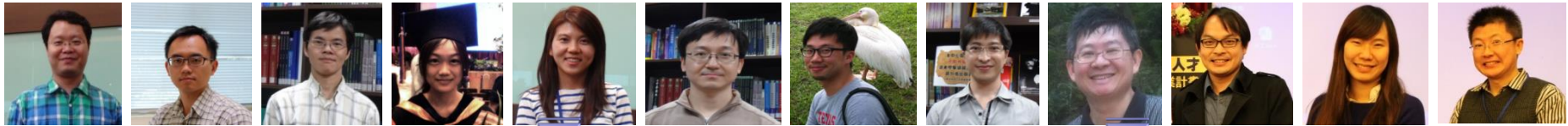
- 帶動業界晉用博士人才，提升產業研發能量，增加國際市場競爭力
- 解決生技產業高階人才供需失衡問題，改善生技博士畢業即失業現象
- 從學研界疏導高階生技人才到產業界，創造博士就業機會



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

# 102年(第一期)成功導引人才進入產業界



工業技術研究院  
Industrial Technology  
Research Institute

## 79位博士人才



財團法人生物技術開發中心  
DEVELOPMENT CENTER FOR BIOTECHNOLOGY



國家衛生研究院  
National Health Research Institutes



財團法人  
金屬工業研究發展中心  
Metal Industries Research &  
Development Centre



財團法人  
生技醫療科技政策研究中心  
Research Center for Biotechnology and Medicine Policy



財團法人醫藥工業  
技術發展中心  
Medical and Pharmaceutical Industry  
Technology and Development Center



財團法人醫藥品查驗中心  
Center for Drug Evaluation, Taiwan



National Cheng Kung University



## 生技高階人才培訓計畫102-103年(第一、二期)培訓成果

流向	102年(第一期) 人數	103年(第二期) 人數
培訓後創業	5	3
實習廠商留任	57	43
培訓單位留任	8	5
培訓單位媒合	5	4
自行求職	21	22
<b>成功就業 合計</b>	<b>96</b>	<b>77</b>
博士後研究員	7	16
未就業	7	15
未成功就業 合計	14	31
<b>培訓人數 合計</b>	<b>110</b>	<b>108</b>
<b>成功就業率</b>	<b>87%</b>	<b>71%</b>



- **成功導引高階人才進入業界**  
訓儲菁英有75%進入業界就業，25%於學研機構
- **廠商留任意願提高**  
訓儲菁英第一期實習廠商留任率40%，第二期提高為59%
- **工作穩定度高**  
第一期訓儲菁英仍在原就職單位服務年資達1年以上者占成功就業人數69%
- **平均聘僱薪資**  
訓儲菁英的平均聘僱薪資均高於培訓期間之薪資，達6.3萬以上，最高者達9萬以上

# 物盡其用：

## 工業 4.0 智慧製造



### 工業 1.0

#### 生產機械化時代

珍妮紡紗機的發明、瓦特改良蒸汽機，英國運用蒸汽動力讓生產從手工邁入機械時代



### 工業 2.0

#### 大量生產年代

1908年福特汽車創辦人Henry Ford以流水線裝配方式，改革生產流程，大幅降低生產成本



### 工業 3.0

#### 生產自動化普及

1975年德國和日本企業，以電子及網路通訊技術，將讓運算控制功能分布到系統各端，提高整體效能



德國提倡以物聯網、無線通訊為基礎，建構Cyber-Physical Systems(CPS)系統

▲  
複雜度

18世紀末

20世紀初

20世紀/70年代

今天

▶ 時間軸

# 重大發展課題研析

## 解決台灣經濟和生活課題

- 解決老年化和少子化，致工作人力及生產力下降
- 製造業外流(技術與人才)、附加價率下滑
- 中小製造廠商**實體數位化能力不足，將受衝擊**

### 高質(值)精微化

- **價值性(密度)**:精微製造、精密量測、監控和遠程診斷服務、中央監控系統
- **不可模仿性(深度)**:智慧控制器與關鍵元件技術研發
- **技術延伸性(廣度)**:應用IOT、Big Data和雲端等技術，提高產品附加價值

### 敏捷數位化

- **系統**:協助**中小企業**實體製造數位化，並建立CPS系統
- **平台**:智慧生產平台、整線生產平台(跨產業鏈)研發
- **整廠整線設計**:取得整線生產系統、智慧工廠等，具高值化輸出技術，在先進製造等領域產生規模效應。

### 服務人性化

- **人機協同**:設計與製造一體化、遠端控管與排程
- **服務導向**:個人化服務設計、一指下單生產模式
- **創新應用**:達成產業結構轉型，提升中小企業數位製造等創新技術

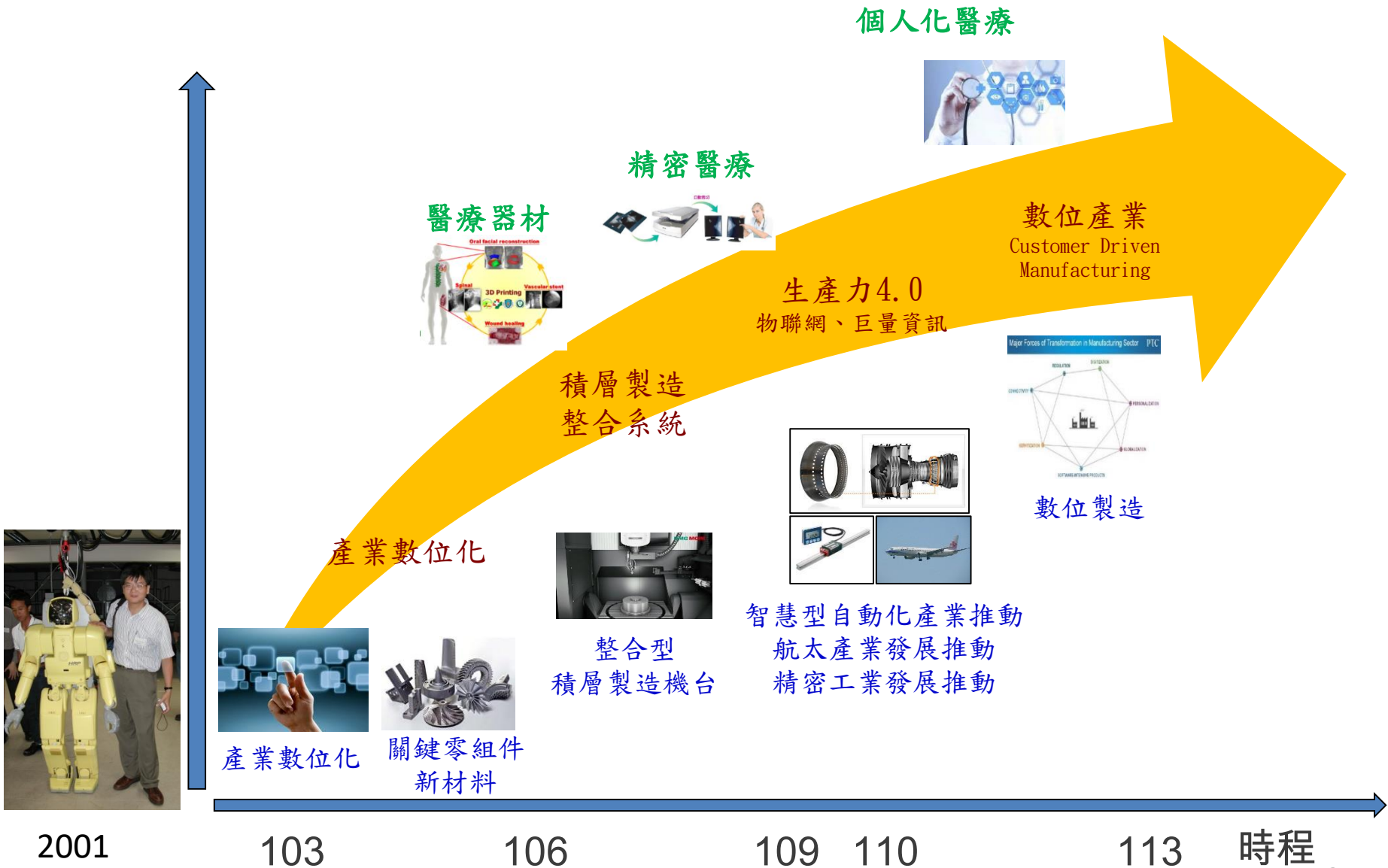
# 臺灣生物經濟發展方案規劃

## 7. 臺灣生物經濟各領域推動重點

	提升產業技術	法規調和引導	培育跨領域人才	推動產業化國際化	資金協助及其他
製藥	類新藥 利基產品	生技新藥條例  醫療器材專法	創業管理人才  強化法規審查人員	建置媒合招商平台、 國際通路	政策工具及上市 櫃機制募集資金  天使或創投資金
醫材	未被滿足之醫療 需求(unmet medical needs)		醫療及醫工跨領 域技術人才	傳統公司轉型永續 經營、Branding Taiwan	
照護	智慧照護醫材與 輔具及服務系統, 穿戴式裝置	長照法、衛生福 利資料統計應用 法規	醫管服務、健康 促進、健康照護 新興產業人才	國際醫療、醫管輸 出平台、一中心一 聯盟	醫管服務產業放 款、跨院醫療系 統、個人記錄
食品	新興食品加工技 術、高齡健康飲 食、國產特色農 產品加工	國際接軌之產業 自主管理法規	食育推動、食品 工廠專業職能及 法規教育	產製儲銷同盟體系、 低溫食品、利基特 色產品	生物資源保存庫、 市場資料庫
農業	種苗、基因體、 生物製劑、智慧 生產、再生資材、 動植物健康管理	農用生物製劑、 新型態疫苗、品 種、資材再應用 等法規	行銷、法規、智 財等管理職能、 創業人才	研發成果產業化量 能、國際商情市場、 新創事業	國際法規資料庫、 農業生技智財網



# 積層製造 (106-109、110-113年)



# Toward Precision Medicine:

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

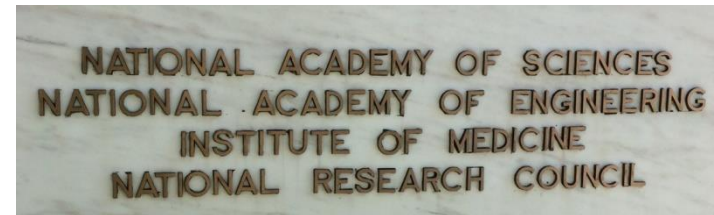
2011

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?

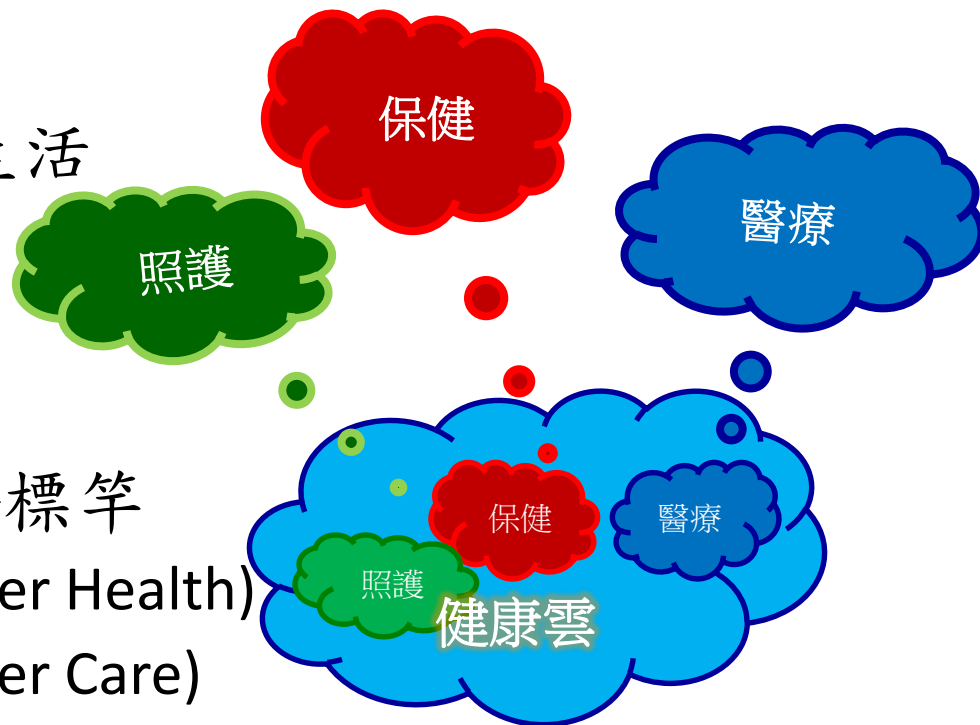
# 健康雲的內涵

- 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)

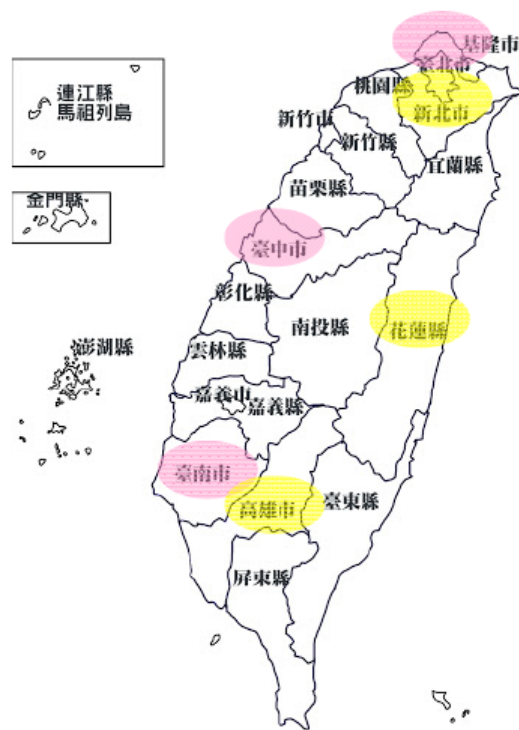
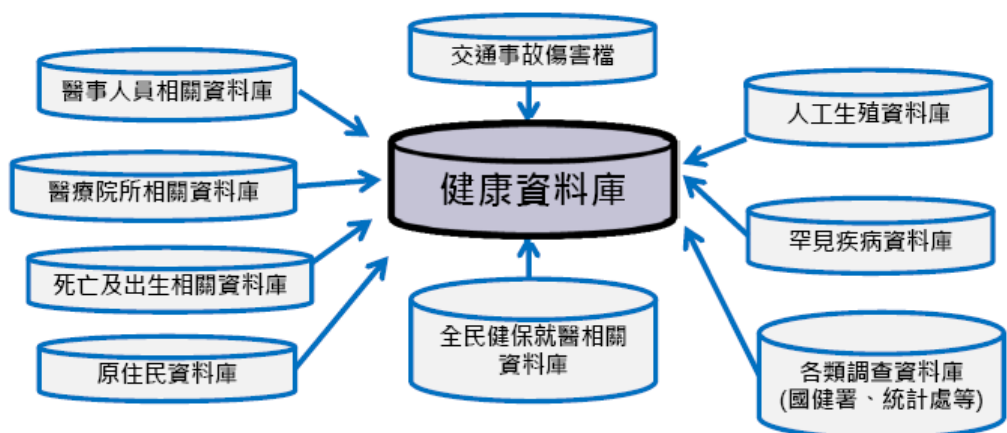




# 健康資料增值應用雲端化服務-執行現況

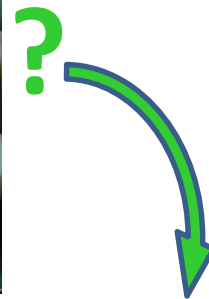
Ministry of Health and Welfare

- 健康資料增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

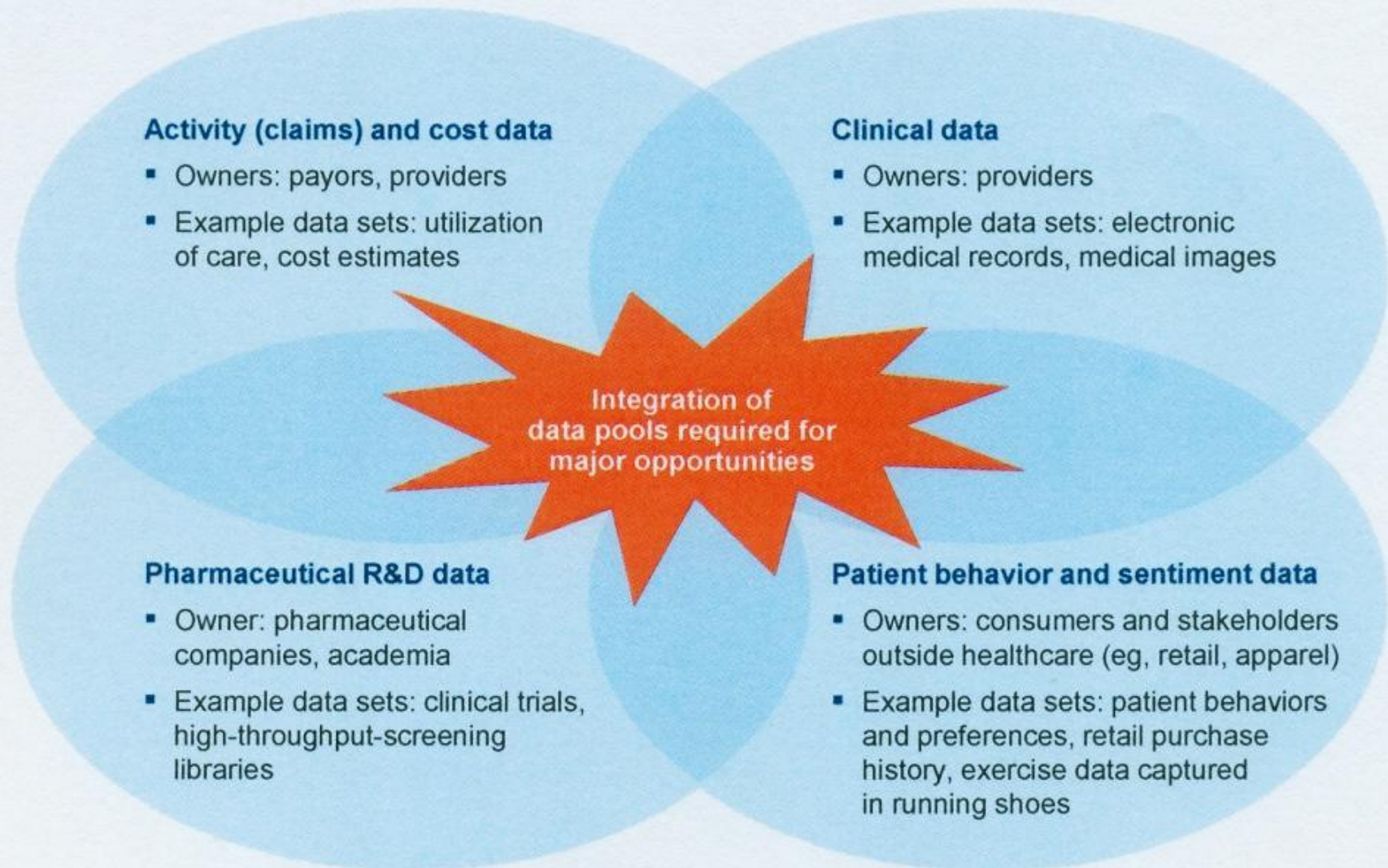
Center for US Health System Reform  
Business Technology Office



# The 'big data' revolution in healthcare

Accelerating value and innovation

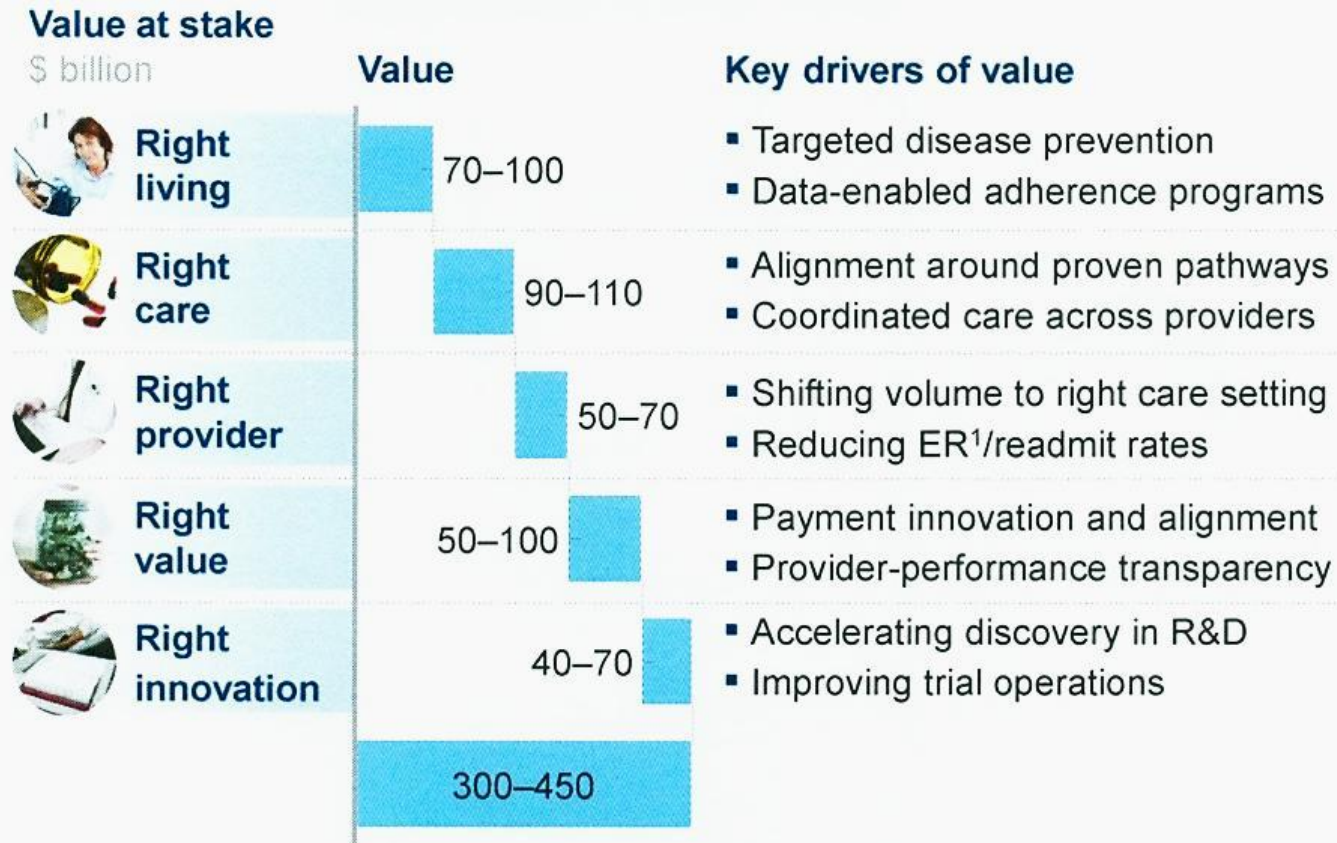
## Exhibit 2: Primary data pools are at the heart of the big-data revolution in healthcare.





# 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.**



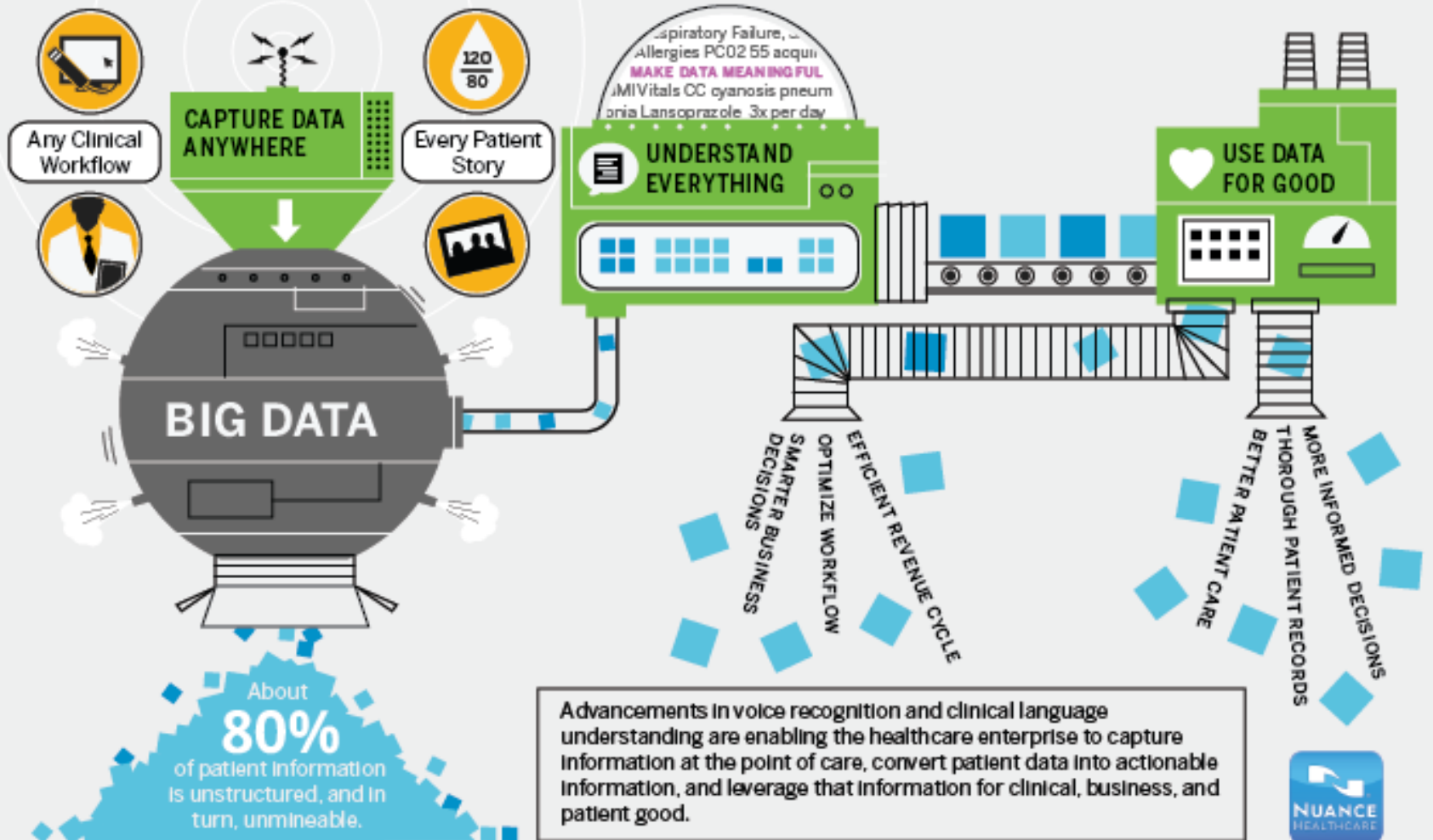
<sup>1</sup> Emergency room.

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.



# 6 Keys to the Future of Big Data in Healthcare Marketing

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**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

# Acknowledgement



**BOST**

行政院科技會報

科技報

Ministry of Science and Technology



行政院國家發展基金管理會

National Development Fund, Executive Yuan



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