

Fusion of nuclear and emerging technologies

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Outline

- ◆ Overview - premise
- ◆ Nuclear technology
- ◆ Emerging technology
- ◆ Fusion – technology/ application
- ◆ MINT – national focus
- ◆ Conclusion

The only constant is CHANGE

- knowledge expands and multiplies
- that which was true may no longer be so
- that which was only concept become reality
- that which was advanced becomes obsolete
- that which was emerging becomes mature
- and the process can be cyclical

Newtonian, quantum, chaos \leftrightarrow order
There are only four elements (wind, water, earth, fire)

Tomography
Wireless
Encryption
Biomimetrics

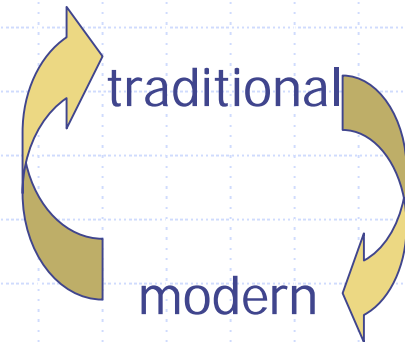
Stone \rightarrow iron \rightarrow atomic \rightarrow space
IT \rightarrow biotechnology \rightarrow nanotechnology
(check name of places...)

R&D \leftrightarrow commercialization

agriculture \rightarrow industrialization

Mechanization
Automation
Intelligent
AI, ES

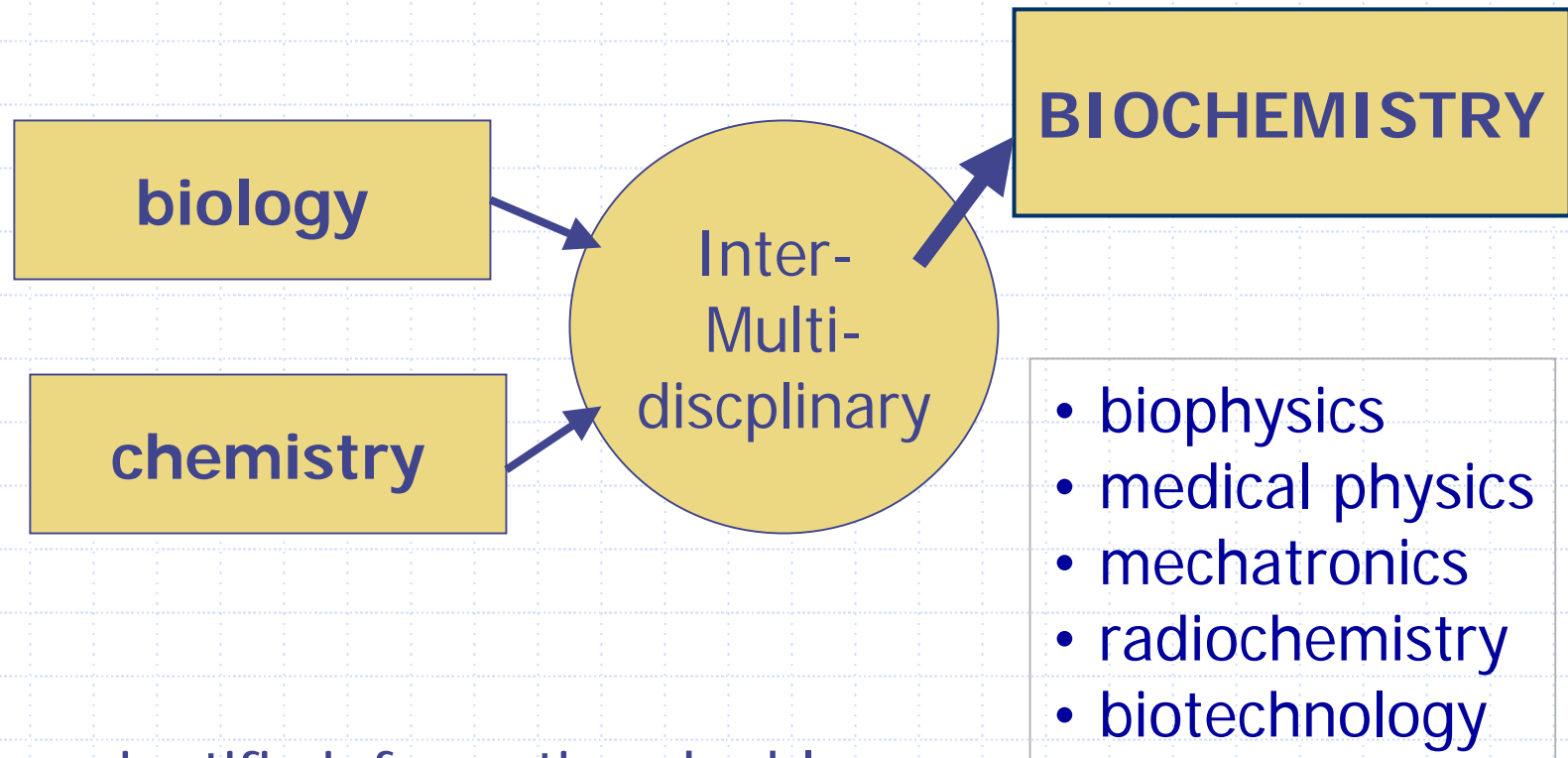
Productivity (p)
Electronic (e)
Mobile (m)
k-economy (k)



The progressive nature of knowledge

- ◆ Vacuum tube – transistors – IC
- ◆ Semiconductors – lithography (uv, x-ray, e-beam)

Knowledge expands and multiplies

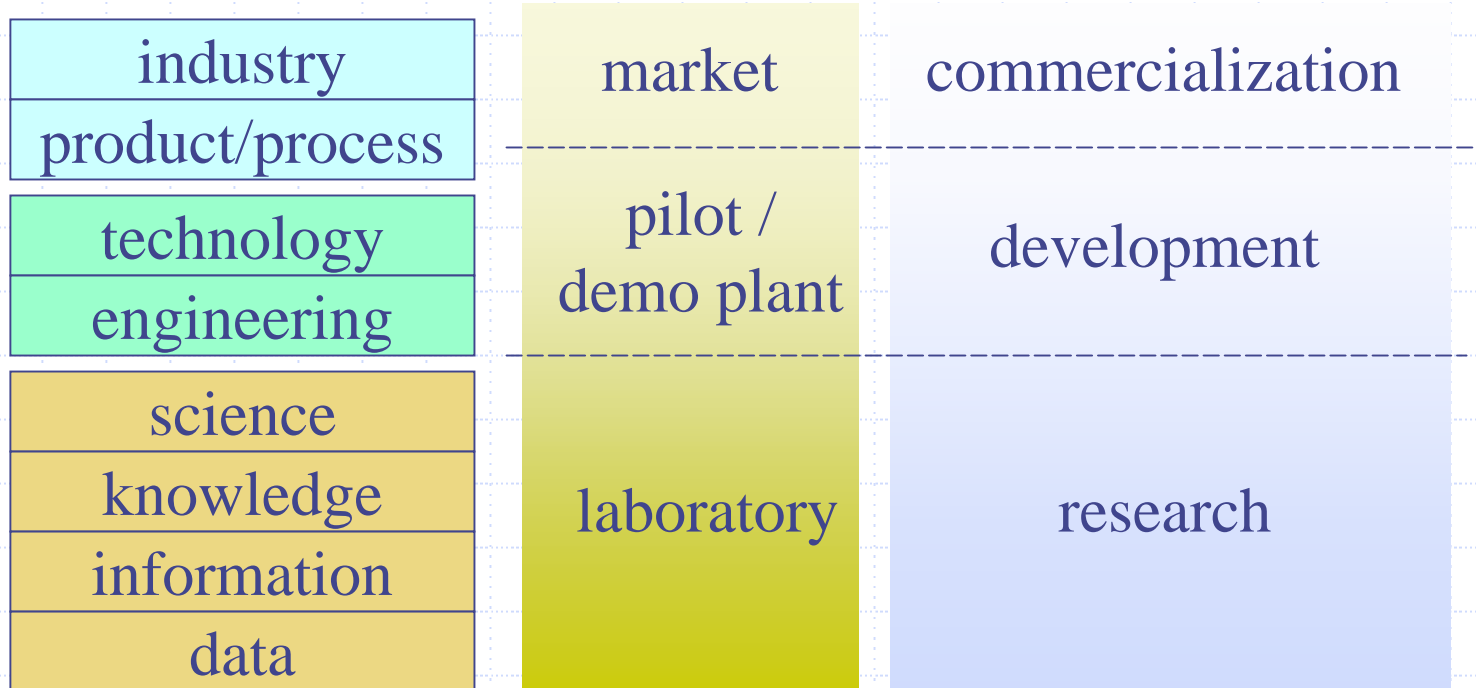


- scientific information doubles every about 15 years

Derek de Solla Price, 1963

Little Science, Big Science. Columbia Univ. Press

R&D: Lab to Market



implications

Everything is interconnected
No technology is an island

Change in one discipline

- render others obsolete
- opens up new possibilities

implications

Need to be multidisciplinary

-- material scientist

(chemistry, physics, computer, biology, physiology)

→ Cooperation

→ Matrix organization

→ Focus area/ target area oriented vs. discipline

Nuclear Science & Technology

**DARK
SIDE**

BRIGHT SIDE

- power generation
- non-power application
 - health
 - agriculture
 - industry
 - manufacturing
 - environment
 - etc.....

The Push

- ◆ Emerging technologies

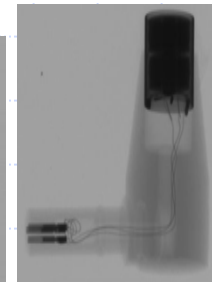
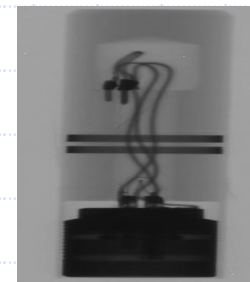
- ICT
- Biotechnology
 - ◆ Agriculture
 - ◆ Medical
 - ◆ Industrial/Manufacturing
- Nanotechnology

- ◆ k – economy

- ◆ new possibilities

Digital Radiography Imaging

- ◆ enabling filmless radiograph of soil material to allow faster access and interpretation and no image degradation over time
- ◆ Improvement needed in:
 - High sensitivity detectors
 - image improvements
 - system efficiency



Optically Stimulated Luminescence (OSL)

- ◆ application of luminescence techniques to sediments as an extremely useful tool in both archaeological and Quaternary contexts. A relatively new approach to chronological problems. Both quartz and feldspar rich sediments, which are otherwise undateable by conventional radiocarbon methods, can be absolutely dated ($\pm \sim 10\%$) within a range of 100 to 200,000 years.

Biosystemics Technology

- ◆ The convergence of nanotechnology, ecological science, biotechnology, information technology and cognitive sciences,
- ◆ prospective impacts on materials science, the management of public systems for bio-health, eco and food system integrity and disease mitigation.

New applications

- ◆ Bioremediation
- ◆ Human genome – ICT
- ◆ Molecular biology – drug development

Smart/ Clever Technologies

- ◆ Smart or intelligent devices and/or systems-taking away the “human factor”
 - reduce human errors
 - make delivery of services more user-friendly
 - hence improve patient compliance
- ◆ Increasing role of computerization/automation, wireless technology, biometry (to access patient records and for identification of victims, etc), bioinformatics and ICT...

Nanotechnology

- ◆ Nanomedicine- Things are getting smaller i.e. nanoscale (e.g. drug delivery via nanoparticles, molecular and receptor-based drug targeting)- **the nuclear advantage** is the possibility to obtain dynamic images of such nanosystems in vivo via radiolabelling and scintigraphic techniques)

Trends

- ◆ Environment-friendliness
 - Minimum waste, waste to wealth
- ◆ Personalization
 - “wellness” and preventive medicine (holistic approach – person, body and mind)
- ◆ Complimentary and Traditional
 - Herbal medicine, etc..

Nanotechnology

The science of developing materials at the atomic and molecular level in order to imbue them with special electrical and chemical properties

Nanotechnology, which deals with devices typically less than 100 nanometers in size, is expected to make a significant contribution to the fields of computer storage, semiconductors, biotechnology, medical, manufacturing and energy.

Radiation Technology

The science of using ionizing radiation such as X-ray, gamma ray, electron beam and ion beam to induce chemical and biological changes in the system at the molecular level.

Radiation technology has been used since 50's for crosslinking, grafting and degradation of plastic materials, sterilizing medical products and preserving foods.

Radiation Technology vis Nanotechnology

Common feature of radiation technology and nanotechnology is that their applications cut across many fields such as medical, agriculture, biotechnology and industrial manufacturing.

Ionizing radiation induces excitation and ionization of single molecules (nanosize) which lead to the formation of active species that will undergo intra-molecular reactions.

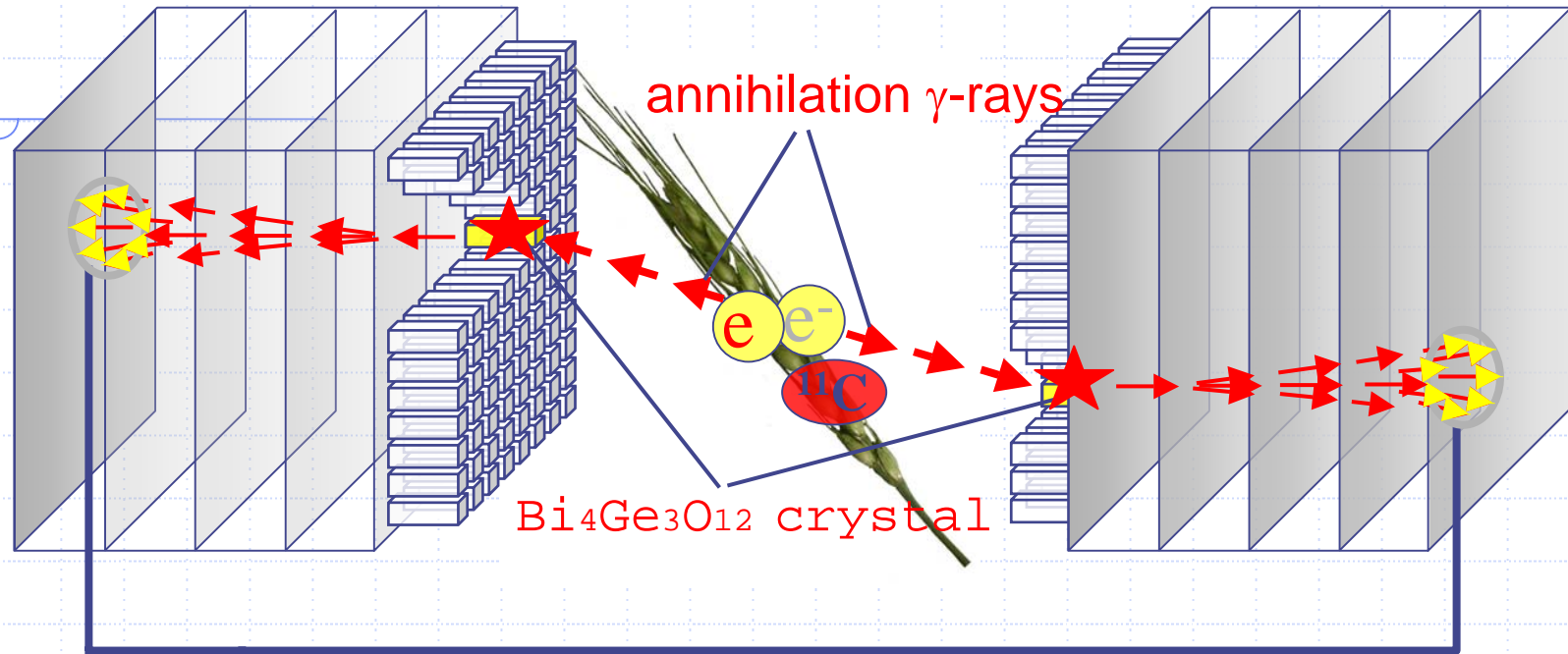
Research & Development at MINT – Radiation vis nano

- Radiation processing of natural rubber/clay nanocomposites
- Radiation processing of nano-sized particles – organic polymer composites
- Radiation synthesis of nanogel e.g. drug delivery systems, encapsulation of cells, selective membranes etc

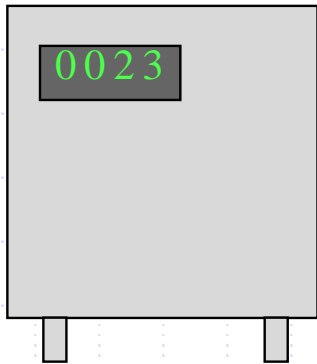
Mutation breeding

- ◆ Combination of radiation induced mutation for plants and tissue culture for propagation
- ◆ Use of mutation breeding to modify bacteria – bioprocessing

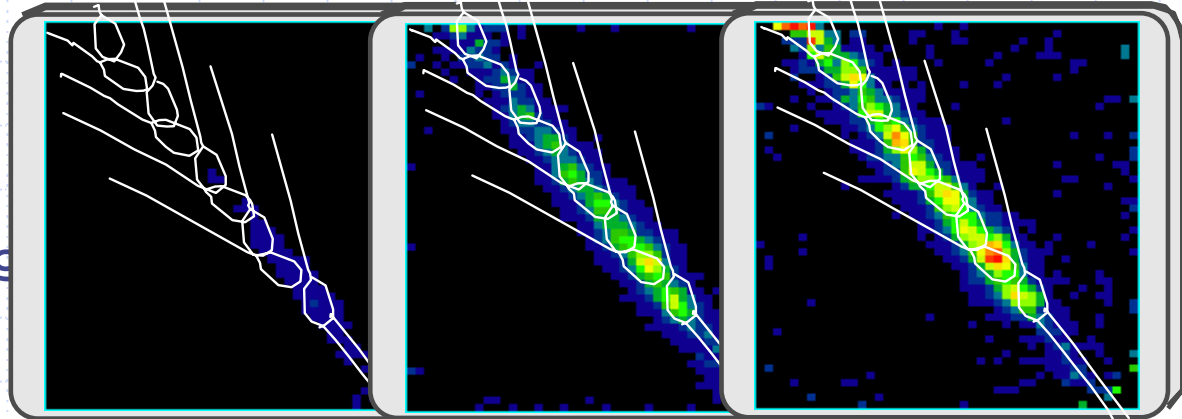
PETIS : Positron Emitting Tracer Imaging System



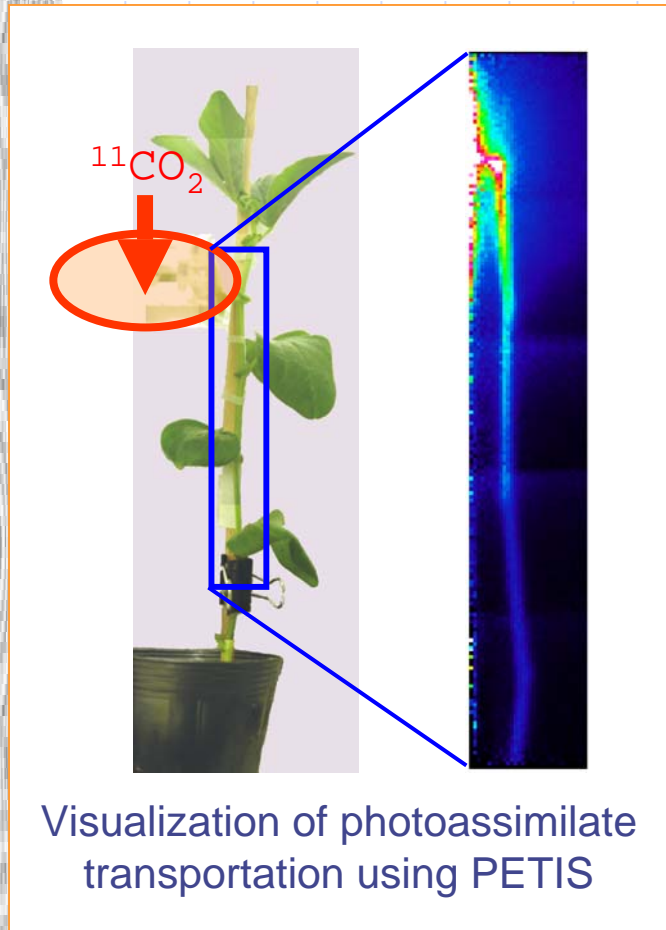
Coincidence counting



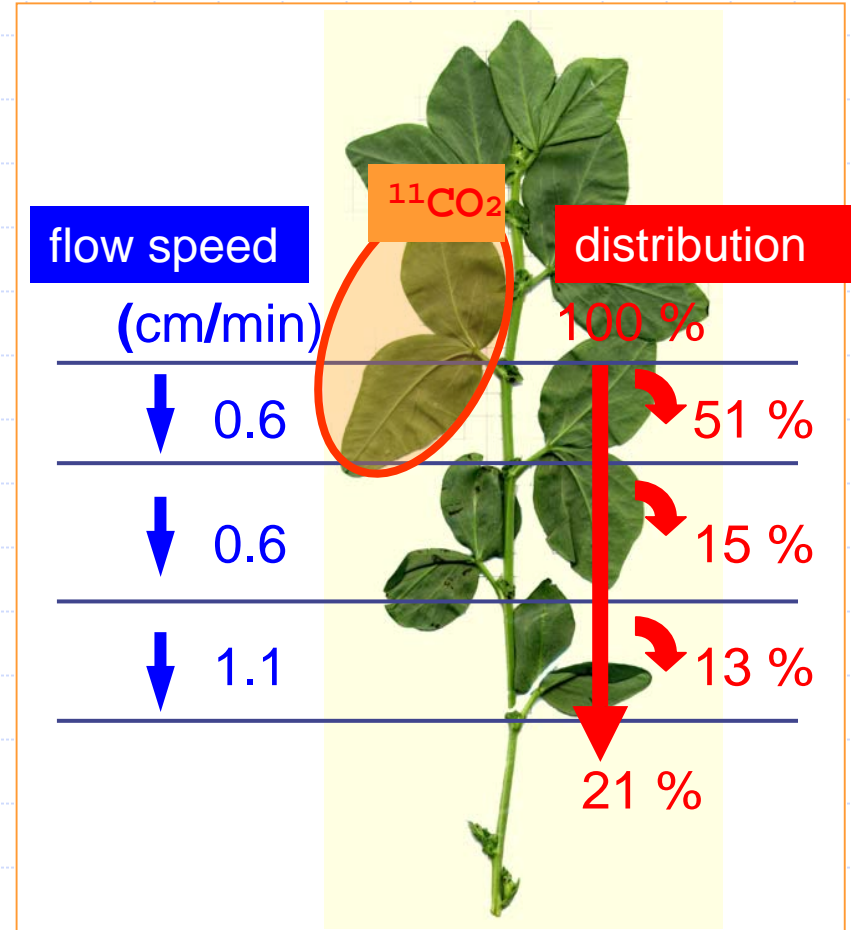
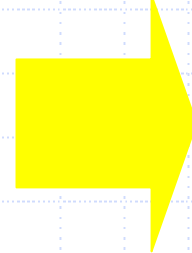
imaging



Mathematical analysis of nutrient transportation



Analysis



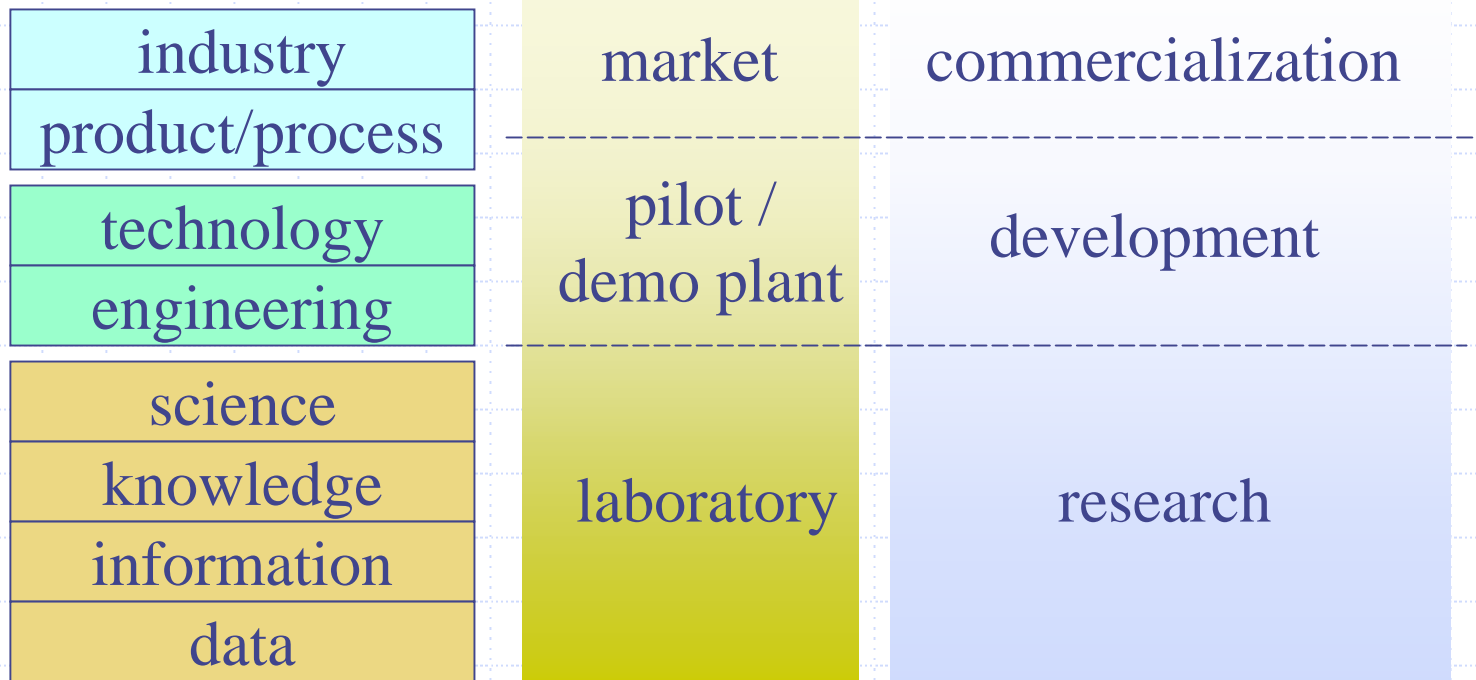
Quantitative understanding of physiological phenomena

Policies: Areas of Thrust



- ◆ Biotechnology
- ◆ ICT
- ◆ Advanced Material
- ◆ Advanced Manufacturing

R&D: Lab to Market



Tapping into unconventional knowledge

Exploration/ expedition

- jungle/ forest
- sea
- everywhere

To the sea



To the forest



Tapping into new avenues

- partnerships
- evoking ownership of the public
 - national heritage
- indigenous resources



Exploitation of existing capability

