THE CONTRIBUTION OF BASIC RESEARCH IN THE ISRAELI ACADEMIA TO BIOTECH, HIGHTECH AND TO THE ECONOMY

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Changing role of Universities

- Traditionally - two roles of the Universities:
- I. Creation of new knowledge - Research
- II. Transmission of knowledge to next generation

- More recently - additional roles:
- I. Contribute to Society
- Ii. Contribute to Economy

- Research in academic institutions is mostly basic, namely curiosity-driven
- In some cases it results in innovations and reaches a stage when these are applicable
- Technology Transfer - leads to conversion of the applicable to Applied Research
- Development into a product can be achieved only by industry
- Only a fraction of basic research leads to applicable innovations and only a small fraction of those become applied
- Several examples from Israeli research

MATHEMATICS – contributions to Economy

The research of Prof. Daniel Kahneman and Amos Tversky (Hebrew University) contributed to the processes governing decision making in Economics. Awarded the Nobel Prize in Economy 2002.

The research of Prof. Yisrael Aumann (Hebrew University) in Game Theory was recognized as a cornerstone and led to the award of a Nobel Prize in Economy 2005.

MATHEMATICS and COMPUTER SCIENCE I

- One of the most important contributions is the Lampel - Ziv (LZ) Algorithm, developed at the Technion.
- The LZ algorithm enables data compression and transmission via the internet. It made a significant contribution to the establishment of the internet as a global communication medium.
- It further led to the development of software programs such as TIFF, ZIP, and JPG for transmission of pictures, from space as well. Enormous economical significance.
- Profs. Ziv and Lampel received many awards and honors, including the Marconi Prize and the Israel Prize.

MATHEMATICS AND COMPUTER SCIENCE II

- RSA (Rivest Shamir, Adelman)
  Algorithm for encryption. Shamir – from WIS
- RSA is an algorithm for public-key cryptography.
  It involves three steps – key generation,
  encryption and descryption.
- RSA is the basis for the science of cryptography
- Global application in the entire banking system
  with huge economical significance

The three developers of RSA won the Turing award.

COMPUTER SCIENCES - HARDWARE

- Development of Flash Memory
- Dov Moran, along with other scientists from the academia, developed the Disk-on-Key, in the start-up company M- System
- The company acquired the 4X technology, from the Tel-Aviv University for improving the product.
- M-System was acquired for $1.55 billion by Sun-Disk, that continues to develop the products

SOFTWARE and HARDWARE

A few additional examples:

- Babylon – translation software to 75 languages – Amnon Ovadia
- Algorithm for picture sharpening – Raanan Fattal (Hebrew University). Used by Adobe Company
- Video abstracts – Shmuel Peleg (Hebrew Univ)
- Videoscript for smart cards – Adi Shamir (WIS) - NDC
- Zend Technologies – Zeev Surasky and Andi Gutmans and other Technion scientists – for dynamic internet
- ICQ messaging program developed by MIRABILIS – a company established by 5 Israeli scientists.

PHYSICS

- Research in Physics is mainly theoretical and contributes to the extension of knowledge and understanding the laws of nature.
- Some Israeli contributions:

1) Particle Physics – prediction of the quarks
   by Yuval Neeman (TAU) and Haim Harari (WIS)
2) Aharonov - Bohm effect (TAU) –
   Yakir Aharonov received the President Medal by Barak Obama
3) Mesoscopic Physics of Quantum Systems - Joseph Imri (WIS)
4) Understanding of "Black Holes" – Yaacov Beckenstein (Heb Univ)
5) Quasi – crystals – Dan Schechtman (Technion)

All these researchers received the Israel Prize,
Beckenstein received the wolf Prize and
Schechtman– The Nobel Prize 2012.

CHEMISTRY

- Discovery of Ubiquitin by Hershko and Ciechanover (Nobel Laureates 2004, Technion)
- Application – development of novel anti-cancer drugs
- Ribosome structure by Ada Yonath (Nobel Laureate 2009, Weizmann Institute)
- Application – potential development of novel antibiotics, based on crystallograhy
- Discovery of Quazicrystals (Nobel Laureate Dan Shechtman, Technion) - novel materials

CHEMISTRY - Nanomaterials

- I. Nanoparticles – Fullerenes based on inorganic materials (Weizmann)

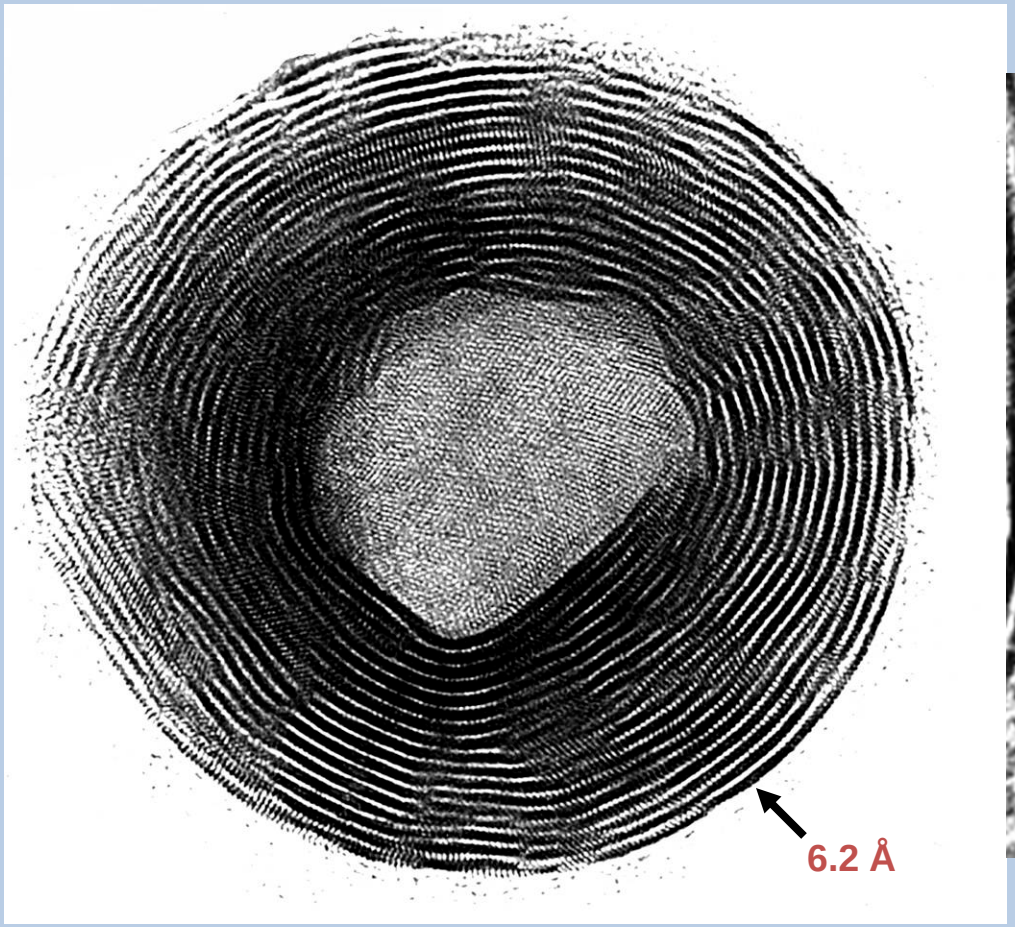
  Applications – Nanospheres for lubricants

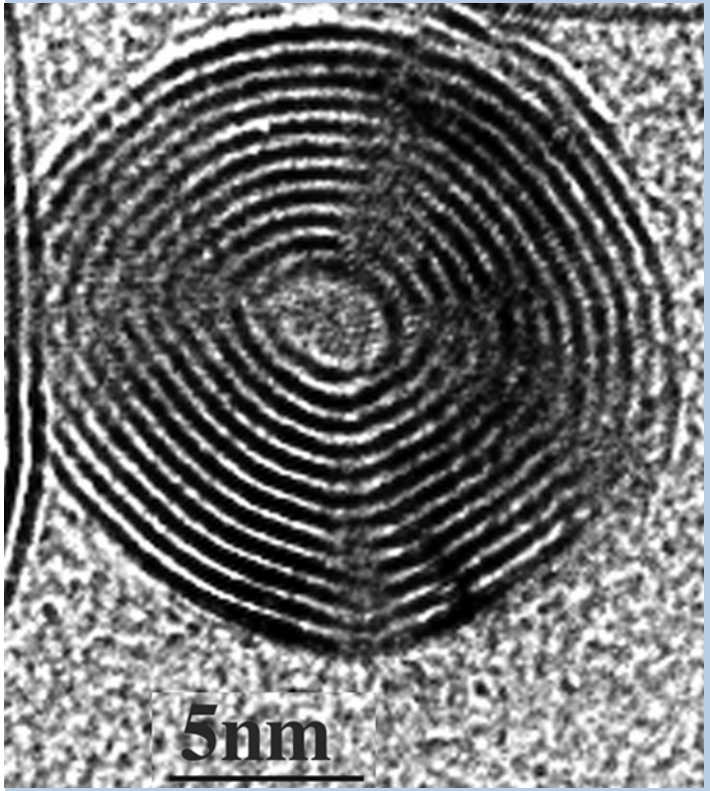
  Nanotubes for extra strength materials

- II. Nanotubes based on peptides - biosensors (TAU)

- III. DNA fibers – use as electrical conductors (Technion)

Fullerene-like WS2 and MoS_2 structures





WS_2

MoS_2

R. Tenne and co-workers

Lubrication using WS_2 nanoparticles

AGRICULTURE

- Discovery of “mother of wheat” by Aharon Aaronson in 1906. The basis for wheat genetics
- Development of high yield wheat strains (Moshe Feldman (WIS)
- Development of the original strains of Cherry Tomatoes – Nahum Kedar (Hebrew University)
- Development of transgenic plants (maize) resistant to herbicides – Jonathan Gressel (WIS)
- Comercialization of special seeds by Zera Co.
- Development of Drip Irrigation

BIOTECHNOLOGY - I

Basic research discoveries

- Electricity conductor DNA – Uri Sivan (Technion) - Metal string with diameter 1/1000 of human hair. Serve as biosensors in Nano electronics
- DNA computing system – Ehud Shapira (WIS) the smallest developed computer, can serve for cancer diagnostics as well as in vivo controlled drug release. (Guinness book, 2004)
- Translation of neural signals in the brain and their presentation in motion on computer screen. Eylon Vaadia (Hebrew University). Potential – movement of artificial limbs by the brain.

BIOTECHNOLOGY II

Start-Up Companies (3 out of about a thousand)

- Protalix –Pharmaceutic platform for production of recombinant protein in plant cells (carrot or tobacco) in plastic reactors. First product – a drug competing with Genzyme's drug for treatment of Gauche. Founder – Yossi Shaltiel (WIS)
- Gamida-Cell- The only company in the world that developed technology for culturing stem cells, to allow preparation of sufficient quantity for cancer treatment from one sample of umbilical cord blood. Founder - Yael Margolin (WIS)
- Compugen – a unique company on a global scale - develops in silico technology for diagnostics and drug discovery

MEDICAL DEVICES

- In medical devices Israel is a power – second (in absolute terms) only to the USA. Two examples:
- Medinol – Development of sophisticated stents for cardiology
- GIVEN Imaging - Development of Pillcam for non-invasive endoscopy
- These companies are not part of the academia, but their founders and staff come from the academia.

DRUG DEVELOPMENT

I. By scientist of the Hebrew University – Yissum

- Excelon – for treatment of Alzheimer Disease
  Developed by Martha Weinstock.
  Produced by Novartis.
- Doxil – Slow release anti-cancer drug
  Developed by Yehezkel Bernholz
  Produced by Johnson & Johnson

Embryonic Stem Cells development for treatment of ADM (Benjamin Rubinof) and Multiple Sclerosis (Tamir Ben-Hur)

DRUG DEVELOPMENT

II. By scientists of the Technion

- Azilect - for the treatment of Parkinson Disease
  Developed by Moussa Yudim
  Produced by TEVA
- Embryonic Stem Cells for medical use (myocarditis)
  Devloped by Yossi Itskovich
- Ubiquitin-based anti-cancer drugs
  Developed by Aharon Ciechanover
- Development of regenerative Medicine - Lior Gepstein

DRUG DEVELOPMENT

III. At the Weizmann Institute

- Rebif – for treatment of Multiple Sclerosis developed by Michel Revel – Serono company
- Copaxone – for the treatment of Multiple Sclerosis developed by Ruth Arnon an Michael Sela - Teva
- Erbitux – for treatment of colon cancer developed by Michael Sela and Ety Pirak – Eli-Lilly

ISRAELI ETHICAL DRUGS

Sales in 2012	University	Company	Drug
$3.8B	Weizmann	TEVA	Copaxone
$2.2B	Weizmann	Merck-Serono	Rebif
$0.9B	Hebrew University	Novartis	Exellon
$1.0B	Weizmann	Eli Lilly	Erbitux
$0.3B	Hebrew University	Johnson & Johnson	Doxil
$0.3B	Technion	TEVA	Azilect

CONCLUSIONS

- In ISRAEL basic research in universities and other academic institutions promotes scientific knowledge, but is often also “translated” into applied science.
- All universities in Israel have Technology Transfer units that secure their Intellectual Property
- Technology transfer enables the inter-relations with industry (Technological Incubators, as well as Start-up Companies) in High-Tech and Bio-Tech
- This interaction promotes the economy of the country as well as its scientific reputation

THANK YOU
For your
Attention