

# Convergence, from the Perspective of Nanotechnology

Mauro Ferrari, PhD

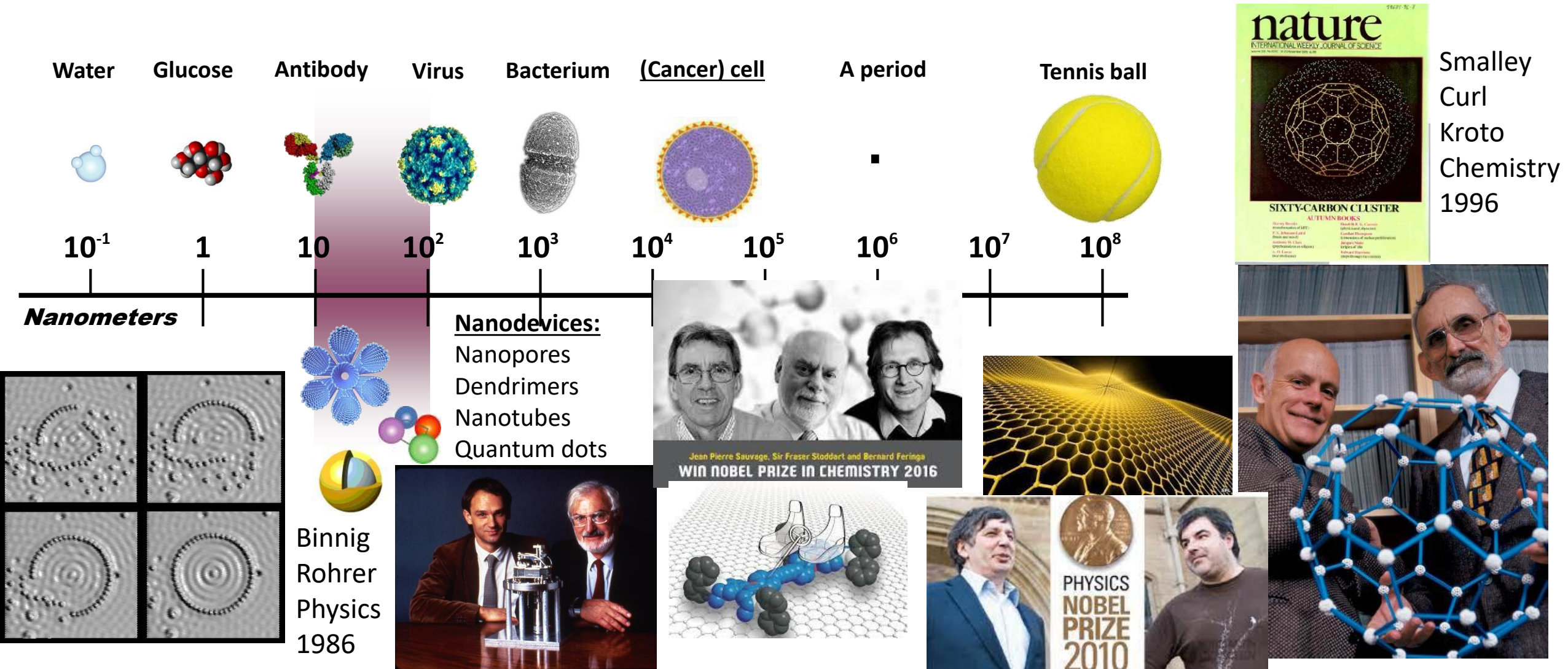
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# NanoTMS = Nano-Technology, Medicine, Science

## Defining “nano”: Dimensions AND Different Behavior





# You know nano....



All smart phones, powered by semiconductor nanoelectronics



Dozens of new cancer drugs

Many consumer products: Textiles, sunscreens, food, materials, cosmetics, sport equipment, aerospace, medtechs, jewelry, furniture, adhesives, paints....

And of course the Art!  
(Chapel of St Zeno Rome)



## INSIDE AN MRNA COVID VACCINE

COVID-19 vaccines made from messenger RNA use lipid nanoparticles — bubbles of fats — to carry the molecules into cells. The mRNA contains the code for cells to produce the 'spike' protein that the coronavirus SARS-CoV-2 uses to enter cells. Here are key innovations in the design of these vaccines.

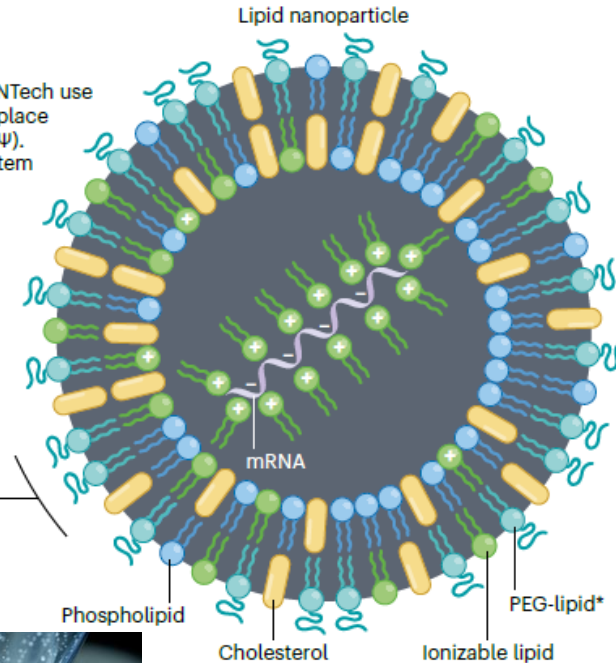
mRNA  
...CGAGΨΨCGΨGΨΨAA...

The vaccines made by Moderna and Pfizer-BioNTech use mRNA that has been chemically modified to replace the uridine (U) nucleotide with pseudouridine (Ψ). This change is thought to stop the immune system reacting to the introduced mRNA.

To help the body mount an effective immune response to later SARS-CoV-2 infections, the mRNA sequence is adapted to stabilize the spike protein in the shape it uses when fusing with human cells.

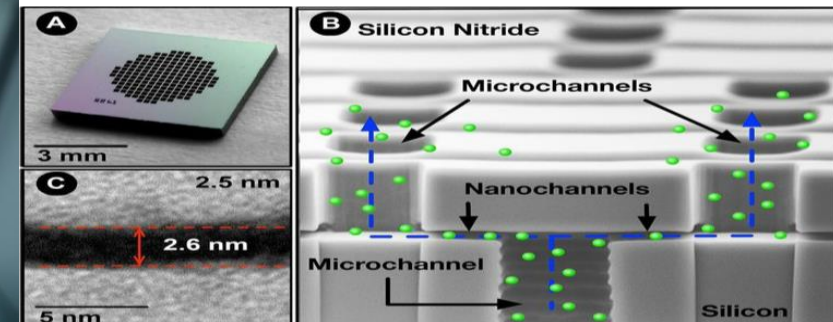
Lipids

The fatty nanoparticle around the mRNA is made of four types of lipid molecule. One of these is 'ionizable': in the vaccine, many of these molecules have a positive charge helping to negatively charged mRNA, they lose that charge in the conditions of the body, reducing toxicity in the body.



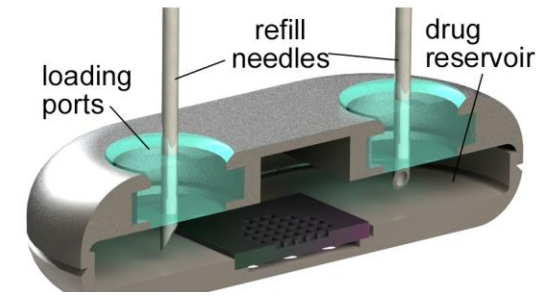
\*Lipid attached to polyethylene glycol

*Nature, 597,  
September 16,  
2021*





# NanoTMS at work: Nanoglands in Space and on Planet Earth



- Mission: Combating muscle atrophy and bone loss for space travel
- Applications in everyday medicine: Osteoporosis, Cancer Cachexia, but same platform for AIDS/HIV and ...
- Enabling technology: Nanochannel Fluidics
- New Science: Non-Fickian Diffusion & Full-Range Osmosis
- Manufacturing Inspiration: “The Lost Wax” technique of sculptors in Ancient Greece

# Convergent or Super-Disdisciplinary ?

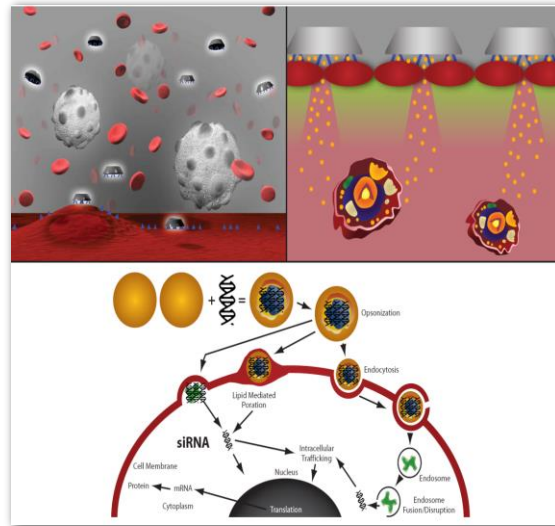
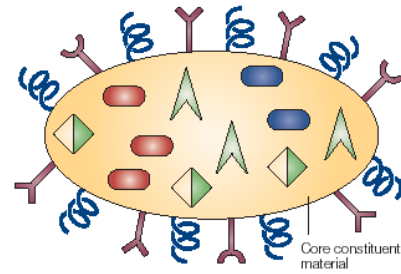
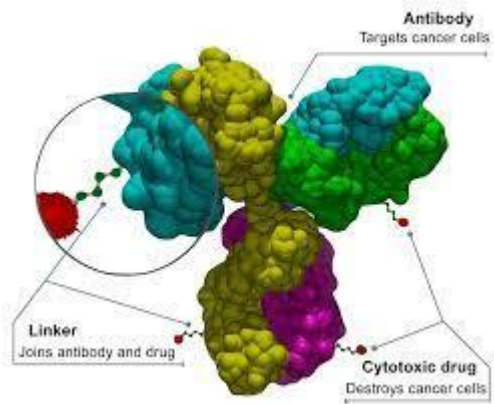
- NanoTMS is multi/trans/inter-disciplinary (super-?)
- How is that different from “convergent”?
- Perhaps a clue to the (inevitable) obsolescence of the taxonomy (matrix) of knowledge?
- Time to “Invert the Matrix”?
- For a world of science at the service of the needs of the global community?



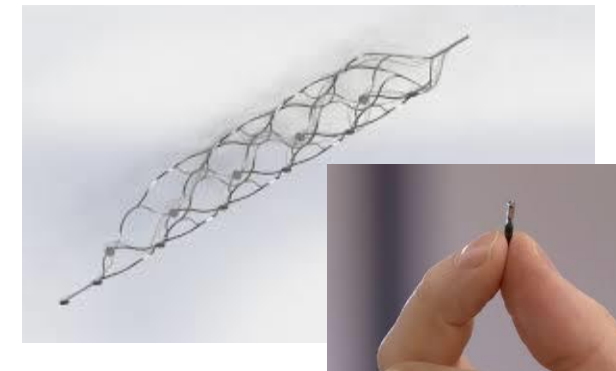


# Vistas on the Future NanoTMS Scenarios

- *A world without cancer death ?*
- Key enabler: Multicomponent (convergent) therapeutic agents



- *A world with instant physical (brain!) connectivity for all ?*



# On ethical challenges for NanoTMS

- Personal impression: The 4-axis approach of beneficence, nonmaleficence, respect/autonomy and justice is sufficient
- However, the relative weights are modified
- Key concerns:
  - Balance between self-determination/privacy and optimal care algorithms, as societally defined
  - Universal access
  - Discriminatory practices (healthcare, opportunity, education, social domains)
  - Differentiation of society into layers (casts) of privilege, of ever-increasing differentials
  - A culture of performance enhancement
  - Direct access to the brain? The “UniMind TikTok” World?
- A failure to suitably address these concerns may lead to irreversible damage in the very fabric of global society

## A Portrait of Nanomedicine and Its Bioethical Implications

Rebecca M. Hall, Tong Sun, and Mauro Ferrari

### Introduction

*A Brief Overview of Nanotechnology and Nanomedicine*

While the definitions employed by different governmental agencies and scientific societies differ somewhat, the term “nanotechnology” is generally understood to refer to the manufacturing, characterization, and use of man-made devices with dimensions on the order of 1-100 nanometers (1 nanometer [nm] = 1 billionth of a meter). Devices that comprise a fundamental functional element that is nanotechnological are also frequently comprised within nanotechnology, as are manufactured objects with dimensions less than one micrometer. The differences in definition lead to occasional paradoxes, such as the fact that the most widely used nanodrug (albumin nanoparticles of dimensions up to 300 nm, comprising the anticancer drug paclitaxel) is labeled a “nanopharmaceutical” by governments of European countries, Canada, and Australia, but it is not a nanotechnology for the U.S. Food and Drug Administration (FDA). It is also common in scientific domains to restrict the term “nanotechnology” to objects that possess special, “emerging” properties that only arise because of their nanoscale dimension. Our perspective has been further restrictive, requiring

**Mauro Ferrari, Ph.D.**, is the President and CEO of The Methodist Hospital Research Institute where he holds the Ernest Cockrell Jr. Distinguished Endowed Chair, and is President of the Alliance for NanoHealth in Houston. He received his Dottore in Matematica from the Università di Padova, Italy, and his Ph.D. in Mechanical Engineering from the University of California, Berkeley. Dr. Ferrari also served as Special Expert on Nanotechnology at the National Cancer Institute in 2003-2005, providing leadership into the formulation, refinement, and approval of the NCI's Alliance for Nanotechnology in Cancer, currently the world's largest program in medical nanotechnology. **Rebecca M. Hall, Ph.D.**, is the Manager of Scientific Communications for The Methodist Hospital Research Institute and has 15 years of experience in cancer and regenerative medicine research. Dr. Hall received her Ph.D. in Immunology from Baylor College of Medicine and B.S. in Biochemistry from the University of Illinois at Urbana-Champaign. She is an Aspen Cancer Conference Fellow and received the Theodore T. Puck Award for Cancer Research for her work on molecular cancer diagnostics while Assistant Professor of Cell and Molecular Biology at Baylor College of Medicine. **Tong Sun, M.S., M.B.A.**, is the Director of Central Operations for The Methodist Hospital Research Institute. Mr. Sun received a M.S. in Biomedical Sciences from the University of Texas Graduate School of Biomedical Sciences at Houston and a M.B.A. from the McCombs School of Business at the University of Texas at Austin. He spent 10 years at the University of Texas M. D. Anderson Cancer Center, conducting research on oncogenes, protein kinases, and signal transduction of leukemia. He was the Director of Management Operations in the Department of Nanomedicine and Biomedical Engineering at the University of Texas Health Science Center at Houston prior to joining The Methodist Hospital Research Institute.

# Thank you for your attention

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