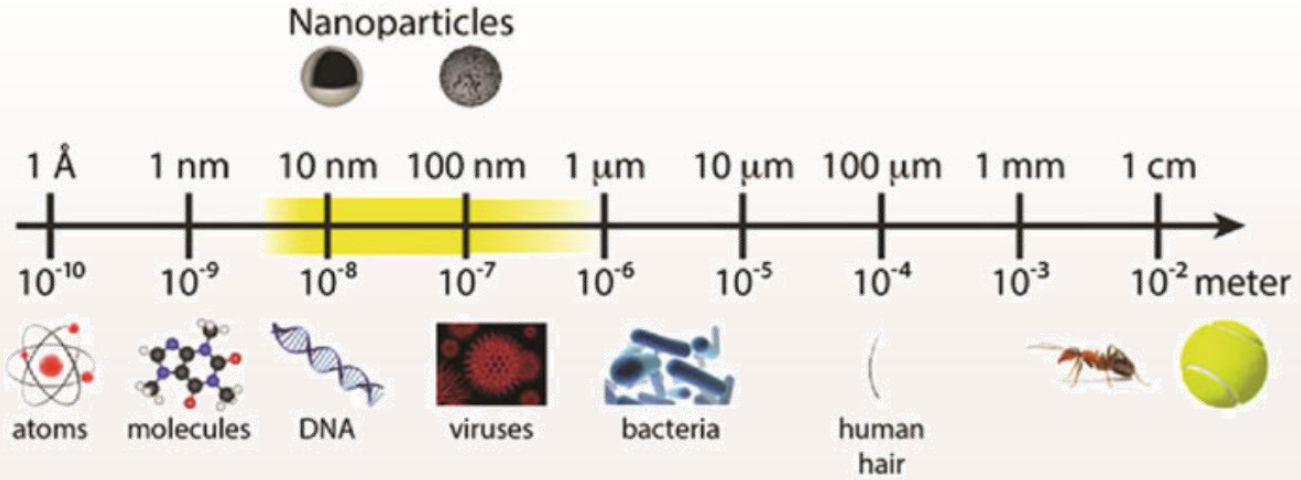
Smart nano-bio devices in NMIBC

Clàudia Mercader Barrull
Hospital Germans Trias i Pujol

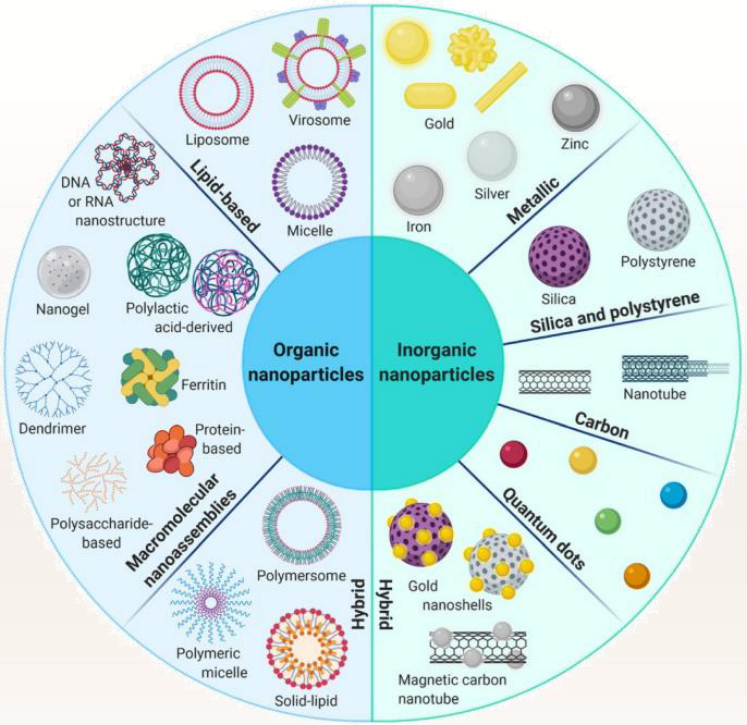
Reed P. (2015). Ant-man. Marvel Studios

What is a nanometre?



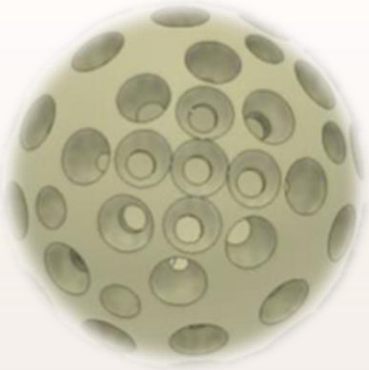
Pabbati, R et al. Nanotechnology for Advances in Medical Microbiology. Environmental and Microbial Biotechnology. Springer, Singapore.

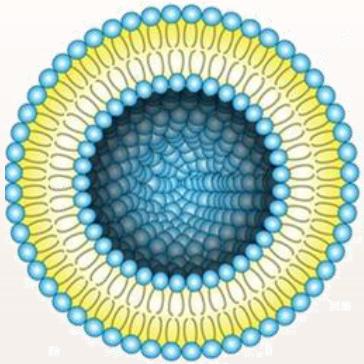
Nanoparticles

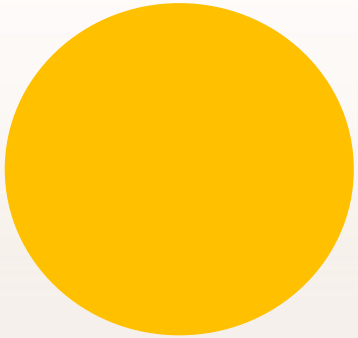


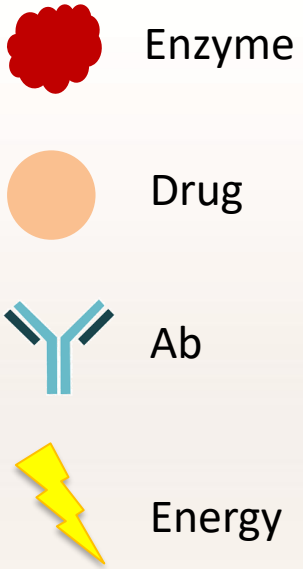
Chehelgerdi *et al. Mol Cancer* 22, 169 (2023).

Smart nano-bio devices









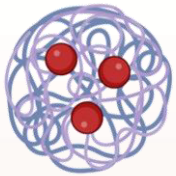
Yang X et Al Mesoporous Silica Nanoparticles for the Uptake of Toxic Antimony from Aqueous Matrices. ACS Omega. 2023.

Caple S Jr. (2023). Transformers: Rise of the Beasts. Pramount Pictures

Applications in biomedicine


Wound healing

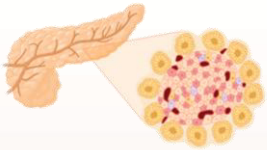

Cancer theraphy


Drug delivery

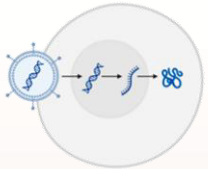

Antimicrobial agent

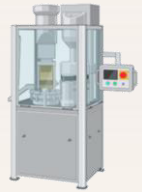

Tissue engineering


Biosensors


Diabetes

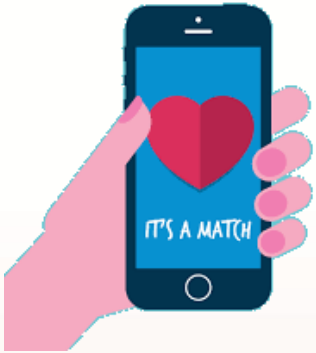

Cosmetics


Gene delivery


Food system

Eker, F et Al. *Molecules* **2024**.

Limitations



BIOCOMPATIBILITY

STABILITY

PRODUCTION

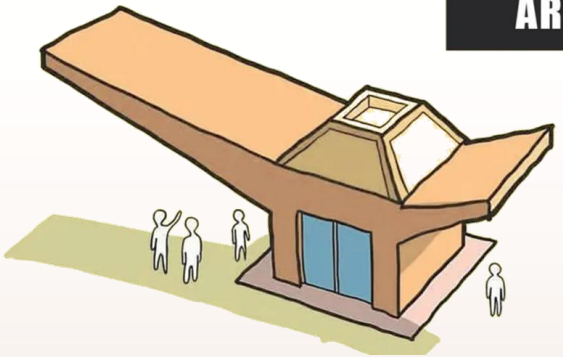
SECURITY

CONTROL

ETHICS

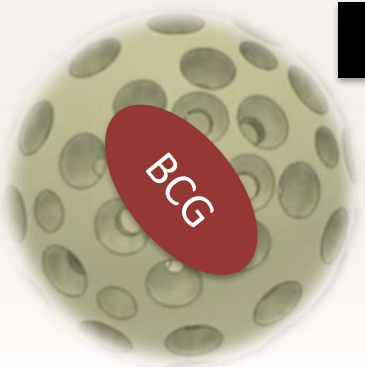
Smart nano-bio device design

ARCHITECT

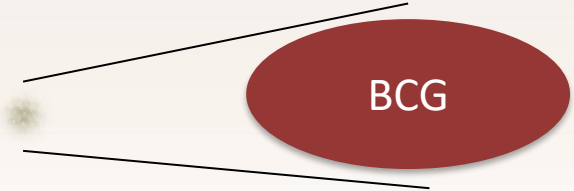


ENGINEER

UROLOGIST

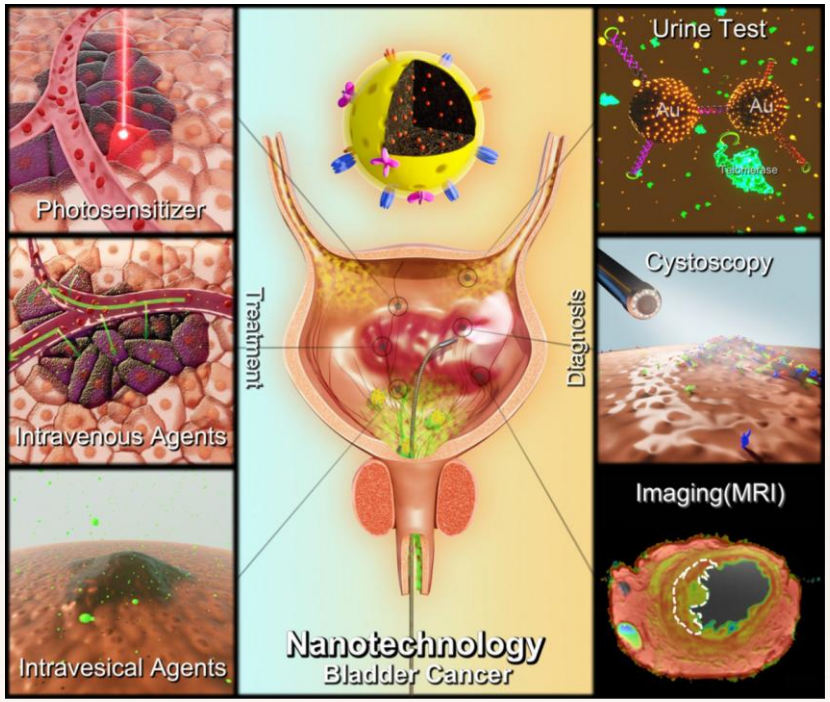


ENGINEER



Applications in bladder cancer

TREATMENT

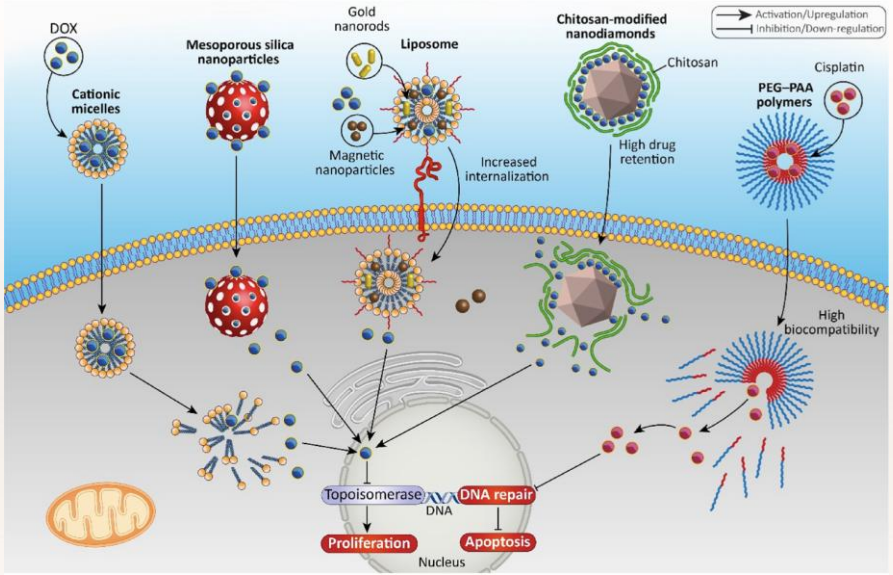


DIAGNOSIS

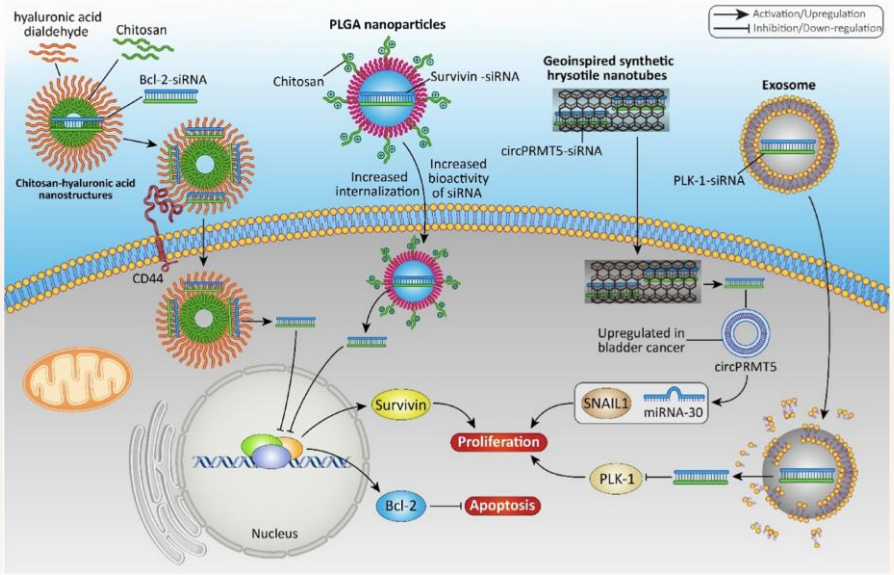
Xu Y *et al.* Application of nanotechnology in the diagnosis and treatment of bladder cancer. *J Nanobiotechnol* 2021.

Applications in bladder cancer

Drug delivery



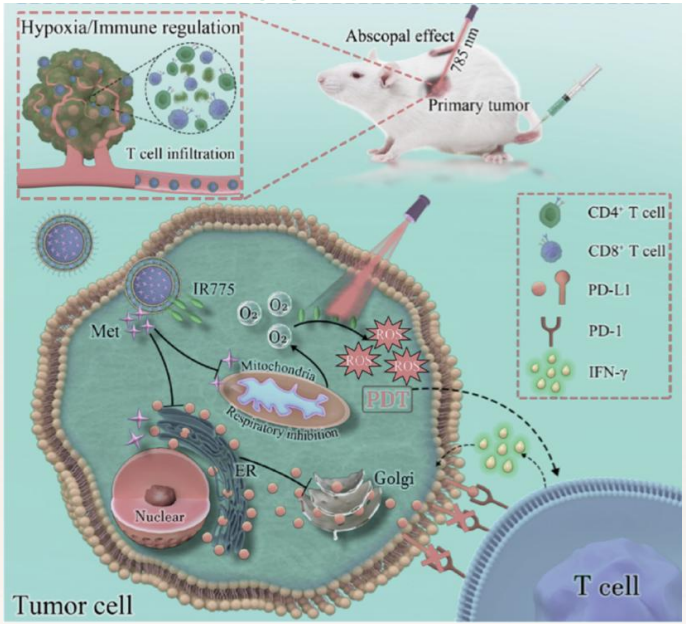
Genetic therapy



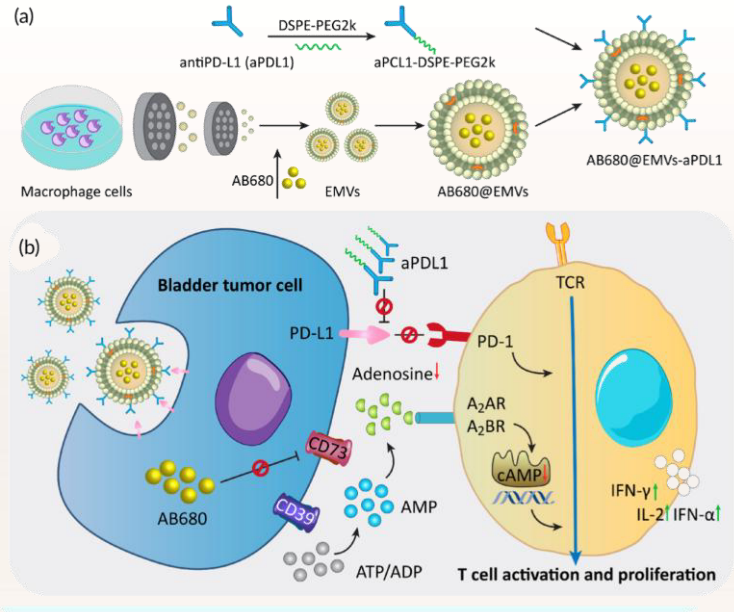
Ashrafizadeh M et al. (Nano)platforms in bladder cancer therapy: Challenges and opportunities. Bioeng Transl Med 2022

Applications in bladder cancer

Phototherapy



Immunotherapy



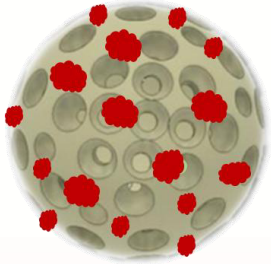
Xiong W et al. ACS Appl Mater Interfaces. 2021
Zhou Q et al. Mol Pharm. 2021

BLADDEBOTS PROJECT

Enzyme propelled nanobots as efficient nanotech platform for bladder cancer therapy

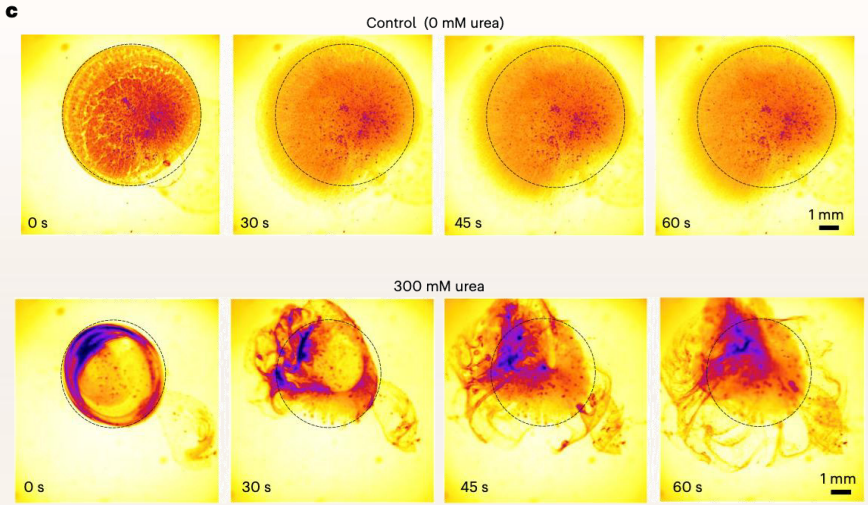
Fundació La Caixa, CaixaResearch

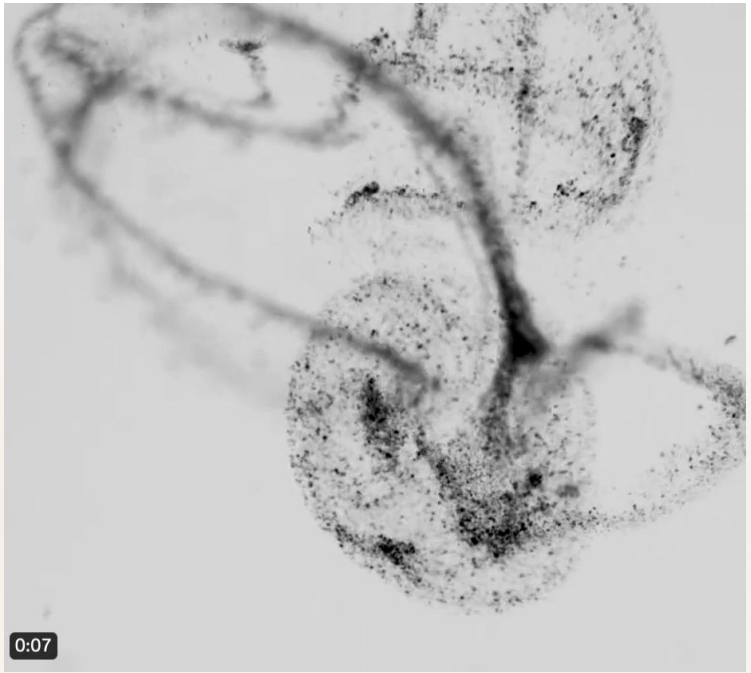
- **Institut de Bioenginyeria de Catalunya IBEC**
- Asociación Centro de Investigación Cooperativa en Biomateriales
- Universitat Autònoma de Barcelona (UAB)
- Fundació Clínic per a la Recerca Biomèdica
- Fundació Catalunya-La Pedrera, España
- Associació Catalana de Comunicació Científica



Urease

BLADDEBOTS PROJECT





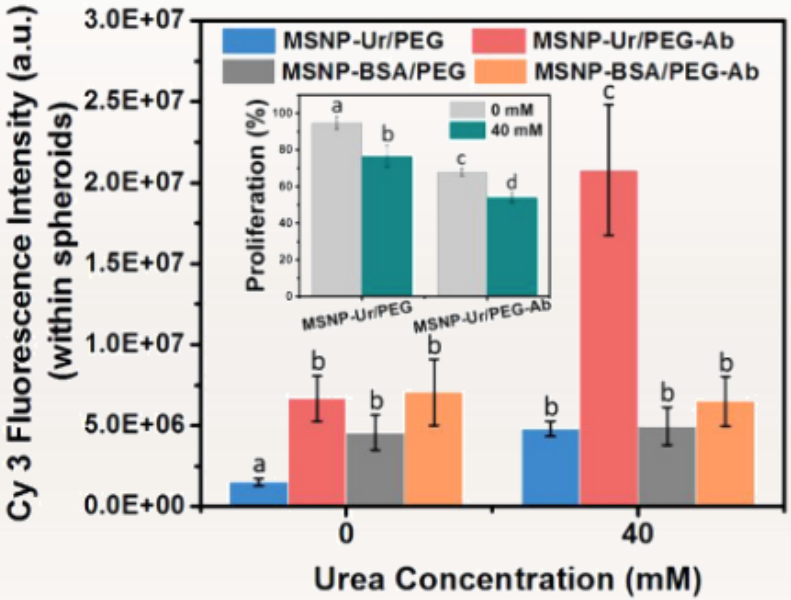
@SamuelNanobots

Adapted from: Simó C et Al. Urease-powered nanobots for radionuclide bladder cancer therapy. Nat Nanotechnol. 2024

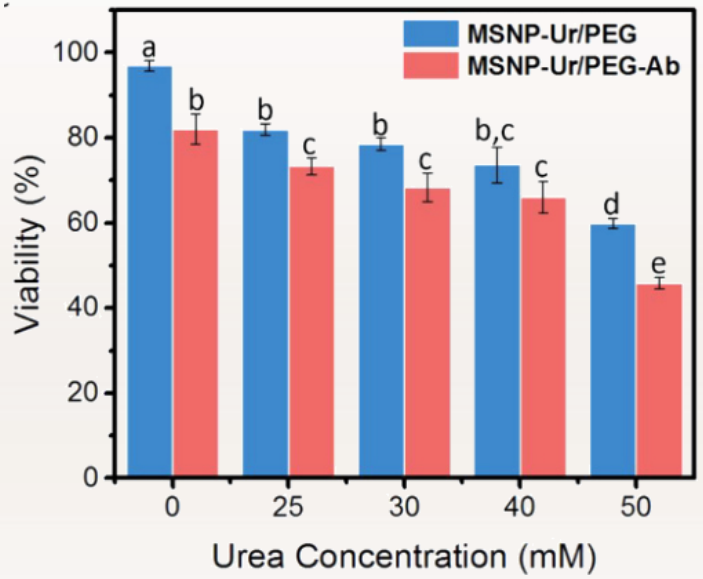
Anti-FGFR3

BLADDEBOTS PROJECT

INTERNALIZATION

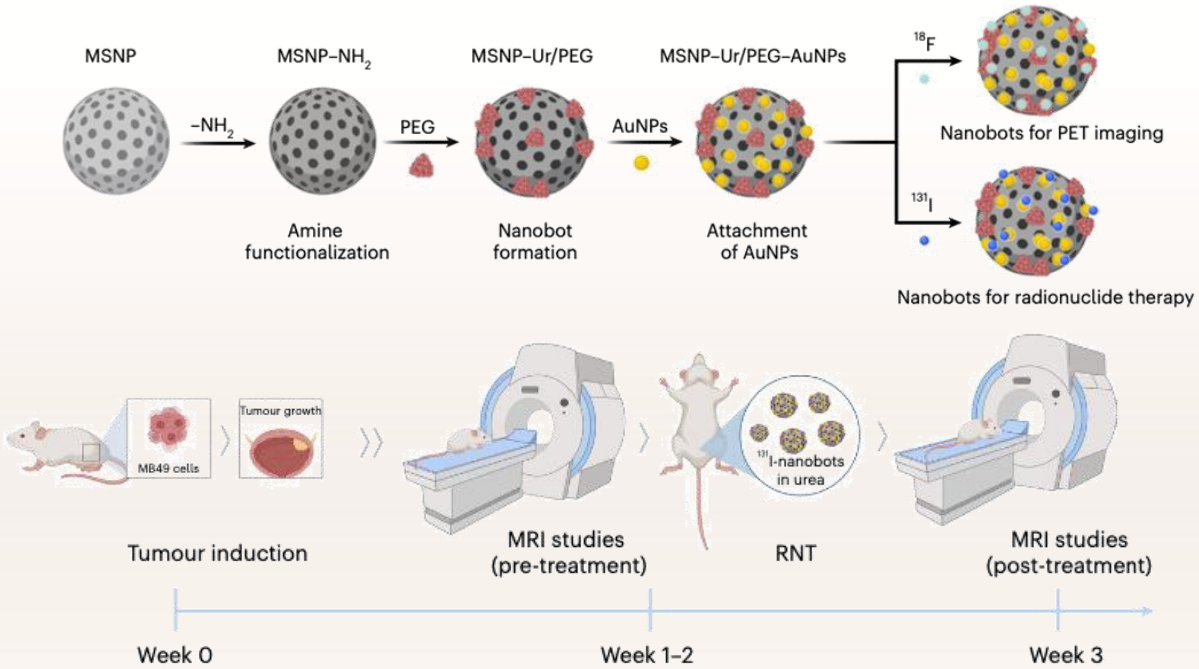


VIALIBILTY



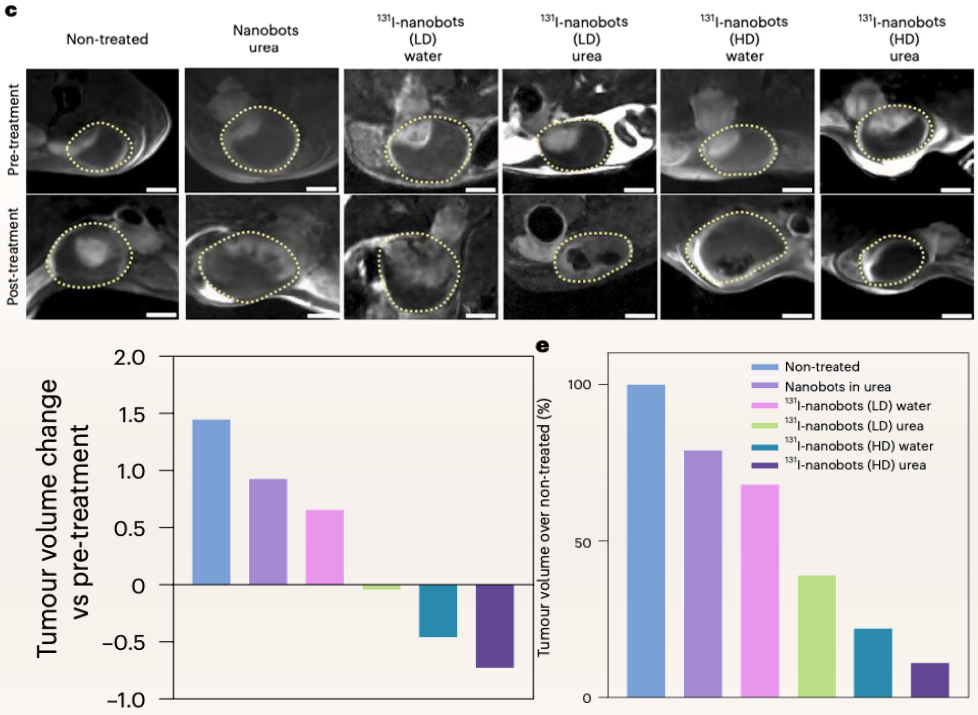
Adapted from: Hortelão AC et Al. Targeting 3D Bladder Cancer Spheroids with Urease-Powered Nanomotors. ACS Nano 2019.

BLADDEBOTS PROJECT



Adapted from: Simó C et Al. Urease-powered nanobots for radionuclide bladder cancer therapy. Nat Nanotechnol. 2024

BLADDEBOTS PROJECT



Adapted from: Simó C et Al. Urease-powered nanobots for radionuclide bladder cancer therapy. Nat Nanotechnol. 2024

Zemeckis R. (1985). Back to the Future. Universal Pictures

Clinical trials

NTC	Phase	Agent	Status	Year of completion
NCT00147238	II	Superparamagnetic nanoparticles	Terminated	2007
NCT02718742	II	Paclitaxel albumin-stabilized nanoparticle	Withdrawn	2018
NCT02009332	I/II	Albumin-bound rapamycin nanoparticles	Completed	2019
NCT02887248	II	Nanoparticle albumin-bound paclitaxel plus gemcitabine	Terminated	2020
NCT06173349	I	PLZ4-Coated Paclitaxel-Loaded Micelles	Recruiting	2026

TAKE HOME MESSAGES

- ✓ **Smart nano bio devices offer limitless potential** in the management of bladder cancer—ranging from gene therapy and immunotherapy to phototherapy, advanced imaging techniques, or targeted drug delivery.
- ✓ **Their development demands a multidisciplinary approach**, involving collaboration among physicists, chemists, biologists, medical doctors, or pharmaceutical scientists amongst others.
- ✓ **Most current research remains in preclinical phases** (in vitro and animal models), although early human studies are already underway.
- ✓ **In the near future, these devices are expected to become part of the clinical toolkit**, revolutionizing both diagnosis and personalized treatment strategies for bladder cancer.