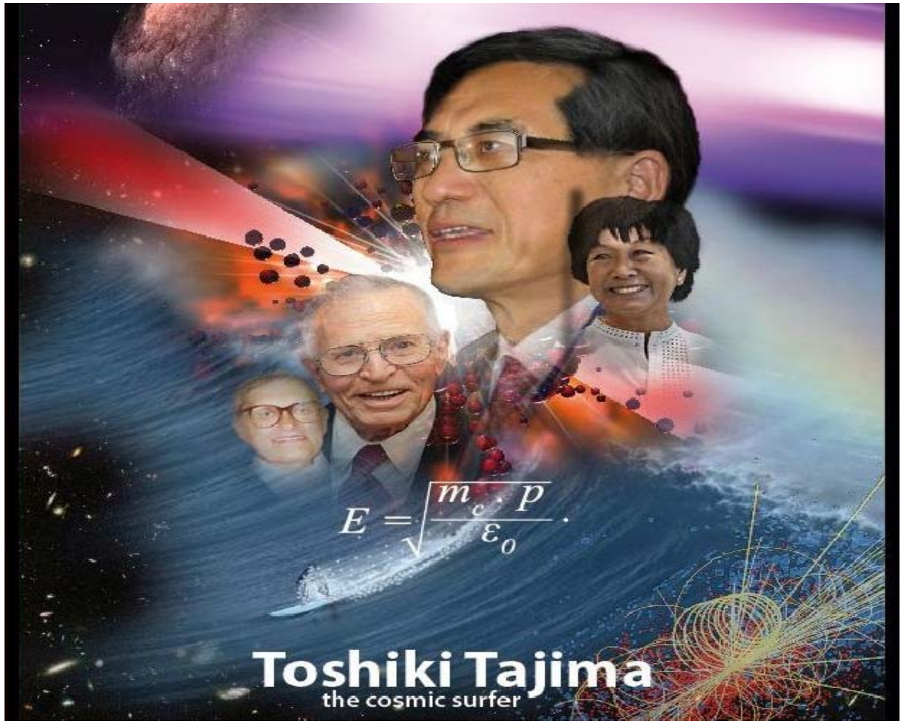
A Scientific Journey from Wakefields to Astrophysics and Fusion : A Symposium in Honor of Toshiki Tajima



Fuyu Tamanoi

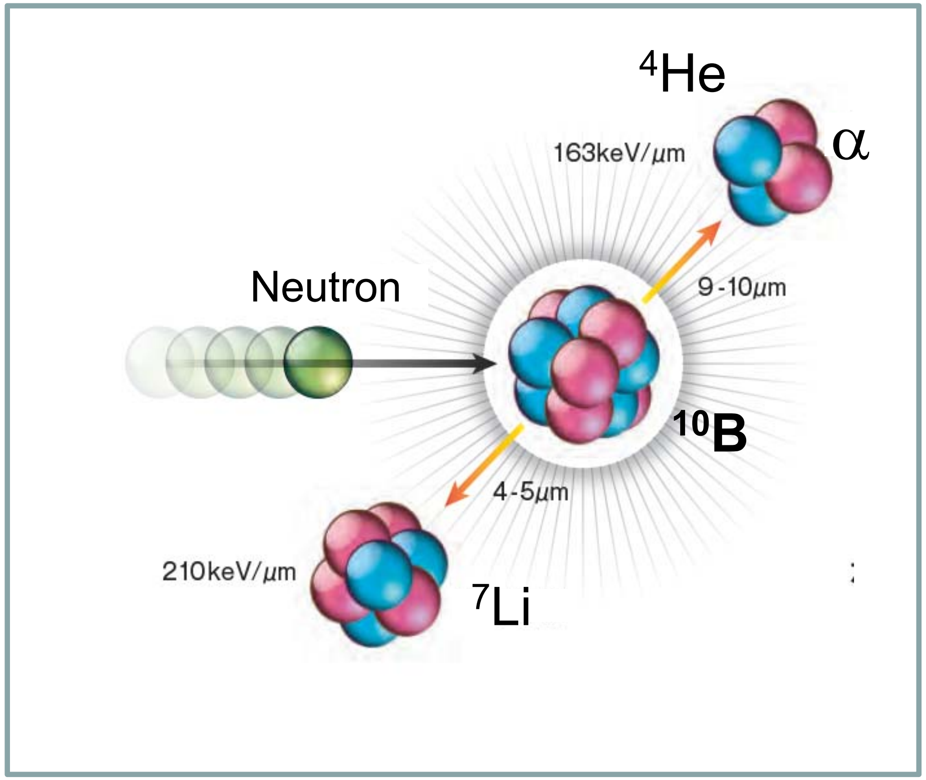
Professor: UCLA
Professor: Kyoto University

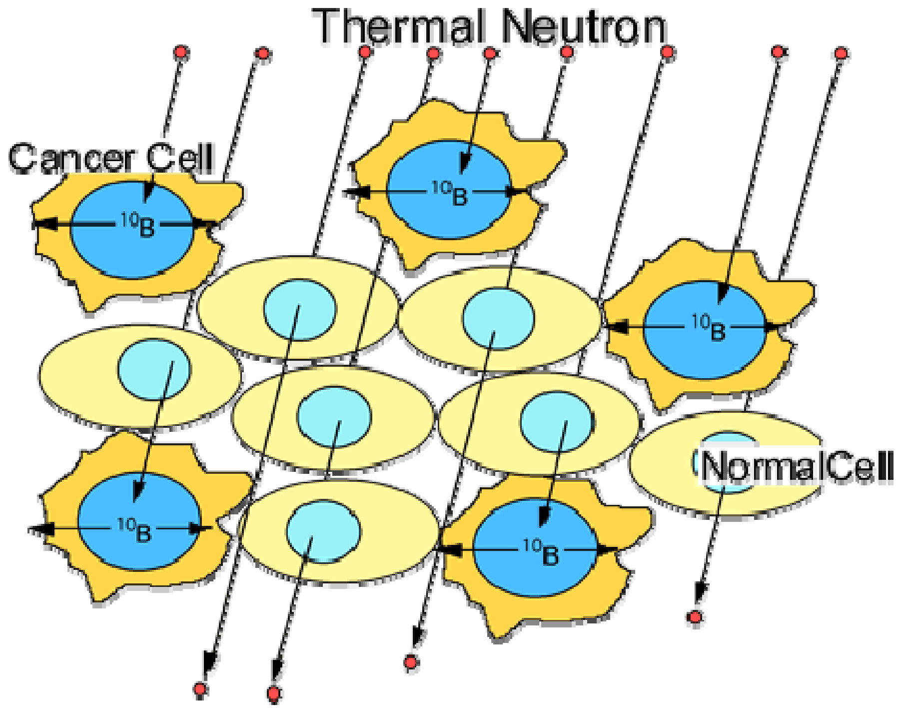
Russia
Alaska
(U.S.)
Canada
South
Korea
Japan
ina
United States
Hong Kong
(China)
Chinese Taipei
Viet Nam
Mexico
Philippines
Malaysia
Papua
New Guinea
Indonesia
Peru
ei
ssalam
Chile
Australia
New Zealand

BNCT

Boron neutron capture therapy

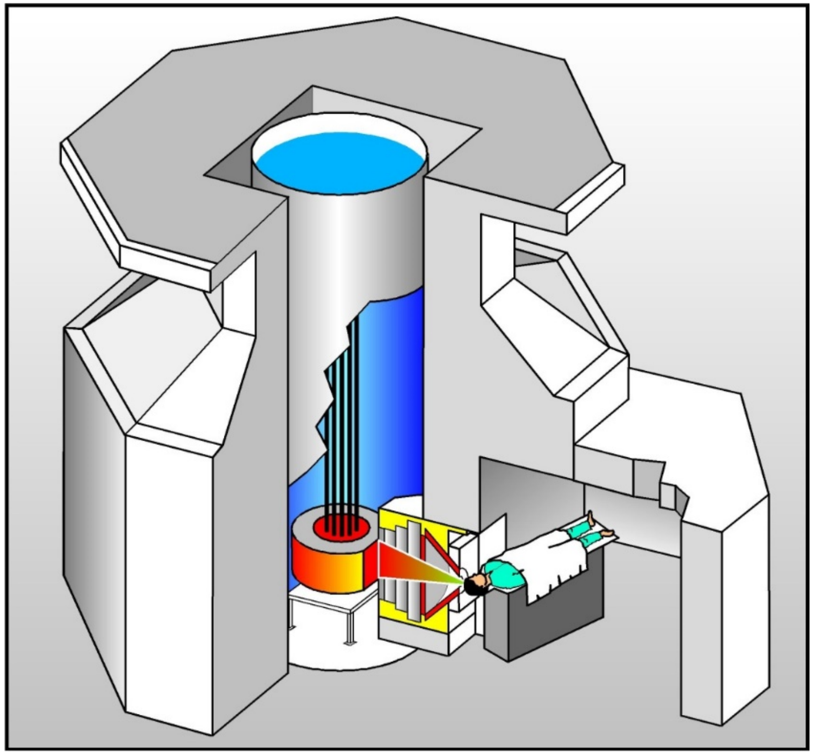
Boron-10, upon exposure to a beam of neutron, splits into ^7Li and ^4He. ^4He is an α-particle that damages any surrounding things but travels only a short distance. Thus, selective killing of cancer cells can be achieved.



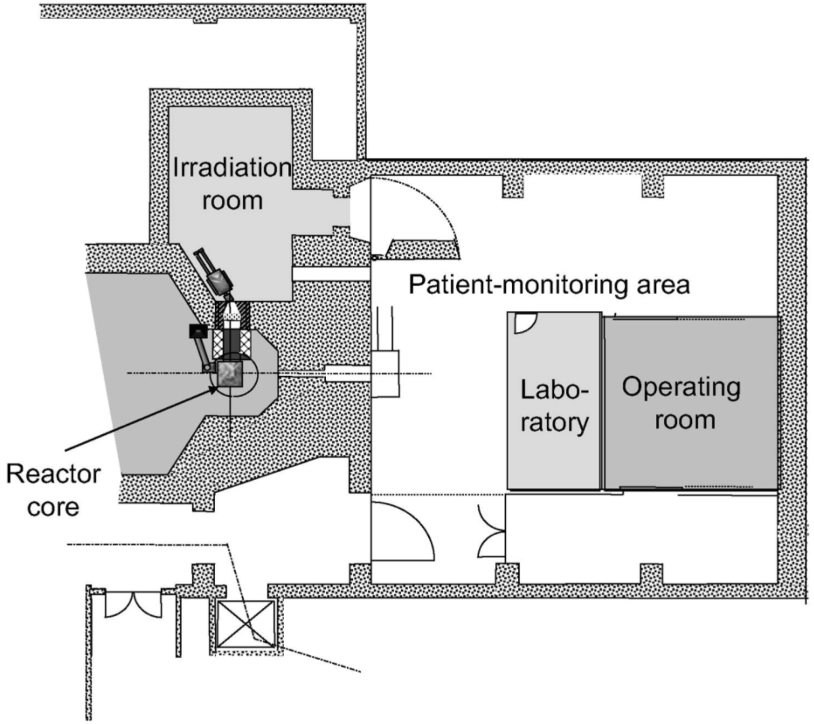


"Ultimate cancer therapy"

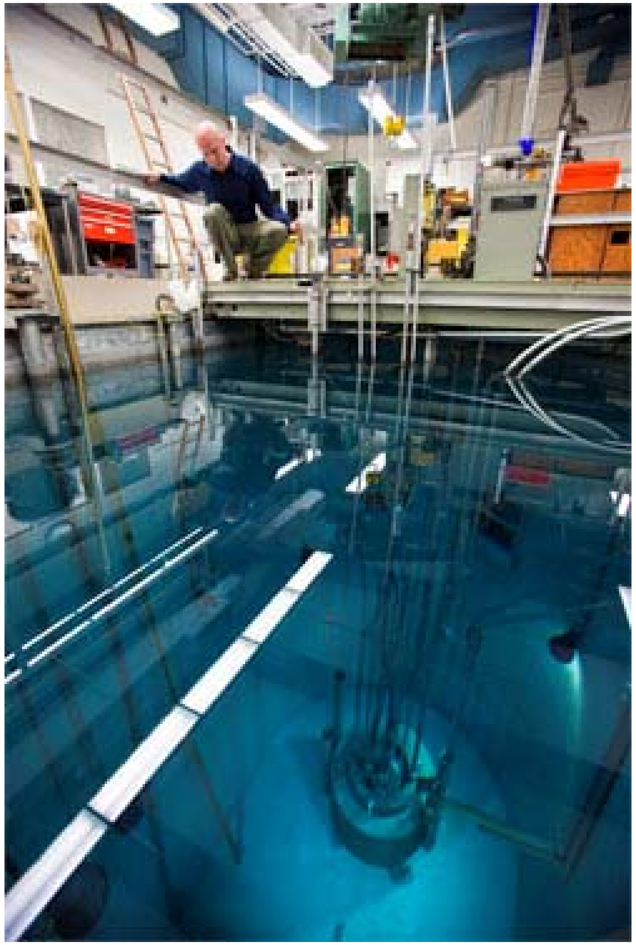
Nuclear reactor based cancer therapy



Nuclear reactor for neutron source



UCI Nuclear reactor



UCI BNCT meetings

Toshi Tajima (Physics)
AJ Shaka (Nuclear Reactor)
Glutekin Gulsen (Tumor imaging)
Artem Smirnov (TAE, Beam and shield)
Fuyu Tamanoi (UCLA, Cancer Therapy)

Critical issues in BNCT approach
Next big thing in BNCT
Convergence with other scientific fields

Extensive clinical studies worldwide are being carried out since 1990

KURRI nuclear reactor based cancer therapy

Cancer patient

Brain tumor

Advanced head and neck tumor
58% response

History of BNCT

1936 Locher's proposal for cancer application

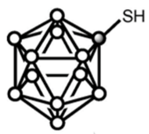
1951 First BNCT clinical trial at Brookhaven Lab

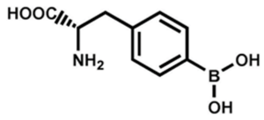
MIT clinical trials

1968 Clinical trials

Japan, Europe, Argentina, Taiwan

BSH, BPA





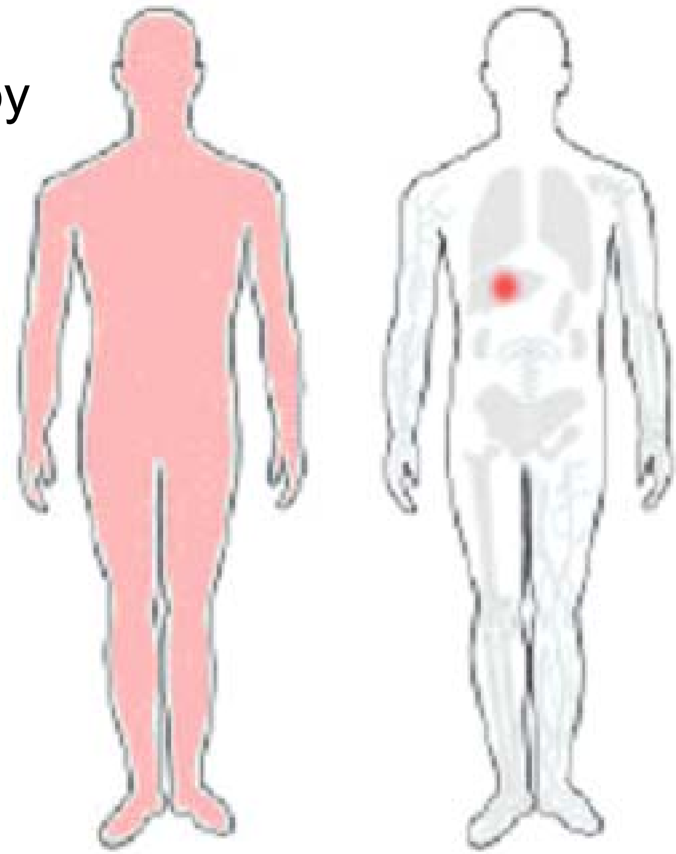
Promising results (good patient response, increased survival).

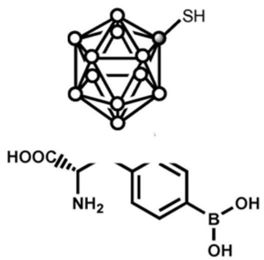
Tumor accumulation of boron-10 is critical!

Nanoparticles enable tumor accumulation of boron compounds

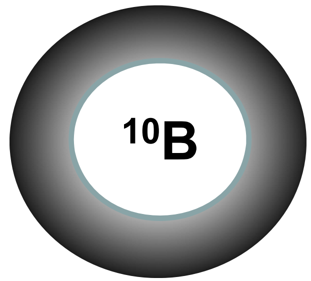
Current
BNCT therapy

Nanoparticle
based therapy



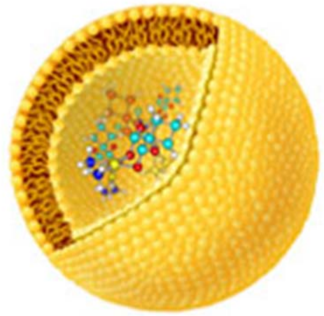


BSH, BPA



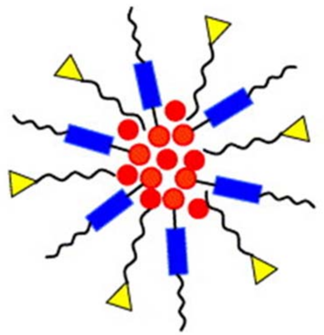
Convergence of nanotechnology and BNCT

Nanoparticles



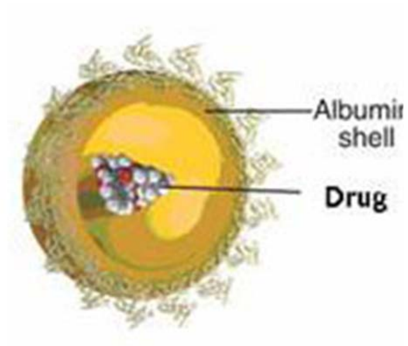
Liposomes

Vault



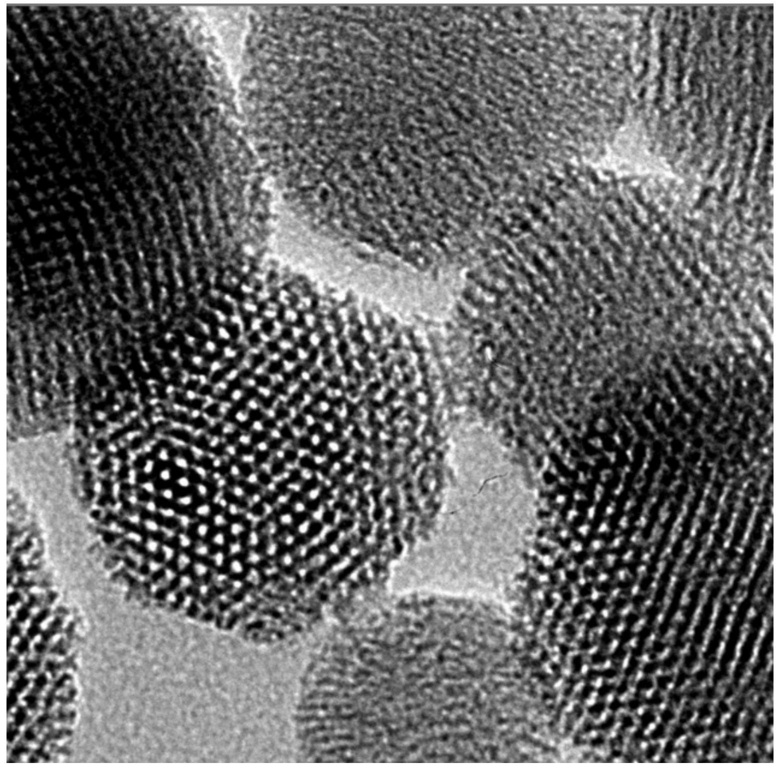
DOX-loaded TPGS-FOL/DOX-PLGA-TPGS NPs

Block copolymer



Protein shell

Mesoporous silica nanoparticles

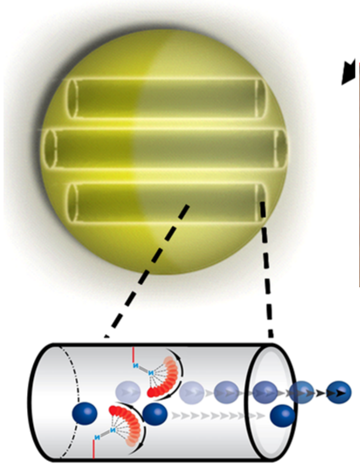


Porous
100 nm diameter
1400 pores/particle

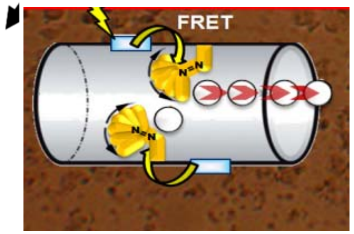
Mechanized Nanoparticles for Controlled Release and Imaging

Nanovalve

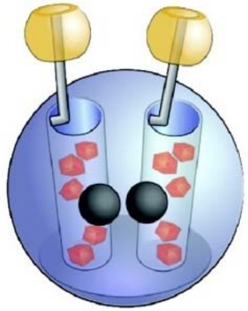
Nanoimpeller



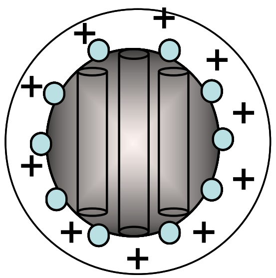
Two-photon nanoimpeller



Magnetic field responsive NP



Nucleic acid delivery

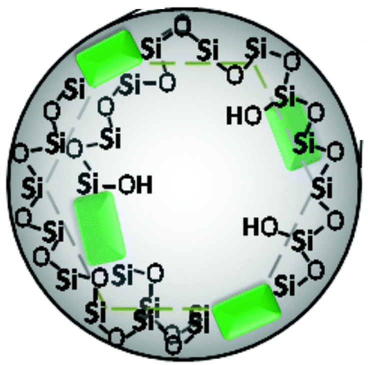


siRNA
miRNA
mRNA
DNA

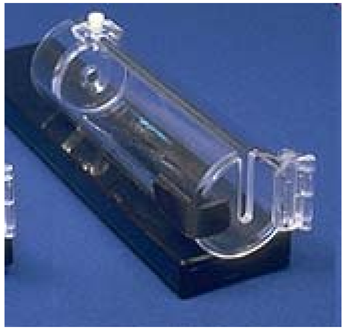
PEI-MSN

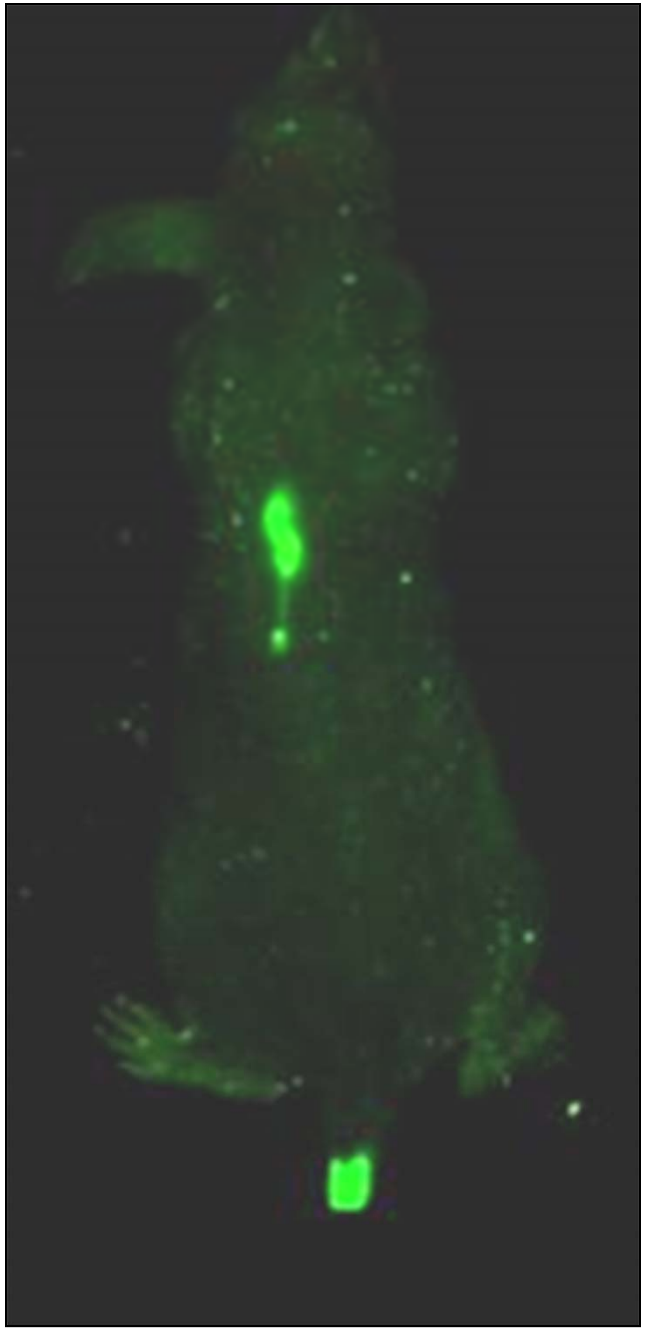
Biodegradable NPs

Incorporating biodegradable bonds into the framework

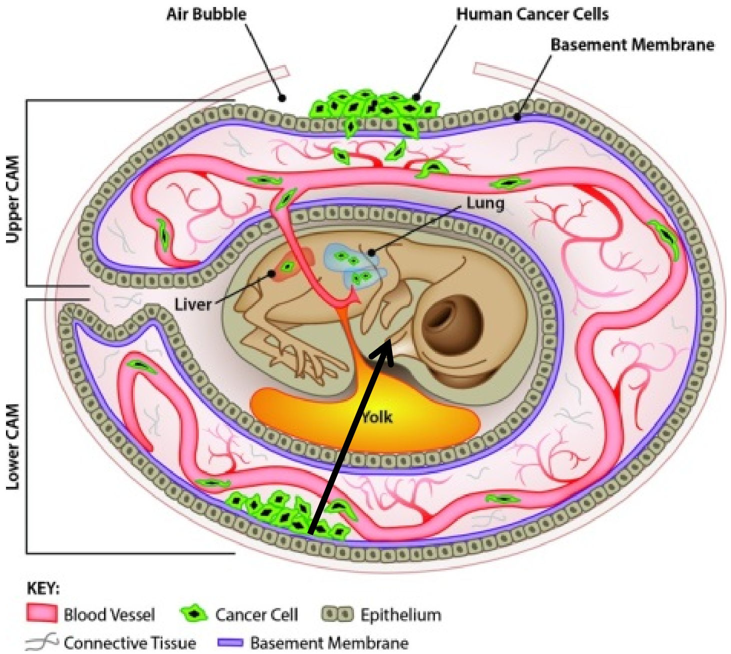


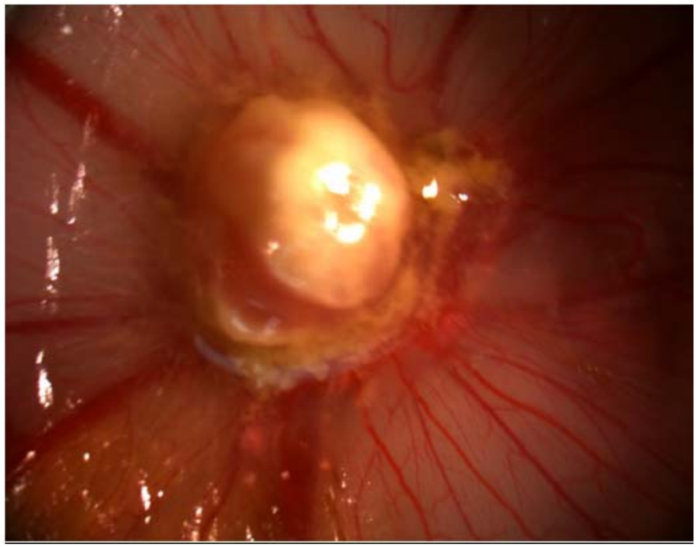
Preferential accumulation of MSNs in the tumor



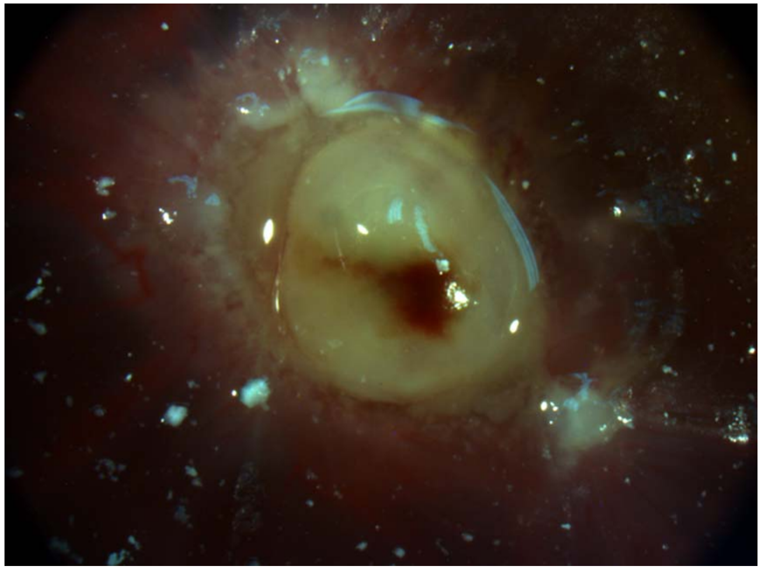


Chicken Egg Tumor Model experiments





Ovarian cancer

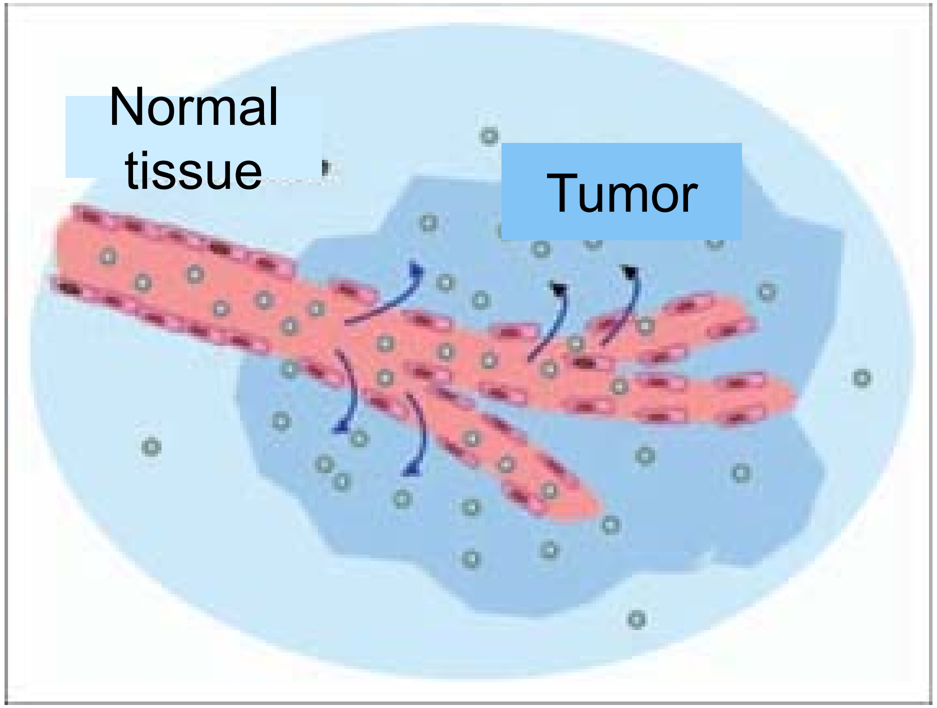


Melanoma

Nanosize enables tumor accumulation

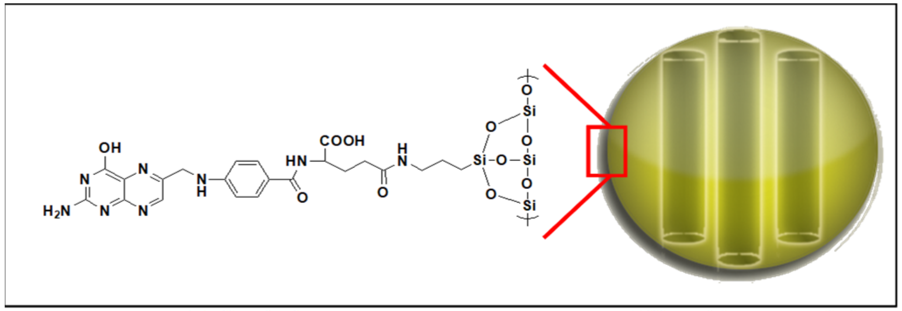
Passive targeting (Enhanced permeability retention)

Size of nanoparticles that can benefit from EPR:
40 - 400 nm

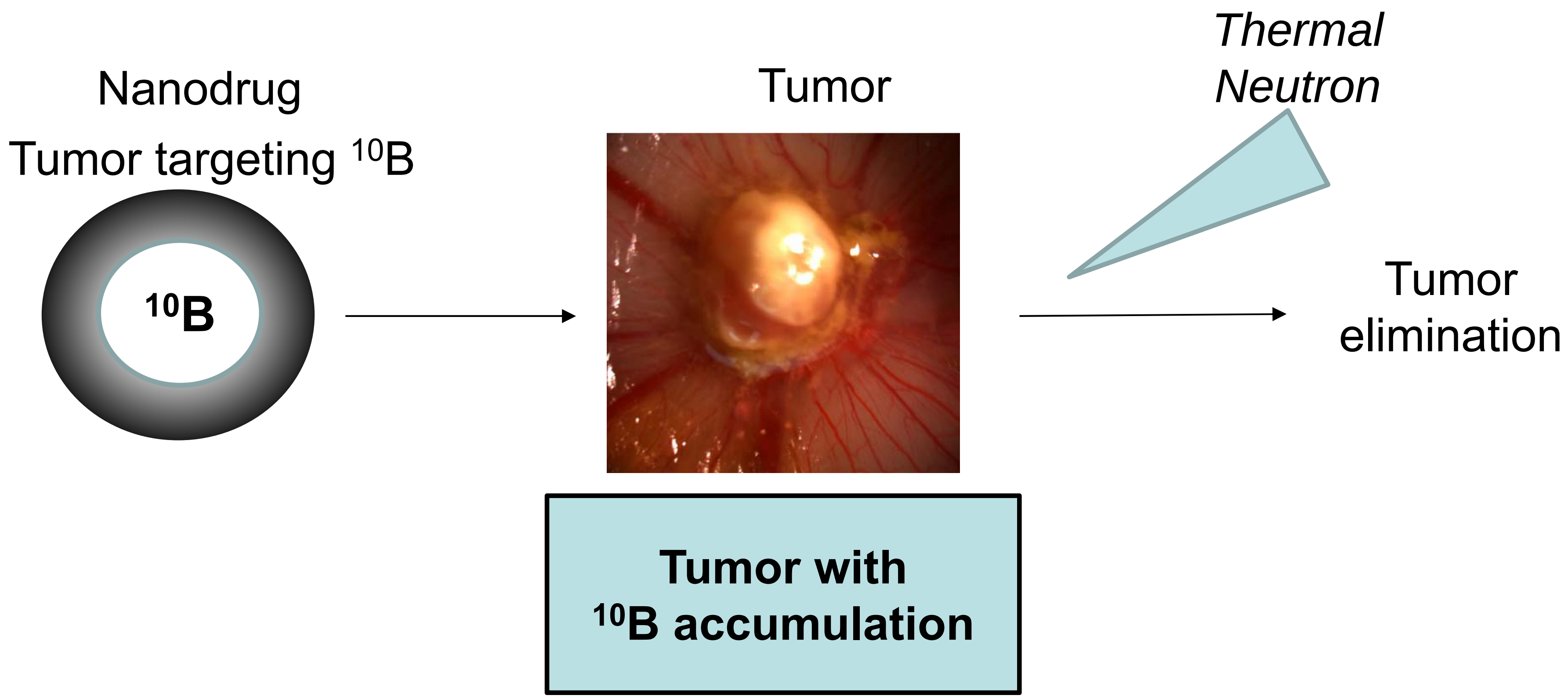


Active targeting

Surface modification of NP

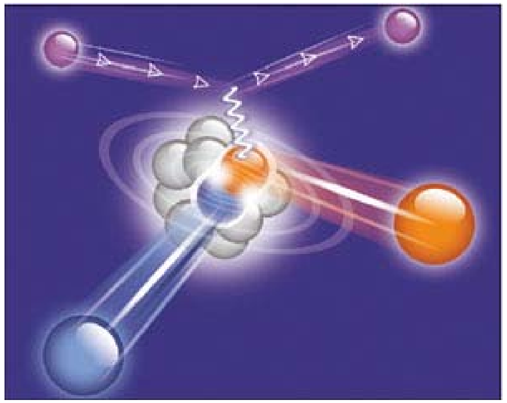


Use of nanoformulated boron is expected to dramatically increase BNCT efficacy



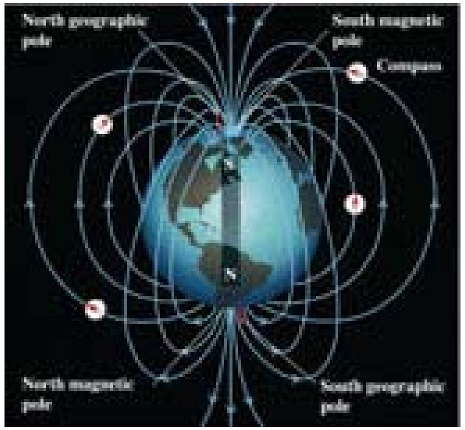
Harnessing physical forces for cancer therapy

Netrons, X-ray



Light

Magnetic field



Nanomaterials

BNCT
Radiation therapy

Photodynamic therapy

Magnetic hyperthermia