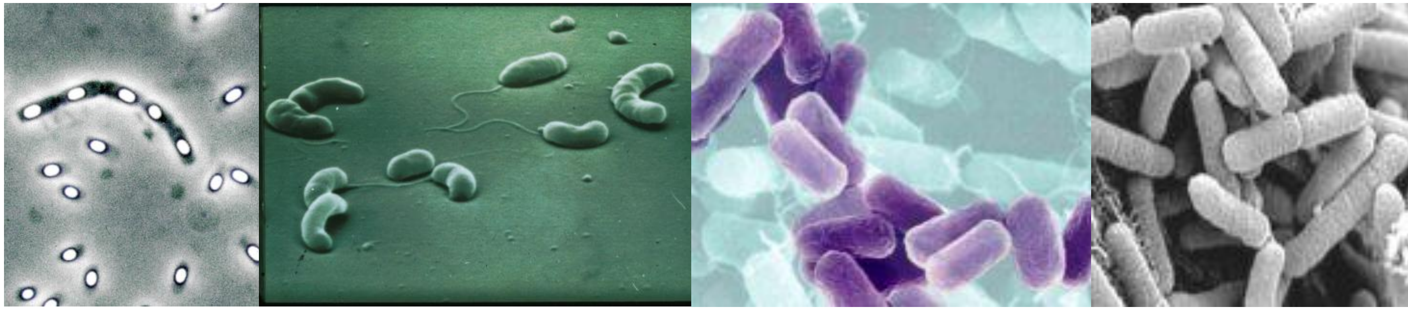


Élelmiszerbiztonság és nanotechnológia

Beczner Judit[1] és Farkas József[2]

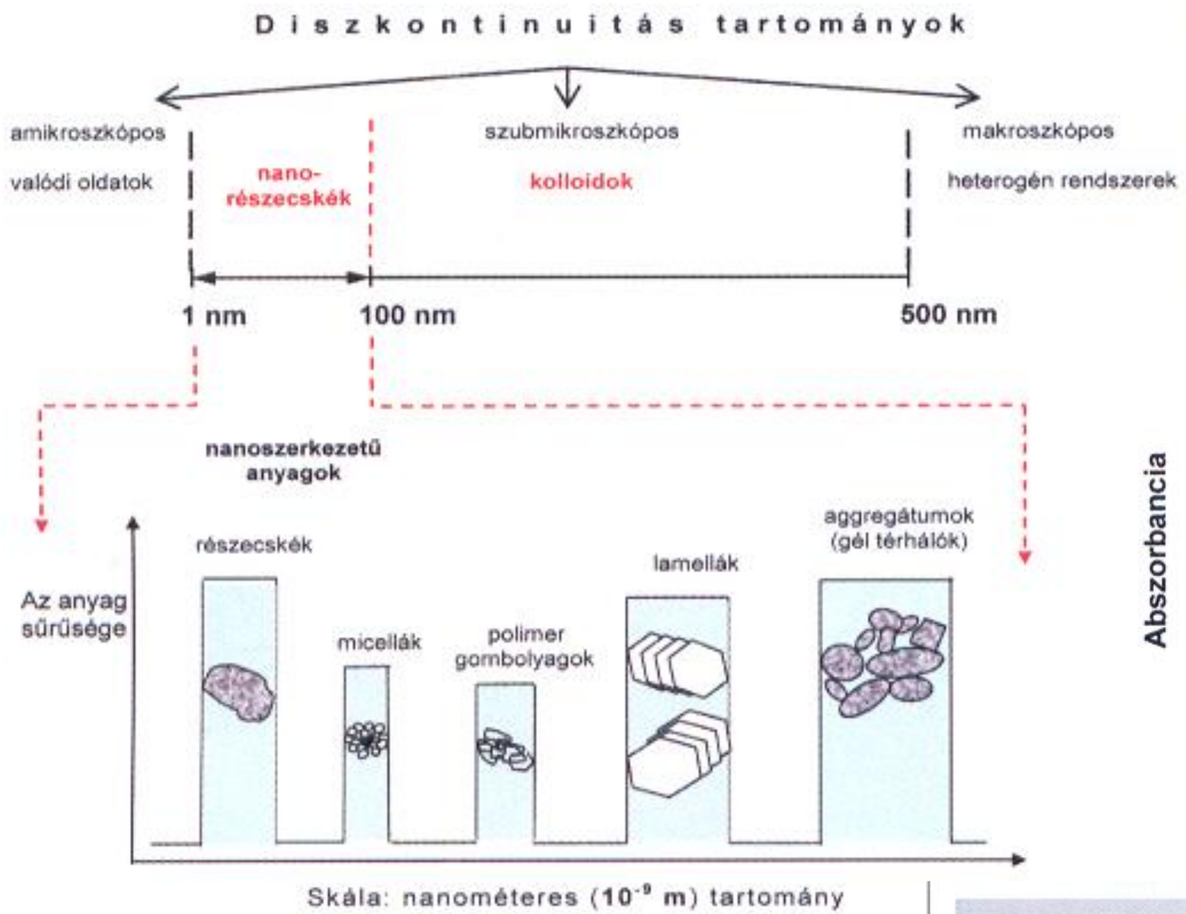
[1]Központi Élelmiszer-tudományi Kutatóintézet,
[2]Budapesti Corvinus Egyetem

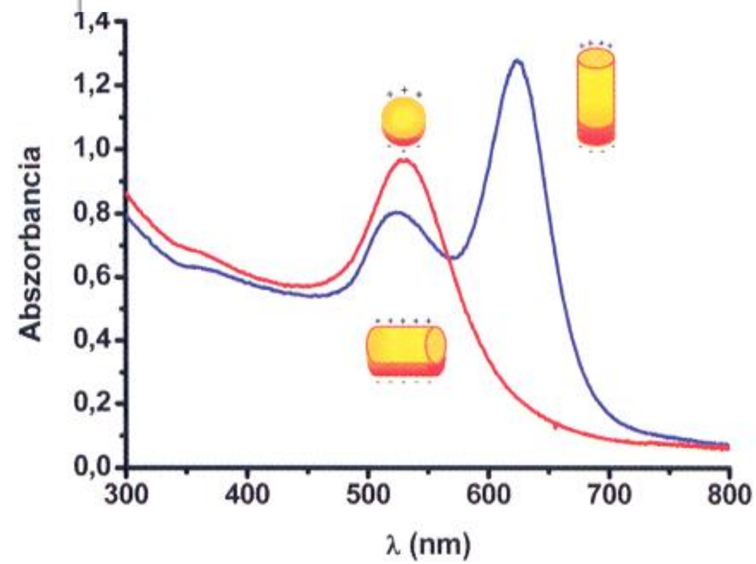
NÉBiH-ÉKI Szeminárium, 2012. május 22.

„Adatbányászás”

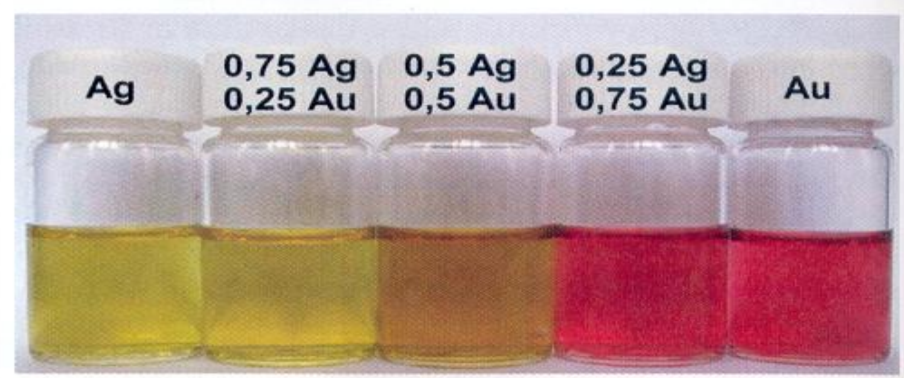
Keresés tárgya: nanotechnology	Google	Science direct
Nano	289 000 000	208 111
Nanomaterials	4 820 000	31 627
- food	13 500 000	8 081
- microbiology	2 400 000	1 975
- food safety	2 130 000	2 802
- health	19 700 000	10 443
- safety	41 700 000	6 788
- food microbiology	249 000	907
- packaging	365 000	1019
- drinks	811 000	442
Nanoparticles in environment	24 000 000	39 697
Naturally occurring nanoparticles	1 040 000	39 665

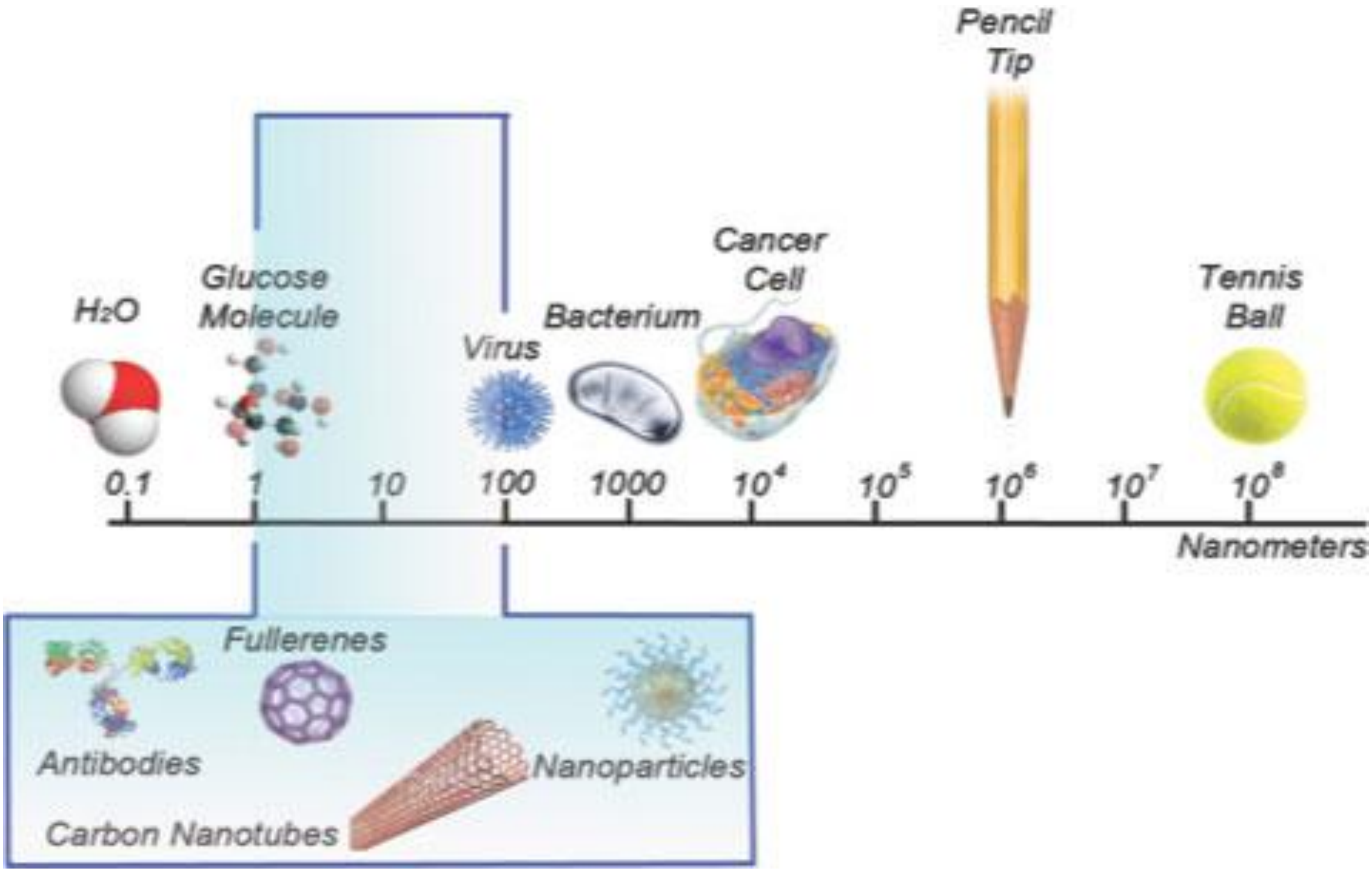
A részecskék mérete és tulajdonságai





Az 1-100 nm tartományban az anyag új fizikai és kémiai tulajdonságokkal rendelkezik. Más lesz a sűrűsége, kristályszerkezete, olvadáspontja, elektromos vezetőképessége, mágnesezhetősége, optikai tulajdonsága, elektronszerkezete…

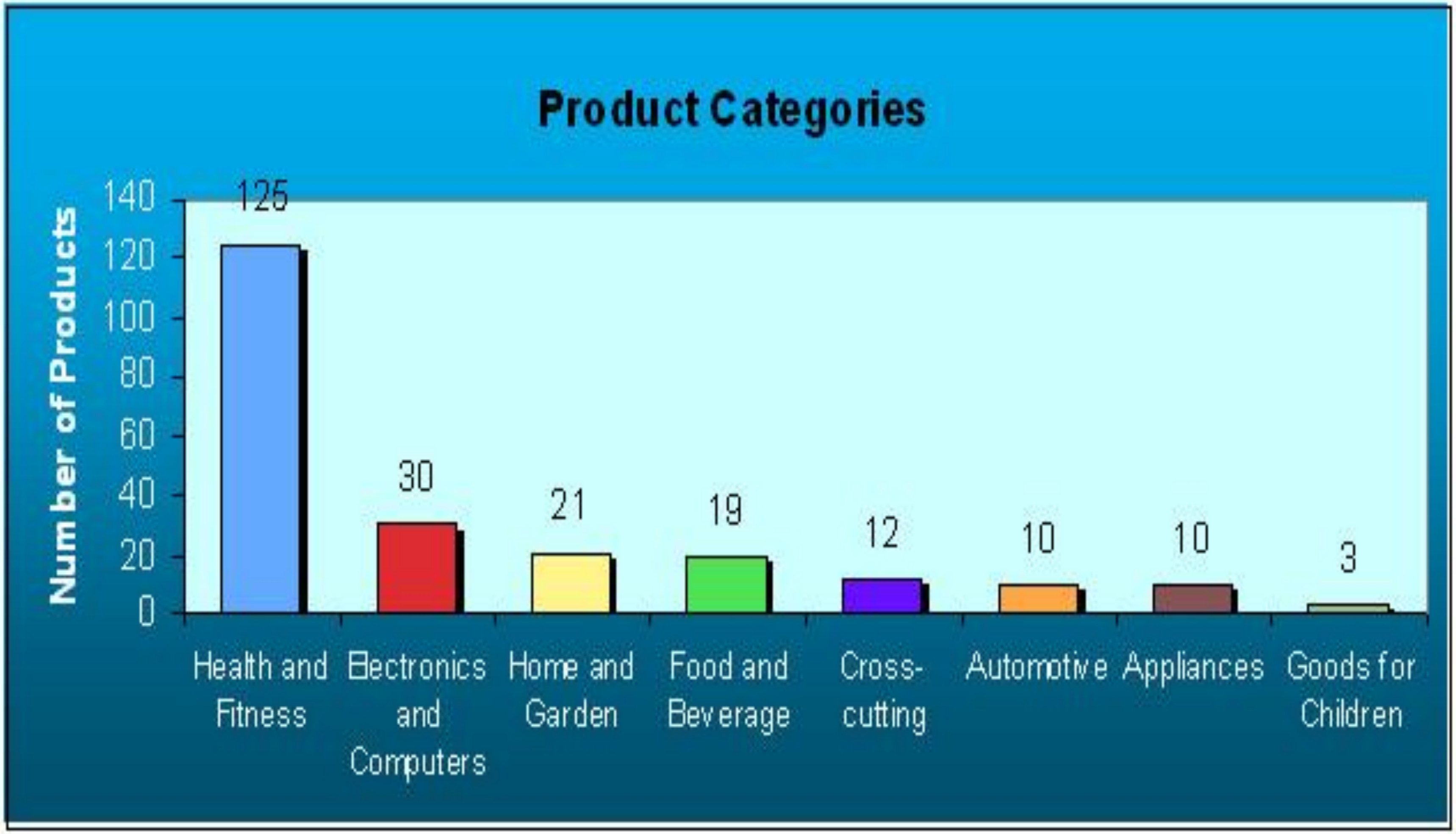


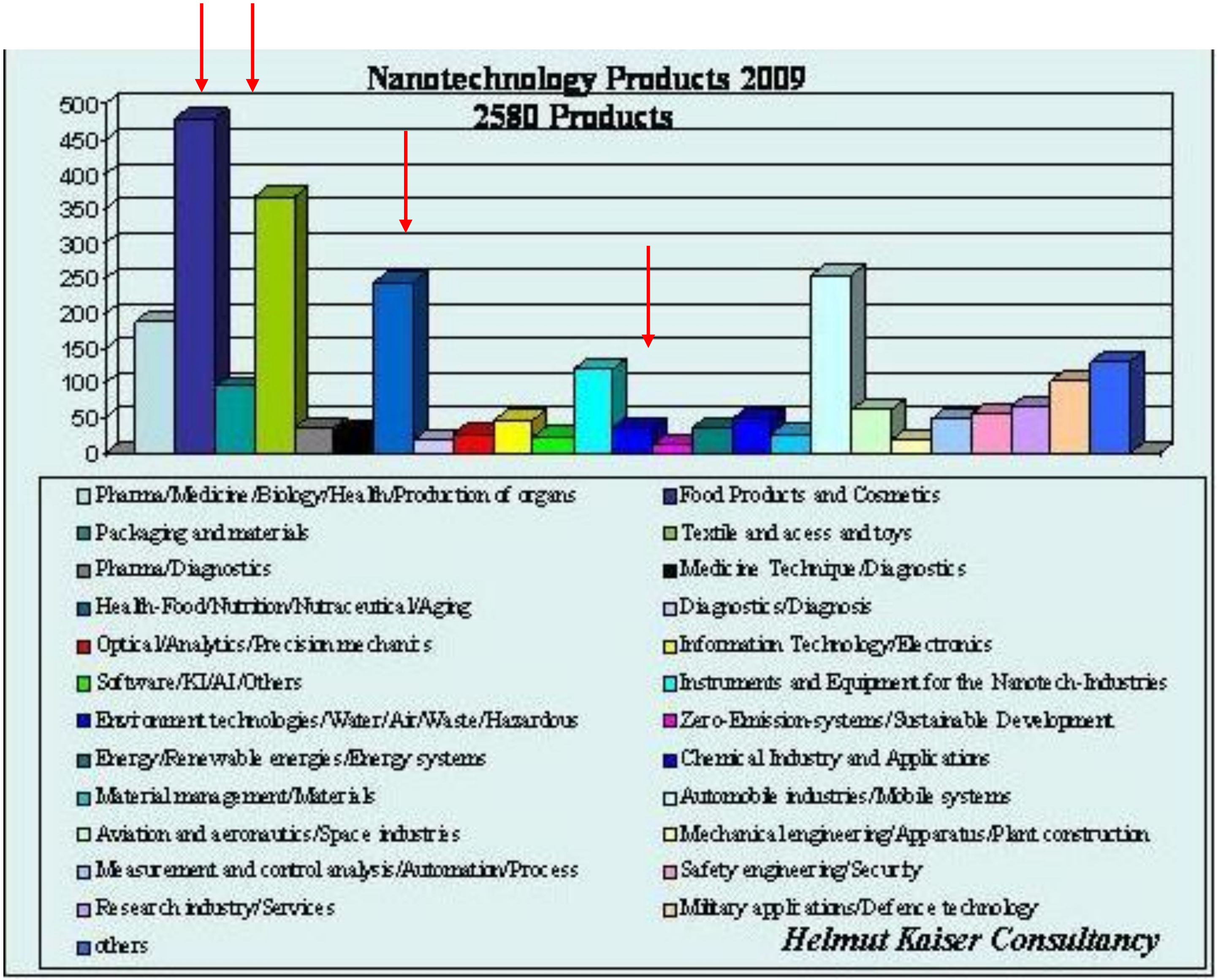


(Suen et al., 2012, University of Waterloo)

A tanulmány ára: 4900 Euro, a „summary" 3200 Euro. ACON AG, Zürich

Nanotermékek, 2007




Nanotechnology Products 2009
2580 Products
500
450
400
350
300
250
200
150
100
50
0
Pharma/Medicine /Biology/Health/Production of organs
Food Products and Cosmetics
Packaging and materials
Textile and acess and toys
Pharma/Diagnostics
Medicine Technique /Diagnostics
Health-Food/Nutrition/Nutraceutical/Aging
Diagnostics/Diagnosis
Optical/Analytics/Precision mechanics
Information Technology/Electronics
Software/KI/AI/Others
Instruments and Equipment for the Nanotech-Industries
Environment technologies/Water/Air/Waste/Hazardous
Zero-Emission-systems/Sustainable Development
Energy/Renewable energies/Energy systems
Chemical Industry and Applications
Material management/Materials
Automobile industries/Mobile systems
Aviation and aeronautics/Space industries
Mechanical engineering/Apparatus/Plant construction
Measurement and control analysis/Automation/Process
Safety engineering/Security
Research industry/Services
Military applications/Defence technology
others
Helmut Kaiser Consultancy

NANOTECHNOLOGY ALREADY AVAILABLE

PERSONAL CARE
Many sunscreens contain nano zinc oxide or titanium dioxide which makes it clear

ANTI-AGEING
The product NV Perricone MD Cosmeceuticals' Men's Fitness Shave Cream claims its carbon nanoparticles can reduce 'fine lines, loss of firmness and discolourations'. Experts say the effect of C60 are 'completely unproven' and can harm cells

GROOMING
SomeWilkinson Sword razor blades use a carbon nano-coating, claiming it helps blades stay sharper longer

DIET SUPPLEMENTS
Are said to be absorbed more quickly and easily

COMING SOON...

ANTI-AGEING
Food and cosmetic firms - working on foods that contain chemicals that are said to prevent wrinkles by promoting skin cell regrowth

HEART DISEASE
Nanoparticles will, it is claimed, patrol the body, clearing clogged arteries and tackling disease

PROGRAMMABLE FOOD
Kraft is working towards 'programmable foods'. These include a colourless, tasteless drink. User can choose the colour and flavour by zapping it for a set period in a microwave oven

LONG-LIFE FOOD
Mars has a U.S. patent for nano coatings that have been tested on M&Ms, Twix and Skittles. They are tasteless but could kill bacteria

OUT OF DATE
Your milk carton will tell you when its contents are sour. Nanoparticles on the carton will sense decomposition gases and change the colour of the label

HEALTHY FOOD
Unilever believes it can reduce the fat content of ice cream, for example, to one per cent

'WILLY WONKA' GUM
A chewing gum that maintains its taste, regardless of how long it is chewed

www.hkc22.com, 2009

Development of nanotechnology markets worldwide by applications 2002 – 2006 – 2010-2015 (bn. US$)

	2002	2006	2010	2015
Total	110,6	299,9	516,9	891,1
Materials	39,1	108	179	279,2
Electronics	52	129	160	246,4
Life Industries	4,9	18,4	84	172,5
Chemicals	4,4	14	43	82,1
Aerospace	3,4	12	22	57,5
Modeling Tools	3,6	7	9,1	16,4
Sustainability	3,2	11,5	19,8	37

www.hkc22.com, 2009

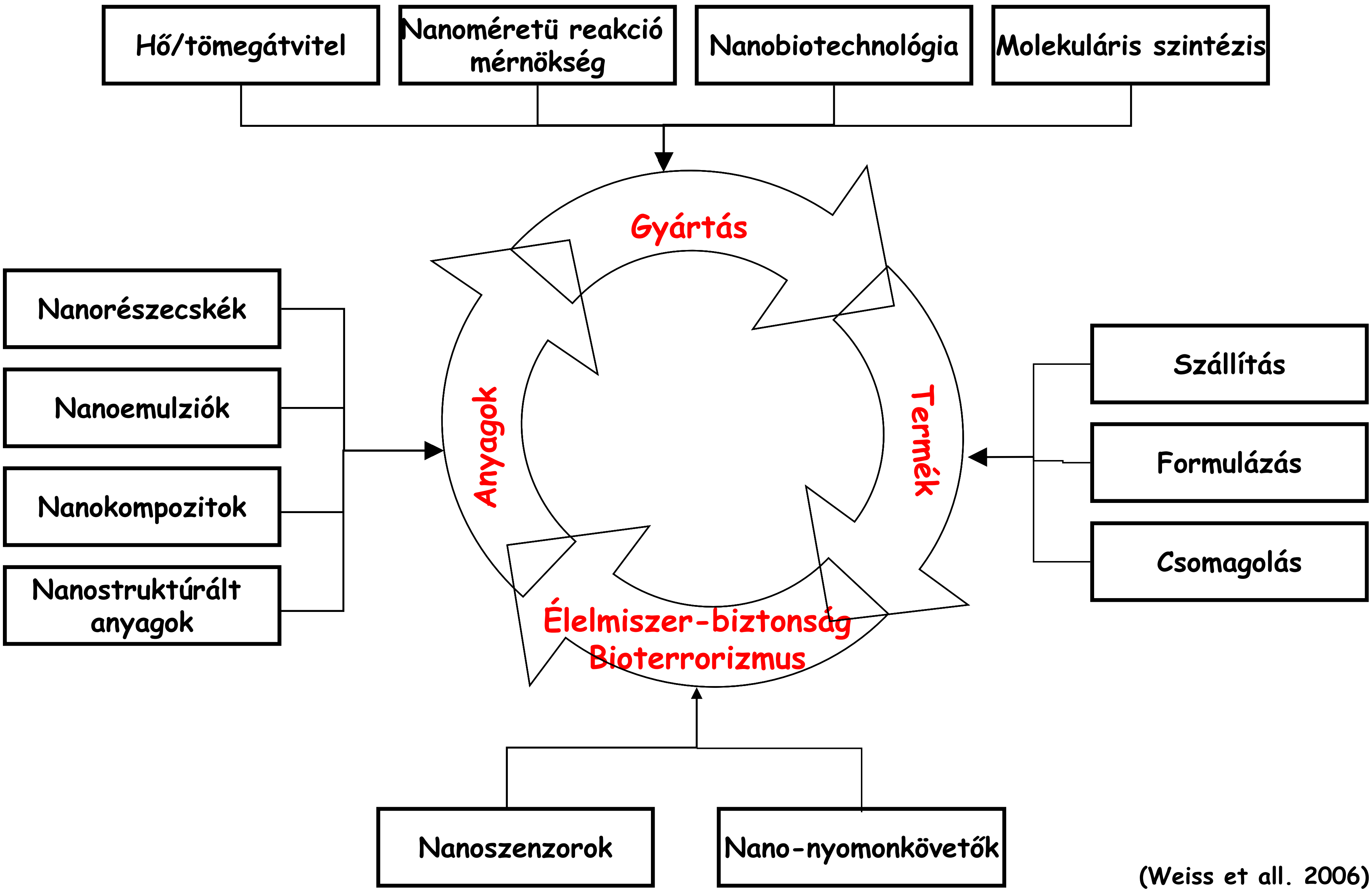
Development of nanotechnology markets worldwide by regions 2002 – 2006 – 2010-2015 (bn. US$)

	2002	2006	2010	2015
World	110.6	299.9	516.9	891.1
NAFTA	82.9	179.9	258.4	409.9
Europe	12.1	74.9	155.7	267.3
Asia	11	32.9	77.5	169.4
Others	4.4	11.9	25.8	44.5

NAFTA: North American Free Trade Agreement

www.hkc22.com, 2009

A nanotechnológia alkalmazási lehetőségei az élelmiszer-tudományban



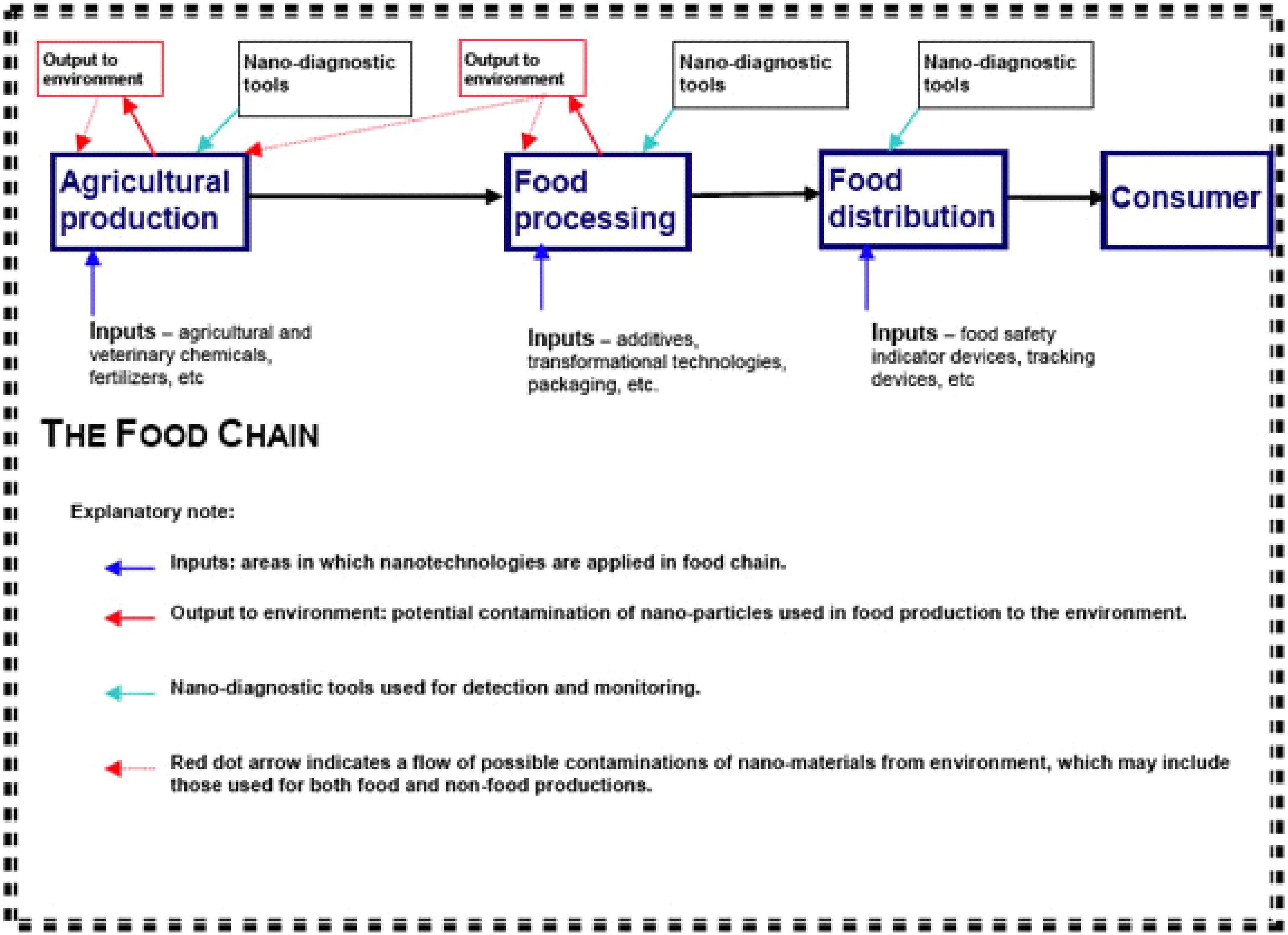
(Weiss et all. 2006)

A nanotechnológia alkalmazásai az élelmiszerláncban




Agriculture	Food Processing	Food Packaging	Supplements
• Single molecule detection to determine enzyme/ substrate interactions • Nanocapsules for delivery of pesticides, fertilizers and other agrichemicals more efficiently • Delivery of growth hormones in a controlled fashion • Nanosensors for monitoring soil conditions and crop growth • Nanochips for identity preservation and tracking • Nanosensors for detection of animal and plant pathogens • Nanocapsules to deliver vaccines • Nanoparticles to deliver DNA to plants (targeted genetic engineering)	• Nanocapsules to improve bioavailability of neutraceuticals in standard ingredients such as cooking oils • Nanoencapsulated flavor enhancers • Nanotubes and nanoparticles as gelation and viscosifying agents • Nanocapsule infusion of plant based steroids to replace a meat's cholesterol • Nanoparticles to selectively bind and remove chemicals or pathogens from food • Nanoemulsions and –particles for better availability and dispersion of nutrients	• Antibodies attached to fluorescent nanoparticles to detect chemicals or foodborne pathogens • Biodegradable nanosensors for temperature, moisture and time monitoring • Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption • Electrochemical nano-sensors to detect ethylene • Antimicrobial and antifungal surface coatings with nanoparticles (silver, magnesium, zinc) • Lighter, stronger and more heat-resistant films with silicate nanoparticles • Modified permeation behavior of foils	• Nanosize powders to increase absorption of nutrients • Cellulose nanocrystal composites as drug carrier • Nanoencapsulation of neutraceuticals for better absorption, better stability or targeted delivery • Nanocochleates (coiled nanoparticles) to deliver nutrients more efficiently to cells without affecting color or taste of food • Vitamin sprays dispersing active molecules into nanodroplets for better absorption

www.nanowerk.com



www.nanowerk.com

WHO, FAO

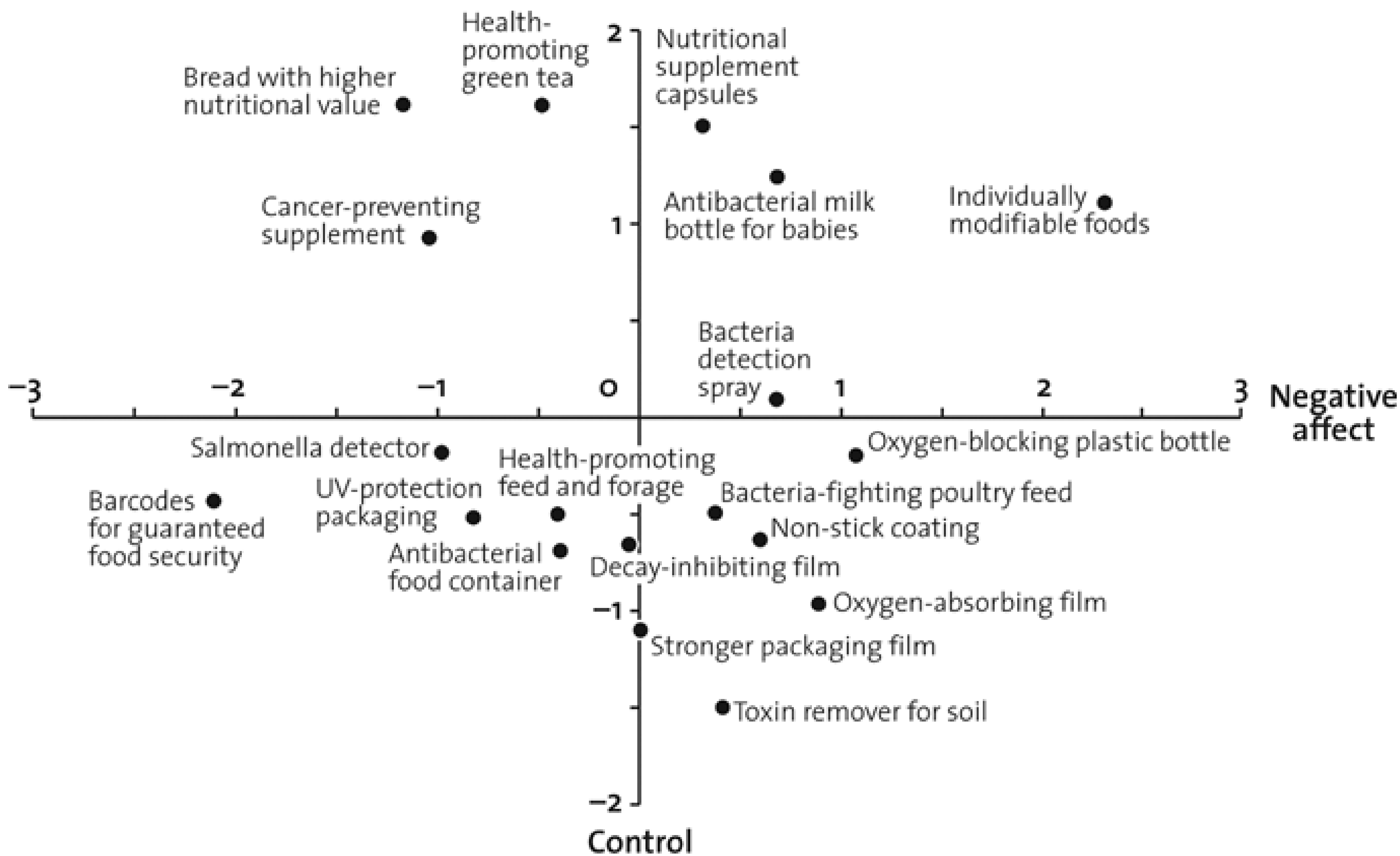
Summary of applications of nanotechnology in the food production chain.

Chain phase	Application	Nanotechnology	Function	Likelihood of free NPs available to consumers
Agricultural production	Nanosensors	Nanospray on food commodities	Binds and colors micro-organisms	+
		Hand-held devices	Detection of contaminants, mycotoxins and microorganism	–
	Pesticides	Nano-emulsions, encapsulates	Increased efficacy and water solubility	++
		Triggered release nano-encapsulates	Triggered (local) release	++
	Water purification/ soil cleaning	Filters with nano-pores	Pathogen/contaminant removal	–
		NPs	Removal/catalysation/oxidation of contaminants	–/+
Production and processing of food	Food production	Nano-ceramic devices	Large reactive surface area	–/+
	Refrigerators, storage containers, food preparation equipment	Incorporated nano-sized particles, mostly silver, occasionally zinc-oxide	Anti-bacterial coating	–/+
Conservation	Food products	Nano-sized silver sprays	Anti-bacterial action	++
	Packaging materials	Incorporated sensors	Detection of food deterioration. Monitoring storage conditions	–/+
		Incorporated NPs	Increasing barrier properties, strength of materials	–/+
		Incorporated active NPs	Oxygen scavenging, prevention of growth of pathogens	–/+
'Functional food', consumption	Supplements/additive	Colloidal metal NPs	Claimed enhanced desirable uptake of metal	++
		Delivery systems "Nano-clusters"	Protecting and (targeted) delivery of content	++
		Nano-sized/-clustered food/drinks (nutrients)	Claimed enhanced uptake	++

Legend: "–", no contact of nanotechnology with food; "–/+", contact with food product during production, but no direct consumer exposure to NPs is expected; "+/++", NPs directly added to consumer products.

(Bouwmeester et al., 2009: Regulatory Toxicology and Pharmacology, 53, 52-62)

Percieved risks and benefits of nanotechnology

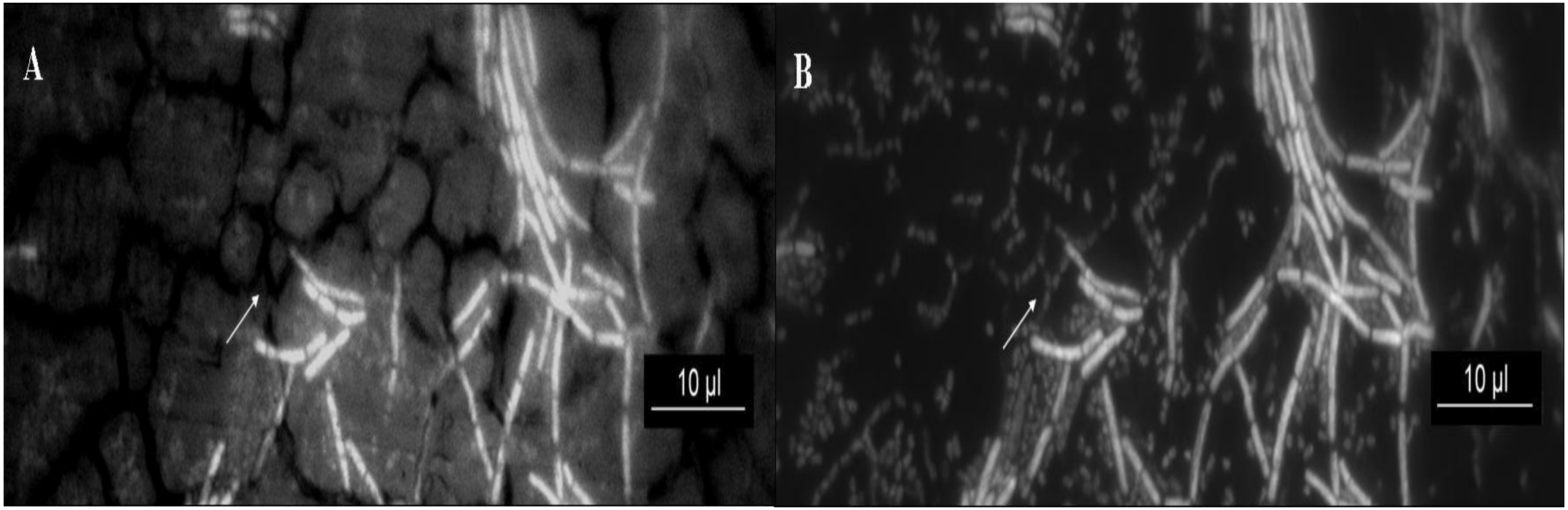


(López et al., (2012), British Fd J, 114, 197-205)

- Mikrobák tapadása felületekhez
- Mikrobák jelenlétének/tapadásának kimutatása: hagyományos (lemezöntés, felületi mikroszkóp, epifluoreszcens mikroszkóp, SEM, fluoreszcens in situ hibridizáció (FISH), és nano-módszerek (atomi erő mikroszkóp; kvarckristály mikromérleg; total internal reflection microscopy TIRM, total internal reflection aqueous fluorescence microscopy TIRAF; bioszenzorok)
- A mikroba tapadásának gátlása
- Antimikrobás hatású nanorészecskék
- Környezeti hatás

Mikroba-tapadás kimutatása 2

Felületi mikroszkópos felvételek (A: CY3/TRI szűrővel, B: GFP/FITC szűrővel)

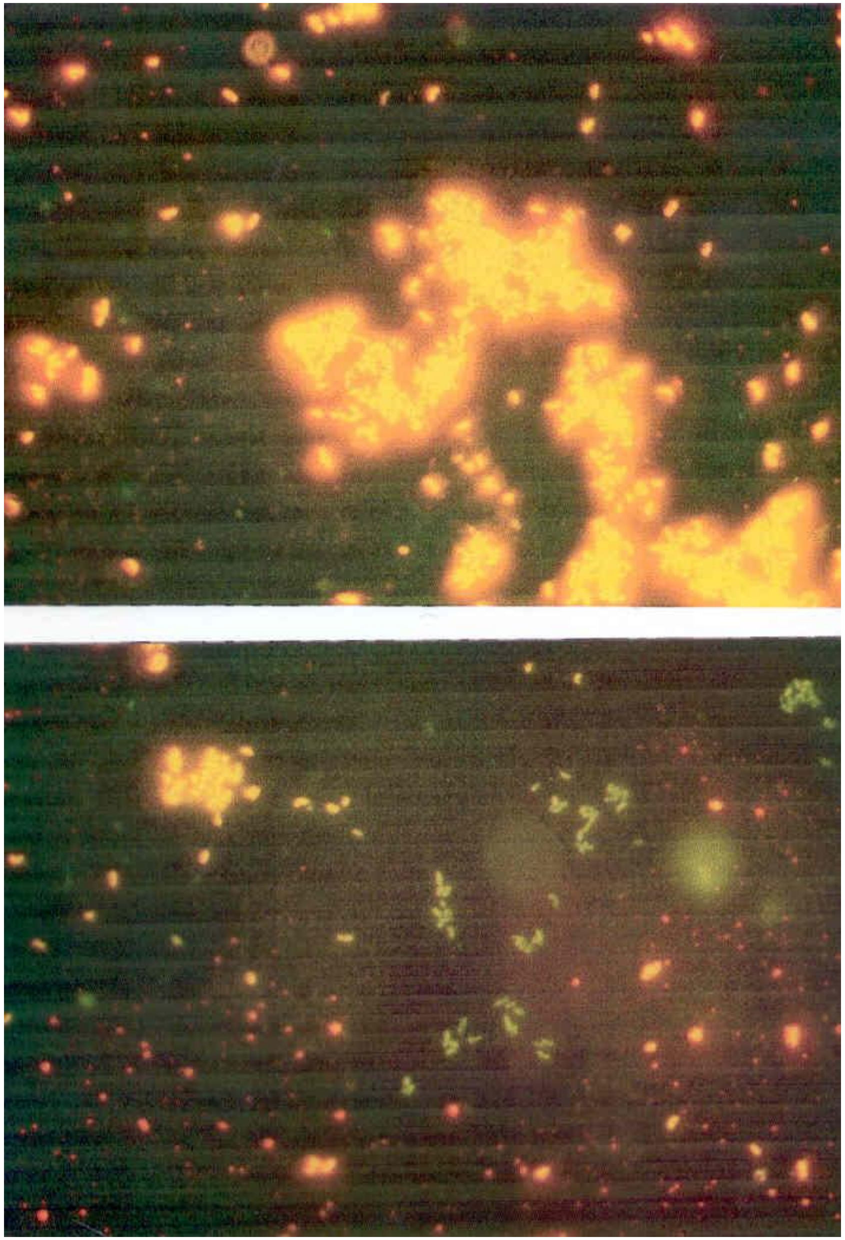


***Pseudomonas fluorescens* és *Lactobacillus delbrueckii* subsp. *bulgaricus*-szal kevert tenyészet, rozsdamentes acél felületén**

(Szekér et al., 2007)

Mikroba-tapadás kimutatása 3

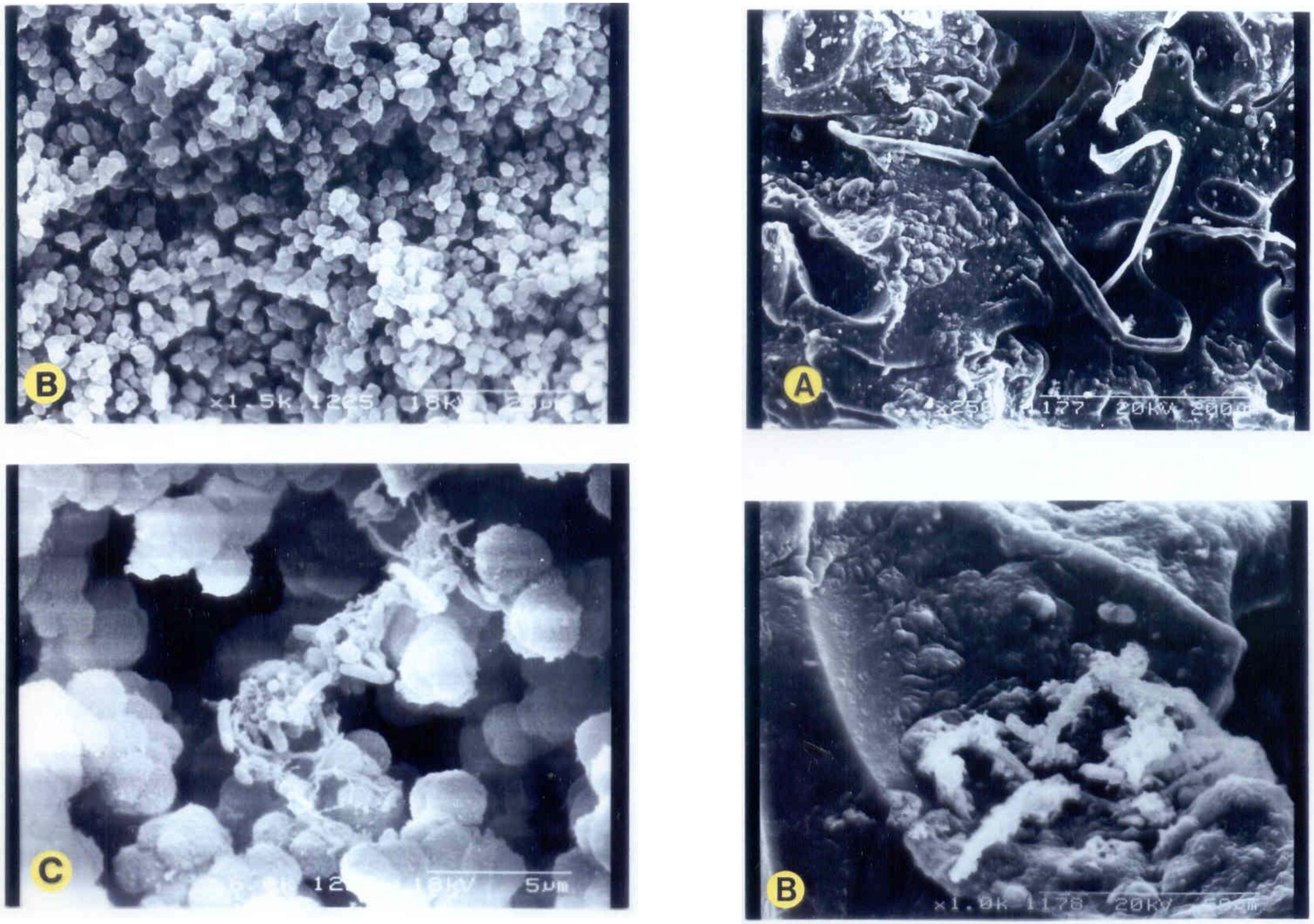
Akridin narancs festést követő epifluoreszcenciás felvétel



(Beczner és Telegdi, nem publ.)

Mikroba-tapadás kimutatása 5

Pásztázó elektronmikroszkópos felvételek

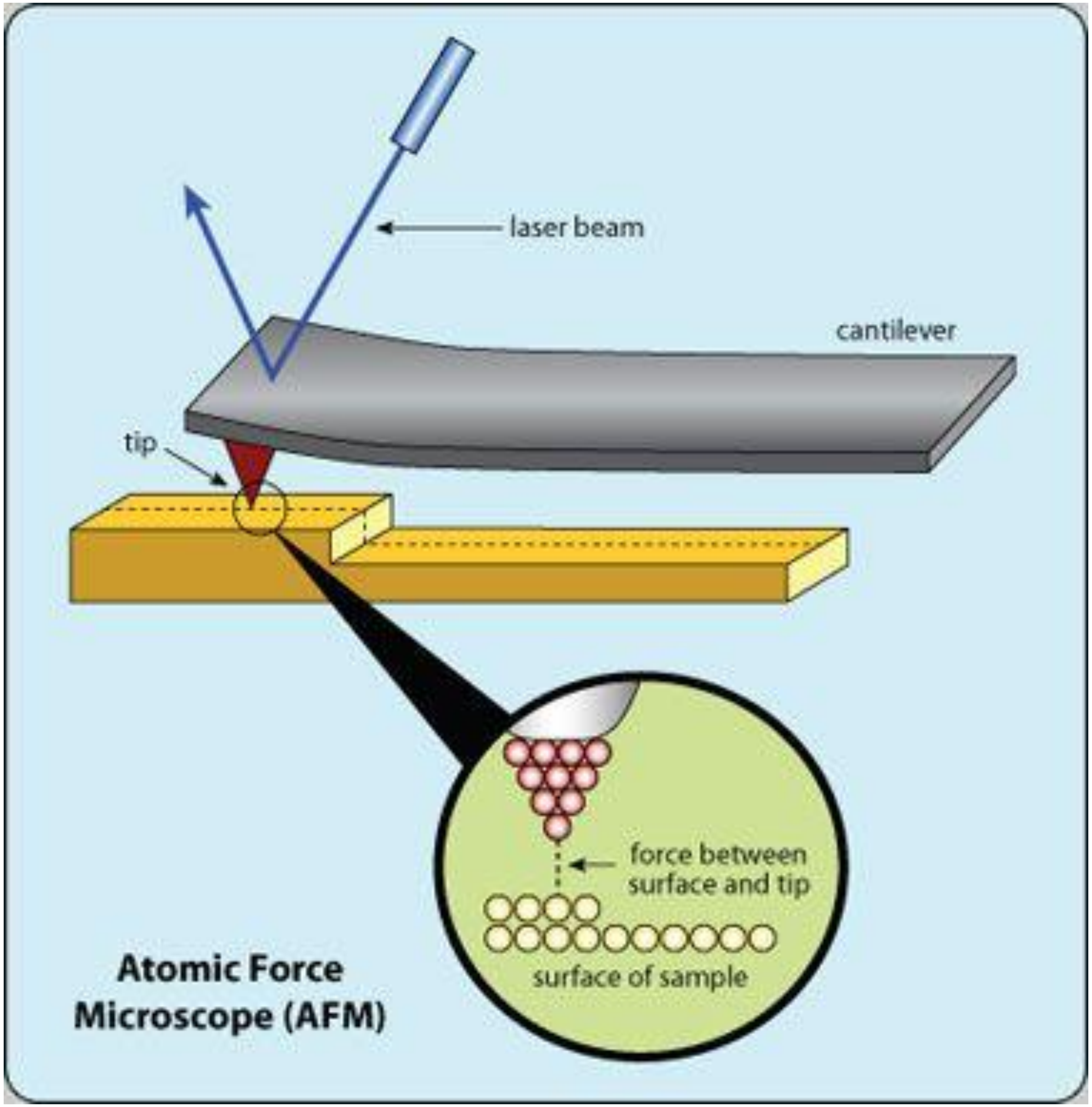


Mikrobák tapadása hidrogélekhez

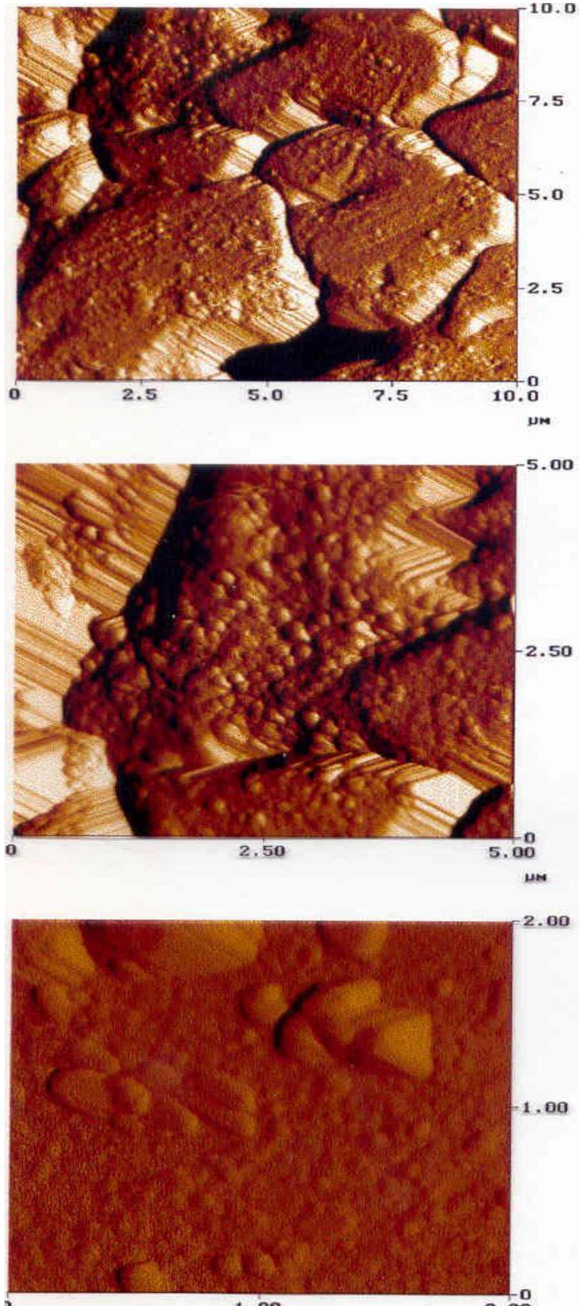
(Beczner et al., nem publ.)

Mikroba-tapadás kimutatása 6

Atomi erő mikroszkóp (AFM)



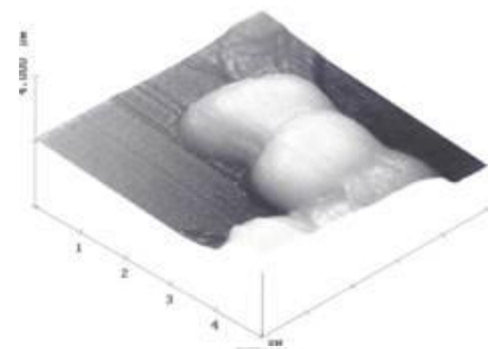
Baromfiipar – nyitókés használat után



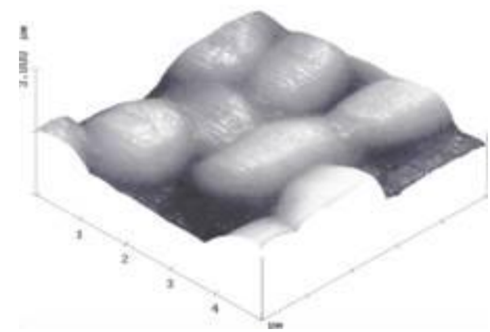
(Beczner et al., 2008)

***Bacillus cereus* spóra**

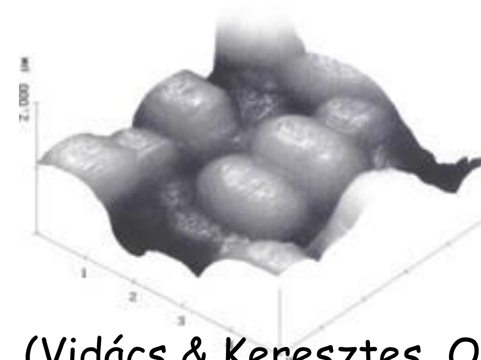
Kontroll



Hőkezelt



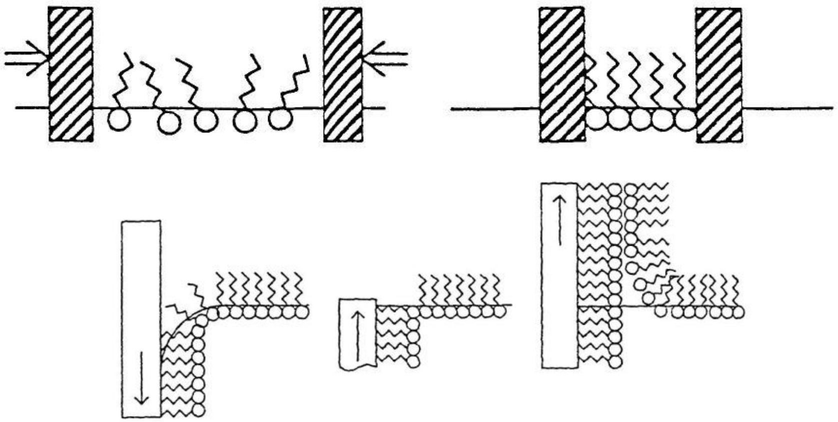
Besugárzott

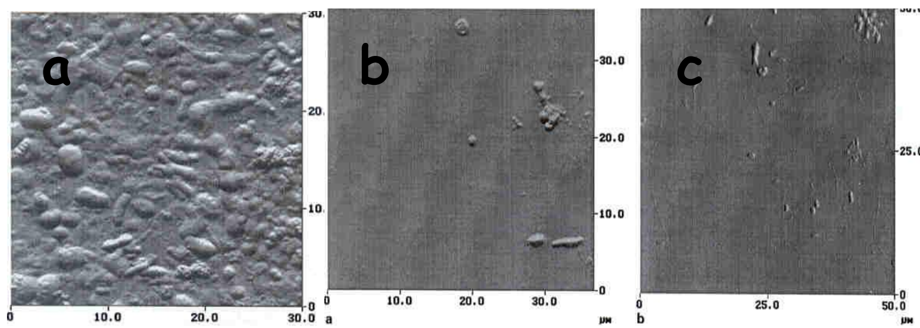


(Vidács & Keresztes, OTKA 1997-99)

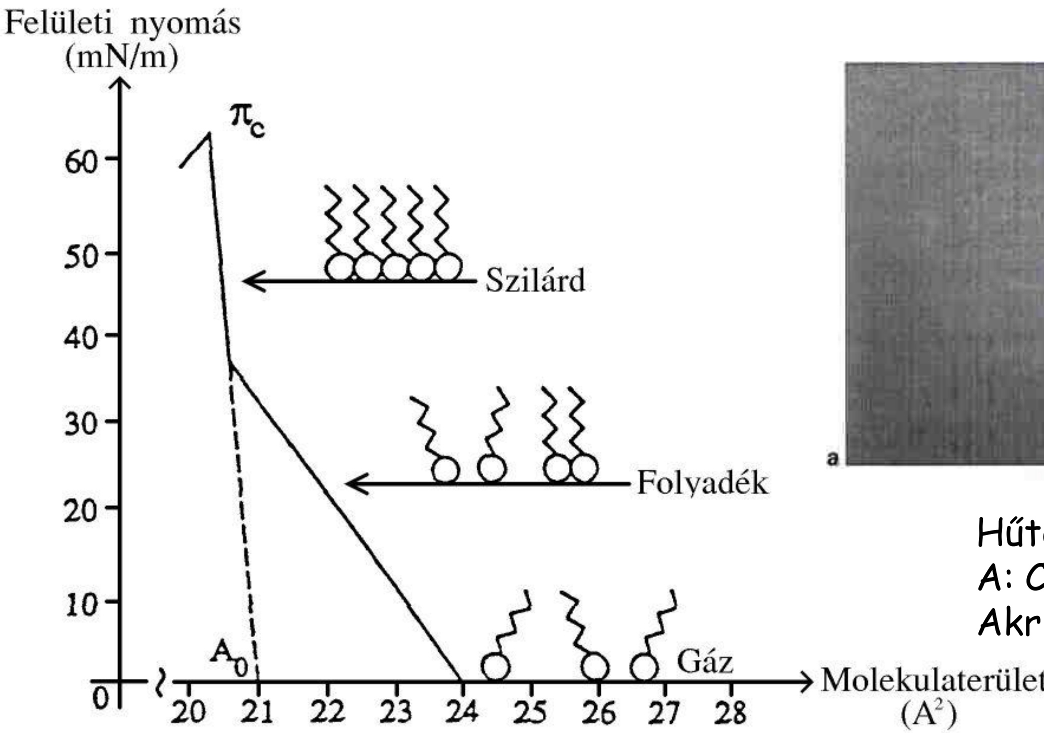
A mikrobák tapadásának gátlása

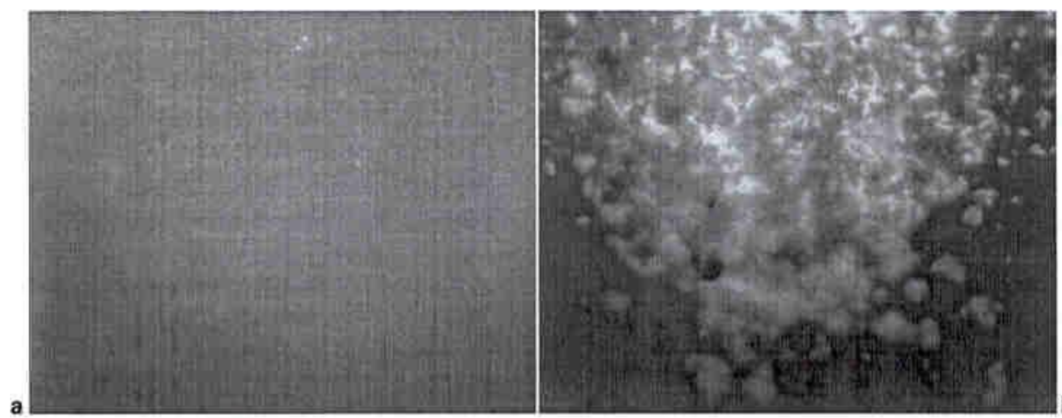
Langmuir-Blodgett nanorétegek





Hűtővízben inkubált üveglap (3 hét)
a: kontroll, b: C18N, c: C18P
AFM felvétel



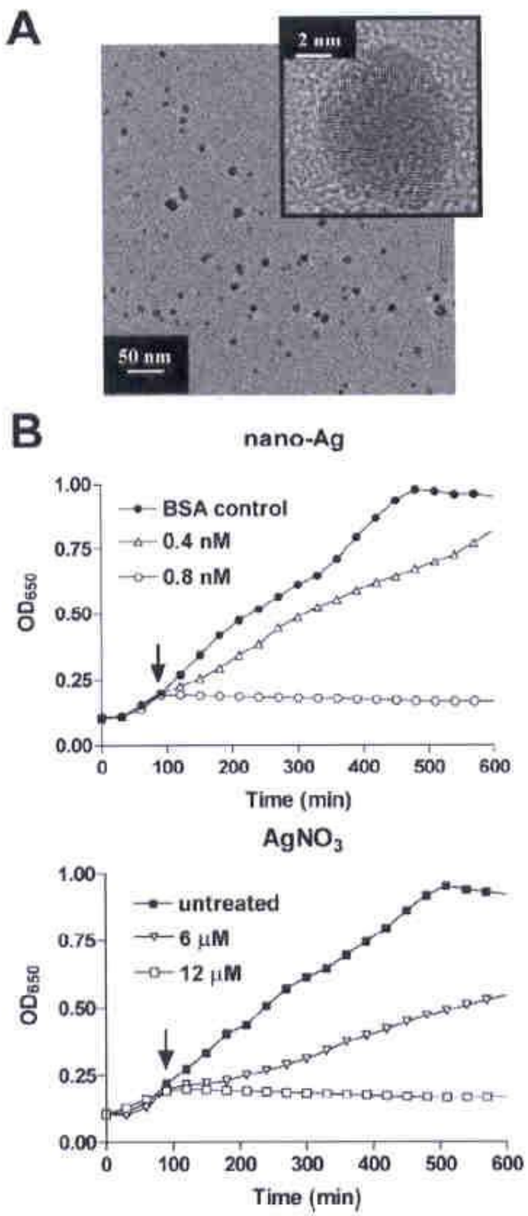


Hűtővízben inkubált armco vas kupon (5 nap)
A: C18 N, 11 monoréteg; b: C18P, 11 monoréteg
Akridin narancs festés, epifluoreszcens mikroszkóp

(Telegdi et al., 2005)

Nanorészecskék mikrobagátló hatása

Nano ezüst (Ag NP)



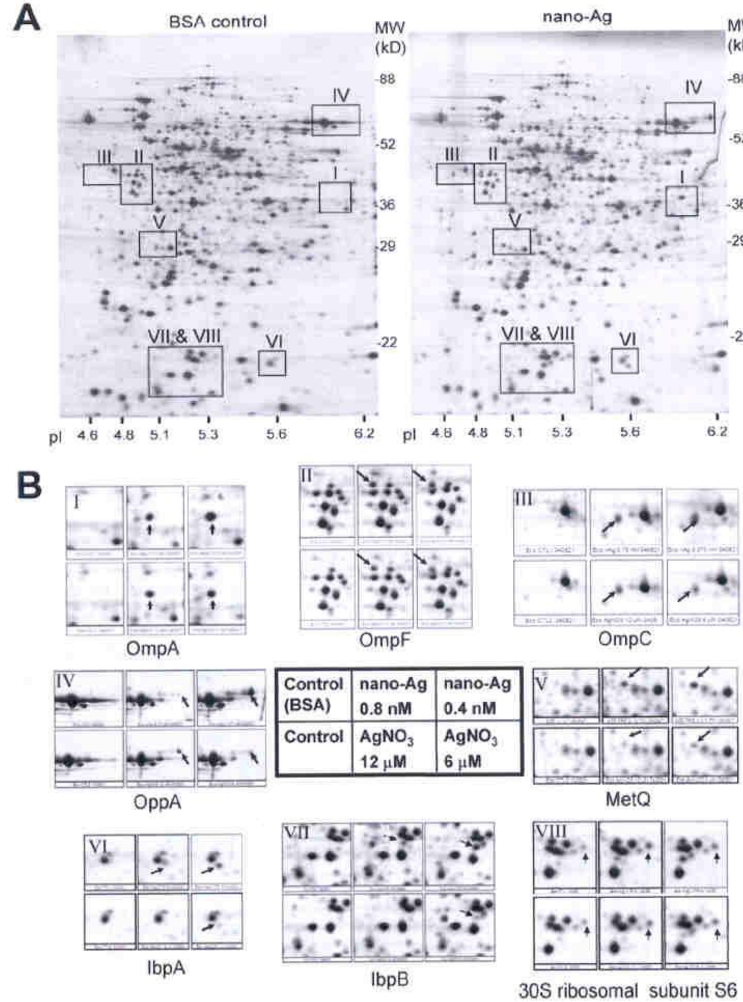


Figure 2. 2-DE analysis of protein samples from *E. coli* cells treated with nano-Ag or $AgNO_3$. *E. coli* cells were grown at 35 °C to the early exponential phase (O. D. $_{650}$ = 0.15) in M9 medium, treated with nano-Ag (0.4 and 0.8 nM, with 0.1% BSA) or $AgNO_3$ (6 and 12 µM) for 30 min, then subjected to 2-DE analysis. (A) 2D gel images of *E. coli* cells treated with nano-Ag or BSA as a control. Squared areas (I−VIII) represent areas of interest containing the silver induced protein spots and are enlarged in (B).

A kezelt *E. coli* fehérjéinek 2D elfo vizsgálata

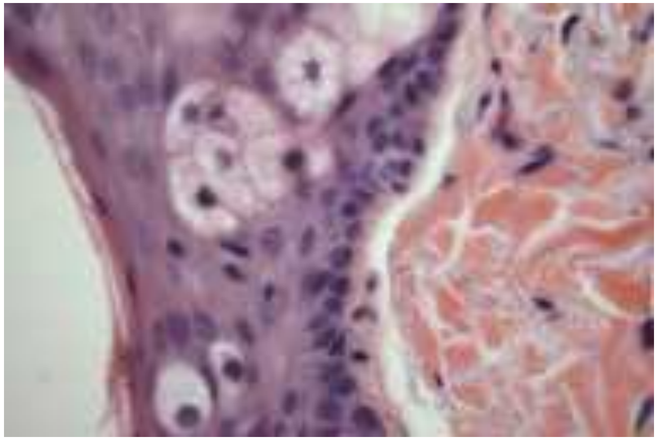
Az Ag NP károsítja a sejt-membránt, a plazma membrán potenciál összeomlik és csökken az intracelluláris ATP mennyisége

A: Ag NP TEM képe; B: Az *E. coli* szaporodására gyakorolt hatás

(Lok et al., 2006)

Előre nem látható veszélyek: nanotechnológiától a nanotoxicitásig

- DNS károsodás
- A sejtfunkció károsítása, szabad-gyök keletkezés (oxigén)
- Az azbesztéhez hasonló károsodás
- Neurológiai problémák
- Szervek károsodása, pl. léziók a májon és a vesén
- A hasznos mikrobák elpusztítása pl. a szennyvíz-tisztító rendszerekben
- Törpe gyökérnövekedés kukorica, szója, répa, uborka és káposzta esetében
- Halaknál a kopoltyú károsodása, légcsere problémák és oxidatív stress

Ezüstkolloid-fogyasztás 10 hónapig – argyria; ezüstszemcsék felhalmozódása a bőr alatti szövetekben, mirigyekben

Akhil Wadhera MD and Max Fung MD
Dermatology Online Journal 11 (1): 12
Department of Dermatology, University of California Davis

Az ezüst-biocid környezeti hatásának elemzése

SCIENCE OF THE TOTAL ENVIRONMENT 390 (2008) 396–409

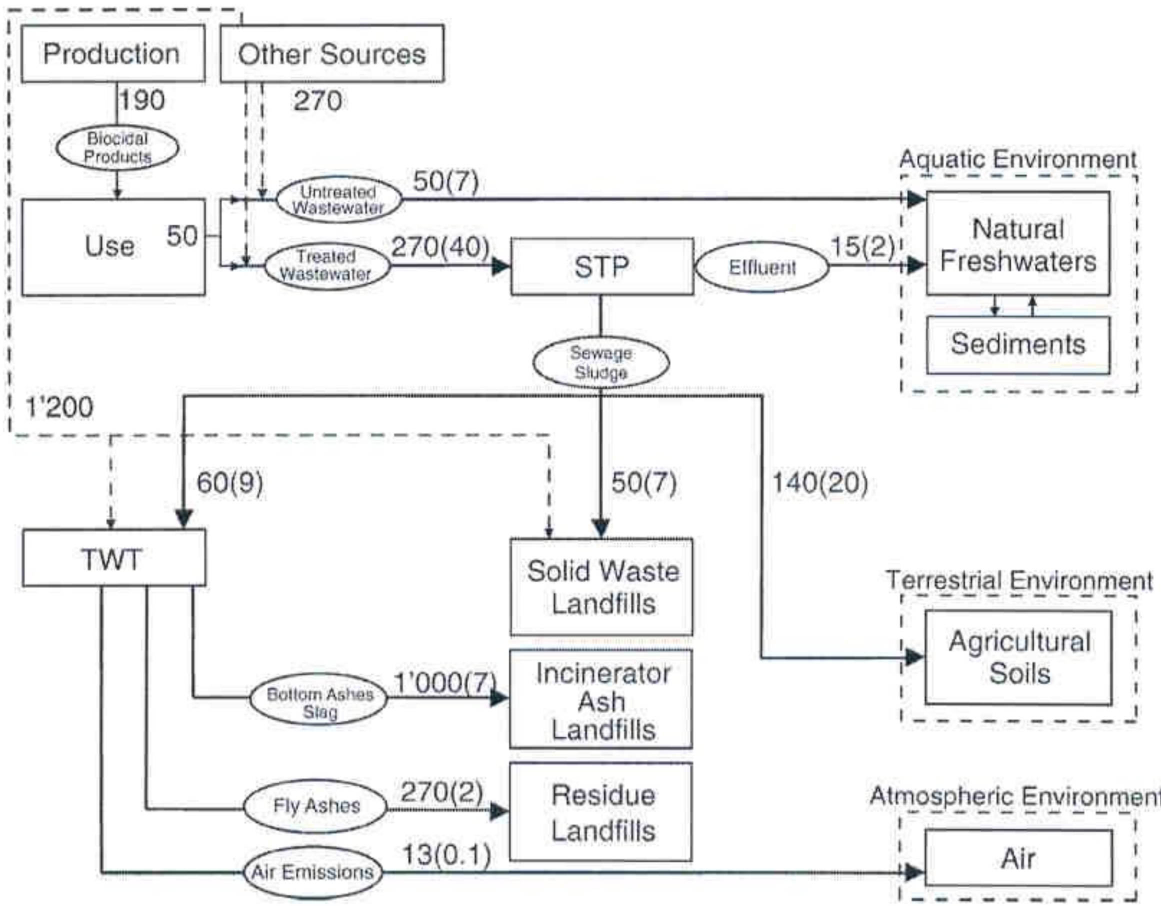
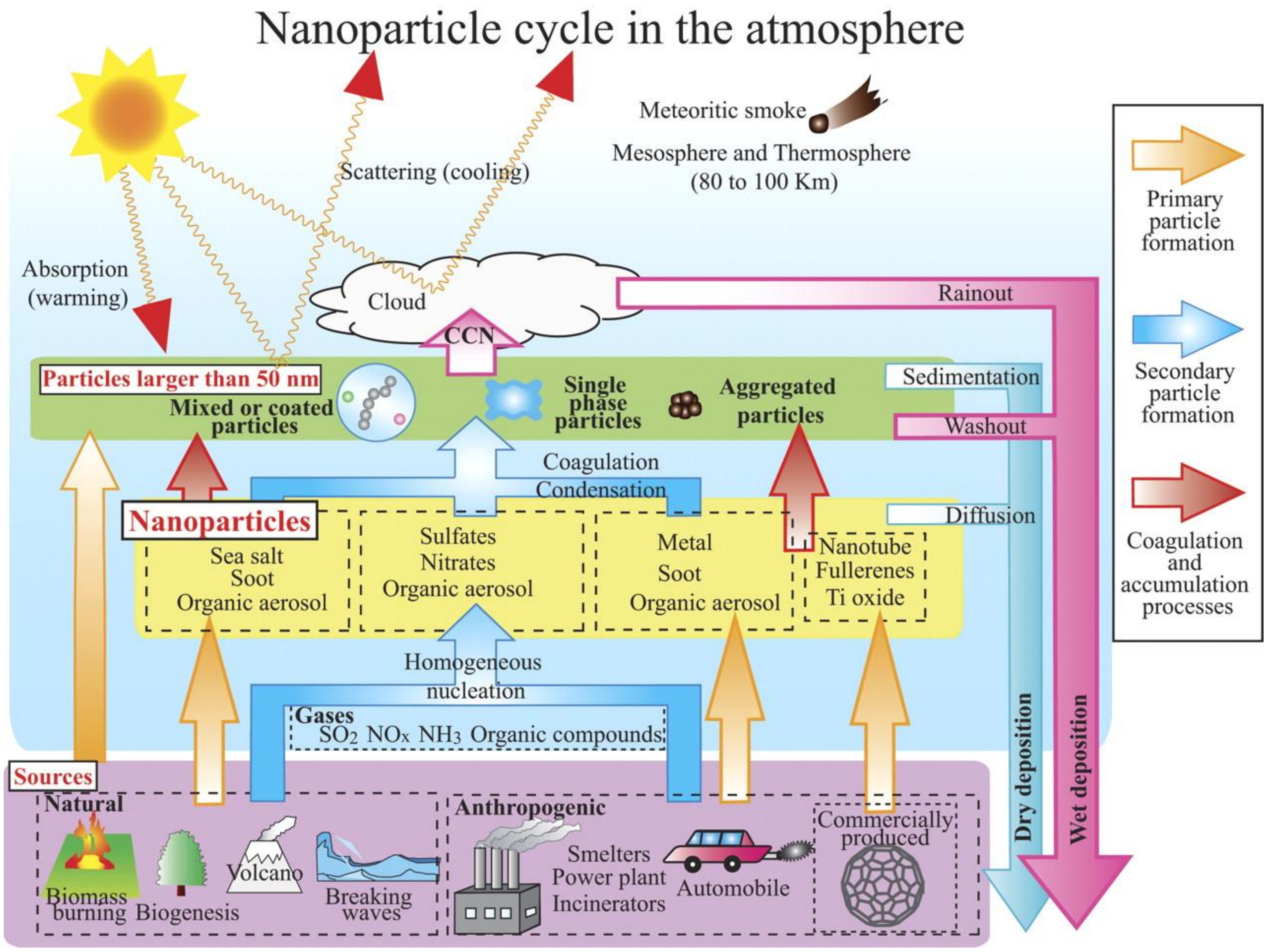


Fig. 2 – Quantified mass flows of silver triggered by the use of biocidal products and by other silver uses (intermediate scenario, values in tonnes per year; values in brackets are amounts originating from the use of biocidal products). Thin arrows represent flows caused by biocidal plastics and textiles. Dashed arrows are silver flows from other sources. Thick arrows are used where mass flows of biocidal products and other silver sources come together. Production of silver-containing plastics and textiles is not considered. Mass flows into the marine ecosystem and silver in leachates and aerial deposition are not quantified.

(Blaser et al., 2008)



(Suen et al., 2012, University of Waterloo)

Table 2 – Specific growth rates (μ) of E. coli PHL628-gfp and the inhibitions by silver species at different concentrations

Concentration (μM)	Ag NP		Ag^+		AgCl colloid	
	μ (d^{-1})	Inhibition (%)	μ (d^{-1})	Inhibition (%)	μ (d^{-1})	Inhibition (%)
1.4	0.40 (±0.03)	17 (±5)	0.41 (±0.02)	11 (±4)	0.43 (±0.01)	7 (±4)
2.8	0.34 (±0.03)	30 (±6)	0.14 (±0.03)	69 (±6)	0.35 (±0.02)	24 (±5)
4.2	0.22 (±0.04)	55 (±8)	0	100	0.16 (±0.03)	66 (±6)

Az Ag NP hatása függ a partikulák méretétől és koncentrációjától. A gátló hatás feltehetően részben az intracelluláris reaktív szabad gyökök felhalmozódásának tulajdonítható; a sejten belül enzimaktivitás gátlás és DNS károsítás az elektron-donor molekulákkal való reagálás következtében.

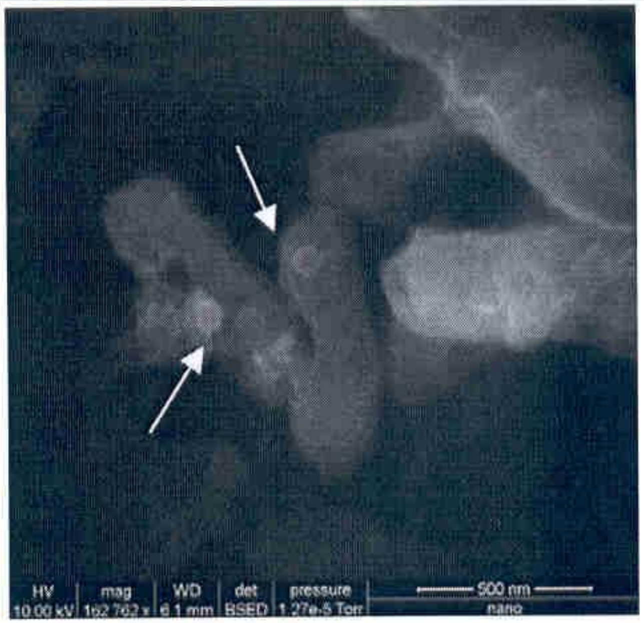


Fig. 7 – Silver nanoparticles adsorbed to the enriched nitrifying culture using a high-speed BSE detector. Arrows show spherical or hexagon types of Ag NPs that attached to the microbial cells, probably causing cell wall pitting. Bar size: 500 nm.

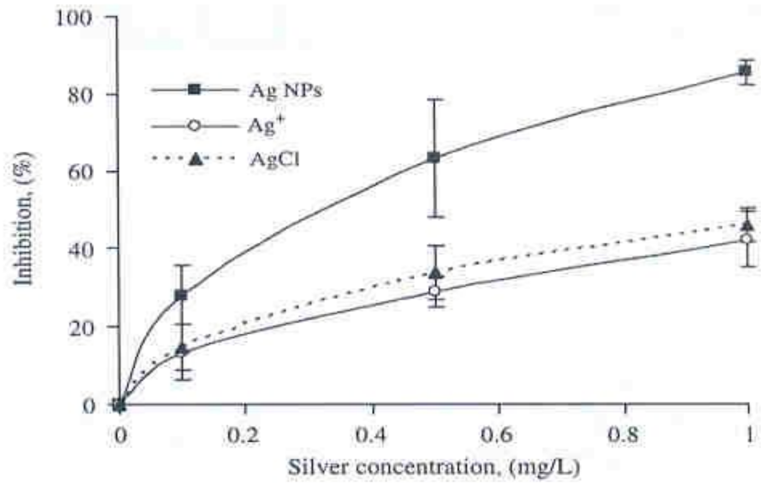


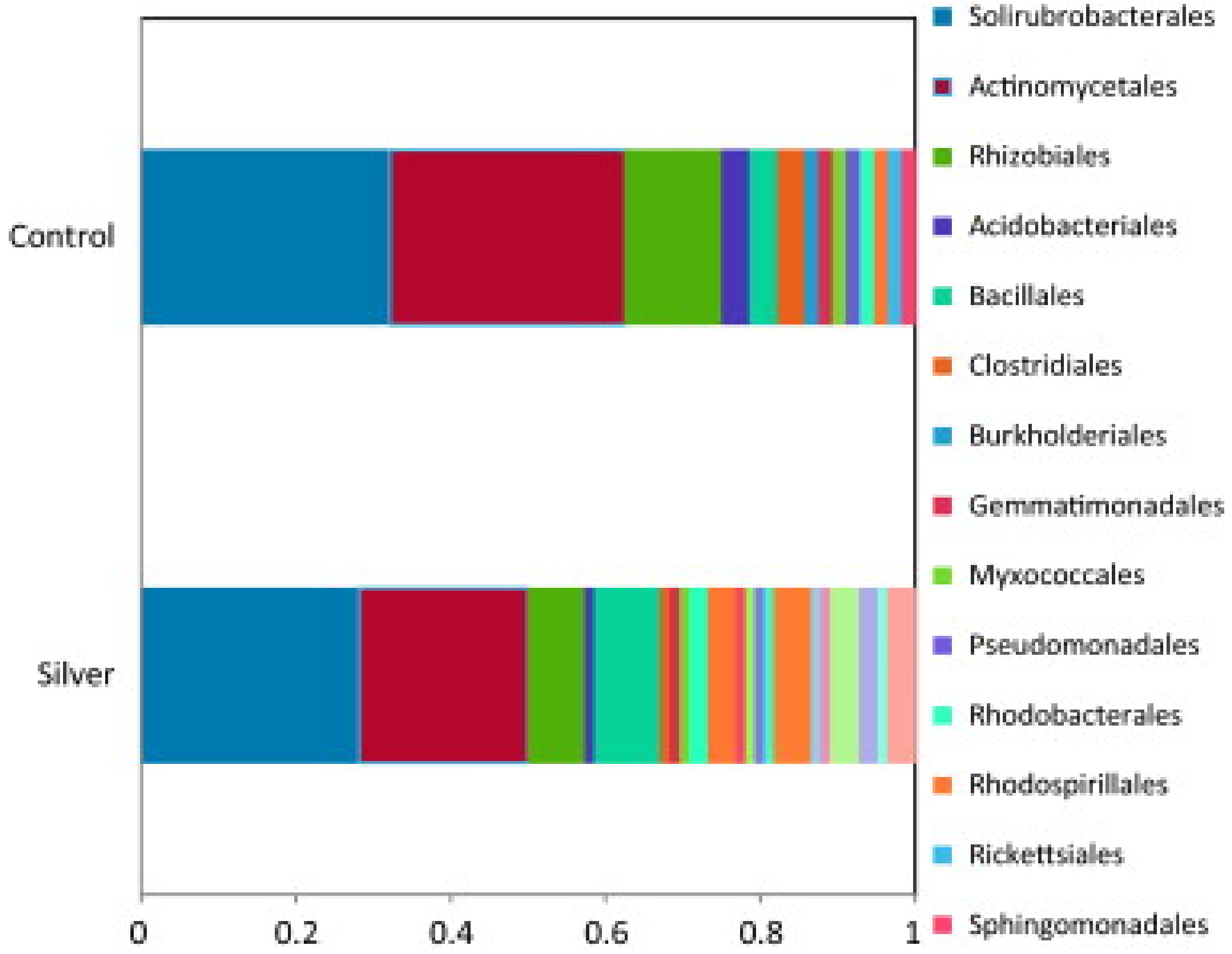
Fig. 4 – Nitrification inhibition as a function of the concentrations of silver in the form of Ag NPs, Ag^+ ions, and AgCl colloids. Error bars indicate one standard deviation.

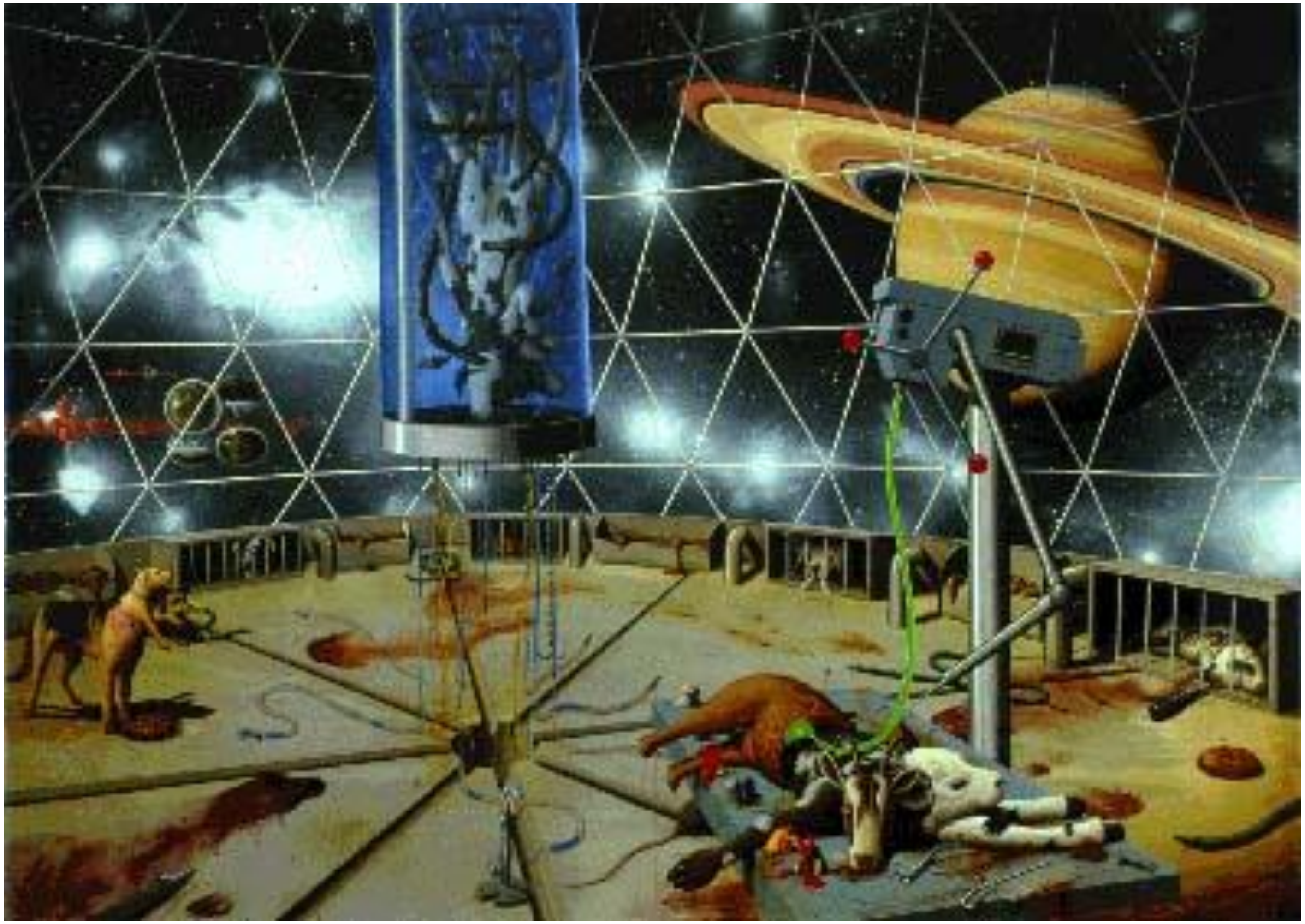
(Choi et al., 2008)

A frissen készített Ag nanopartikulák hatása volt a legerősebb az autotróf nitrifikáló baktériumokra. A heterotróf *E. coli*-ra az ezüst ion volt a legtoxikusabb. A különbség oka: más faj, eltérő membrán-felépítés, más szaporodási sebesség, az eltérő szaporodási körülmények.

Changes in bacterial content of soil exposed to nanosilver

(Kumar et al, 2011)





Alexis Rockman: Biosphere lab (1993)

Alexis Rockman: Bench