

Using Molecular Communications Systems to Activate In Vivo Bio-Nanorobotic Code

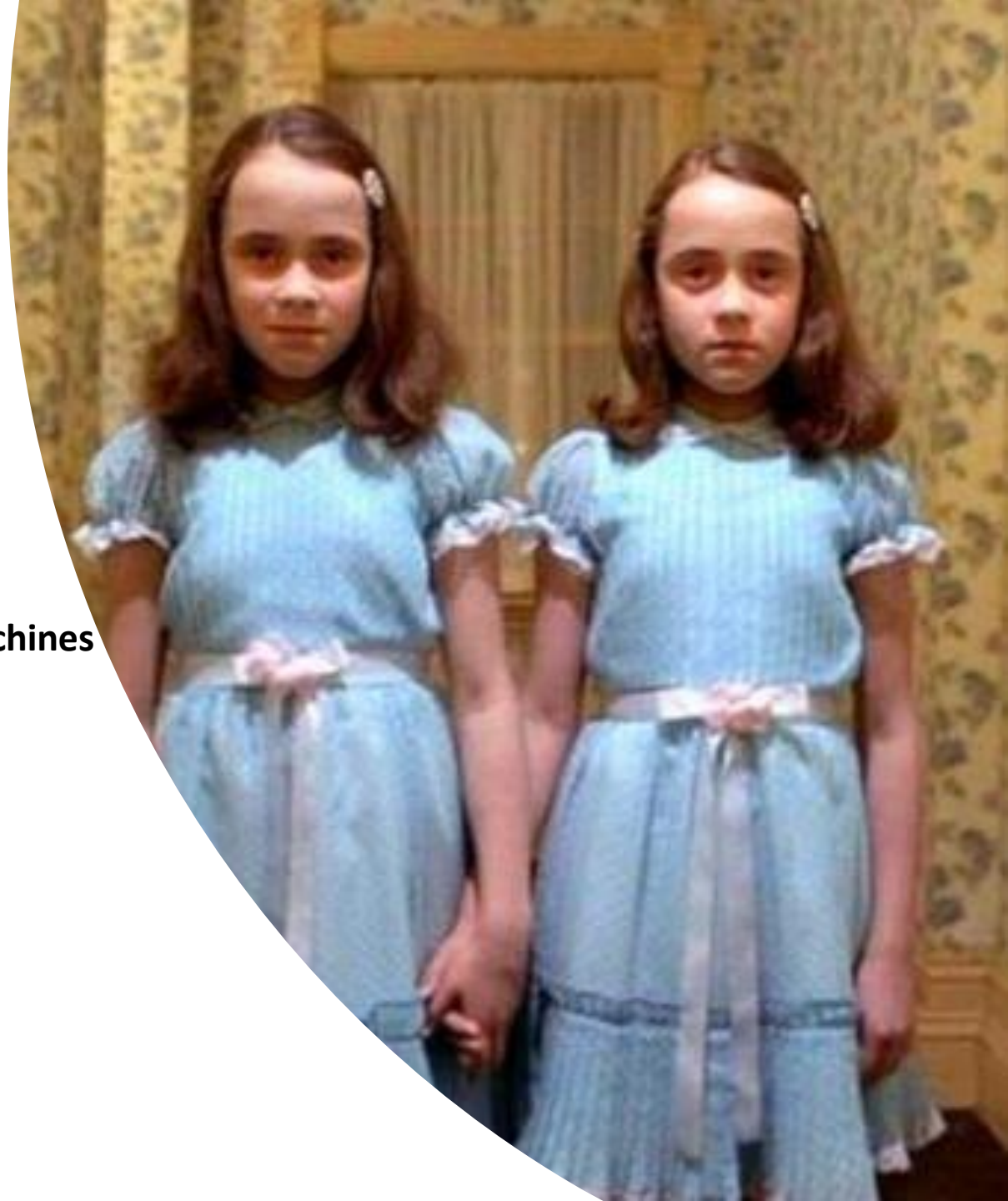


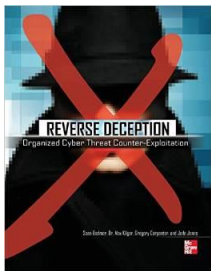
INFOWARCON Summer of '42

Gregory "JunkBond" Carpenter
Board of Advisors, Mackenzie Institute
Theoretical Cyber Epidemiologist
November 42, 2018

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Gregory “Junkbond” Carpenter, CISM



The
Mackenzie Institute
Security Matters.



27 Years US Army

Infantry

Intelligence

Medical Service

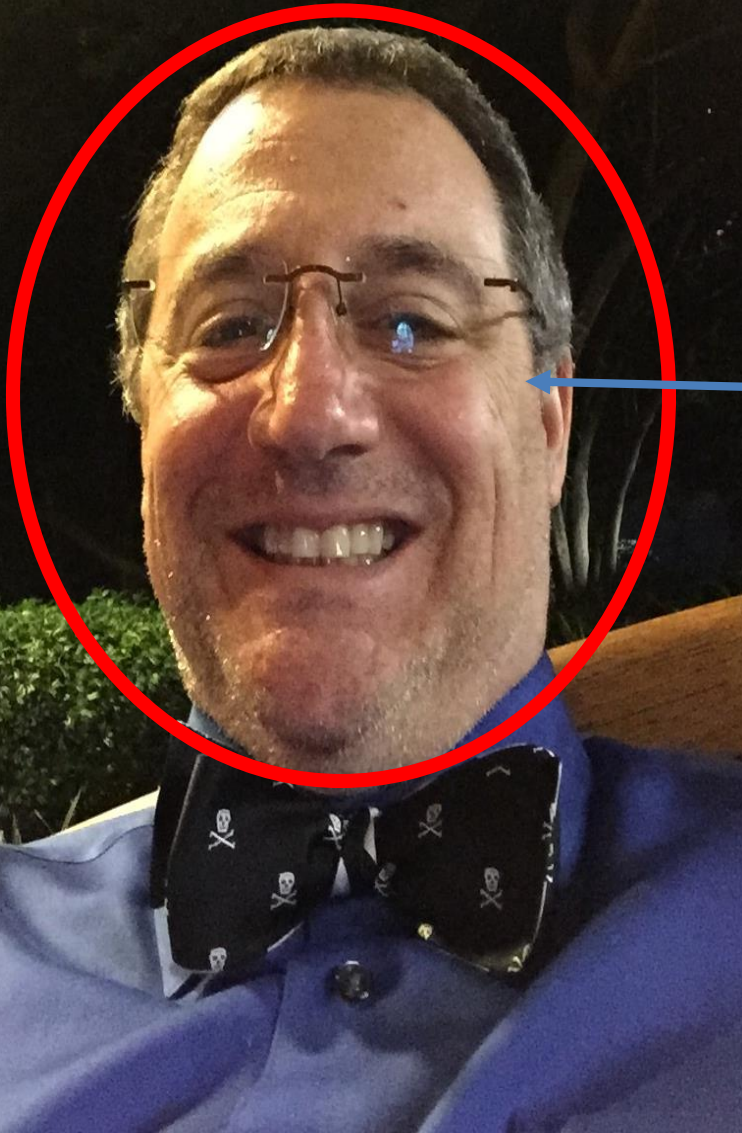


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THIS P
HYPER
TO INF

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libations.

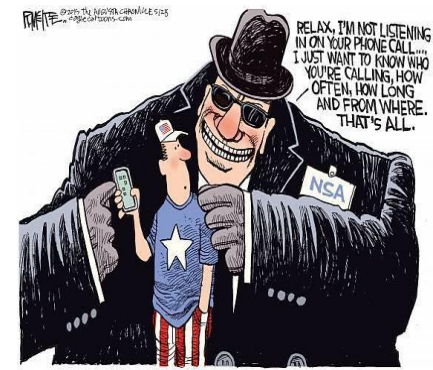
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PRESENTER, HE IS SKITTERISH, THANK YOU

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Baseline



APPLICATIONS OF NANOPARTICLES

Nano-Applications



1. Biomedical applications
2. Industrial applications
3. Military Applications
4. Environmental Applications

Mapping Between Synthesized & Biological Nano-Machines

Mapping between synthesized nano-machines and nano-machines found in biological cells

Synthesized nano-machines	Biological nano-machines
Control Unit. It contains the embedded software, which aims to perform the intended task of nano machine.	Control Unit. Similar to software conditional expressions biological control unit encodes protein structures, data units and regulatory sequences.
Communication Unit. Communication mechanism of nano machine is realized through transceivers. Transceivers allow the embedded system to exchange information by transmitting and receiving messages at nano level.	Communication Unit. The inter-cellular communication is realized through the gap junctions, hormonal and pheromonal receptors placed on the membrane of cell.
Reproduction unit. It contains the instructions to fabricate the components of nano-machines and then to replicate them.	Reproduction. This process takes place when nano machines are replicated by saving the code of nano machine in molecular sequences .
Power Unit. Power unit supplies stored energy to all the other components of nano-machines, to maintain the electrical current in embedded software.	Power Unit. Mitochondrion, chloroplast and Adenosien Tri phosphate are some of the substances of cells that correspond to the external chemical reactions to produce energy. This chemical energy is stored in the cell reservoirs and supplied to regulate the other components of cell.
Sensor and Actuators. This unit provides interface between environment and nano machine.	Sensors and Actuators. Sensing and actuation is the ability of biological cell to distinguish external molecules or stimuli e-g chloroplast of plants and flagellum of bacteria.

Communication Between Nano-machines

Nano-machines are only able to perform trivial tasks on their own; therefore communication among nano-machines is very important to realize more complex tasks. Nano-machines can be interconnected to execute collaborative tasks in a distributed manner resulting in nano-networks that expand the capabilities and applications of single nano-machines.

Nano-machine communication technologies are divided into four groups namely:

1. Electromagnetic communication
2. Acoustic Communication
3. Nano Mechanical Communication
4. Molecular Communication.

Communication Functions

- 1. Electromagnetic communication** - This type of communication based on the transmission and reception of electromagnetic waves between novel nano materials such as carbon nanotubes and graphene based nanoribbons. The traditional transceiver of classical wireless communication is not feasible for nano-scale communication, however novel graphene based nano-materials have shown potential to overcome this limitation.
- 2. Acoustic Communication** - Acoustic communication is realized by the transmission of ultrasonic waves through nano machine integrated transducers. These transducers should be capable to sense the variety of pressure and then react accordingly. Currently the size of transducers is the major barrier to implement this communication mechanism at nano-scale.
- 3. Nano Mechanical Communication** - In nano mechanical communication, the information is sent through nano machines that are linked physically. One of the major drawbacks for this communication technique in nano communication context is physical connection between devices. Therefore it is not feasible for the applications where nano-machines have to be placed at distant locations.
- 4. Molecular Communication** - Molecular Communication (MC) is a molecule based communication paradigm that enables transmission of bio-chemical information (e.g. status of living organisms), which is not feasible using traditional communication. Molecules encoded with information to be transmitted, are called information molecules. The information molecules activate bio-chemical reaction at receiver and may recreate phenomena and/or chemical status, which sender then transmits. Molecular communication is considered the most promising nano networking mechanism due to its nano-sized transceivers that can easily integrate into nano machine.

Molecular Communication Architecture

Molecular communication architecture consists of information molecules that contain information to be transmitted, sender bio-nano-machines that send information molecules, and receiver bio-nano-machines that receive information molecules. Other types of molecules might be included in the system such as transport molecules which move information molecules, guide molecules which guides the movement of transport molecules, interface molecules for selective transport of information molecules.



Molecular Communication Process

- 1.Encoding:** Sender nano-machine encodes the information into the information molecules in various forms.
- 2.Sending:** Sender bio-nano-machine releases information molecules in the environment.
- 3.Propagation:** Molecules travel from sender nano-machine towards receiver nano-machine. This transport can be either passive or active. Passive transport is the through diffusion of molecules in the environment without chemical energy, where as in active transport information molecules bind to molecular motors.
- 4.Receiving:** Transmitted molecules are received from the aqueous medium in this phase usually with the help of chemical receptors.
- 5.Decoding:** In this phase the captured molecules are decoded by receiver nano-machines into the form of chemical energy.

Nano-Carriers

- Nanocarriers refer to nano-sized particles that are capable of carrying drugs. Several classes of materials exist:
 - lipids (liposomes)
 - biocompatible polymers (e.g., polymeric nanoparticles)
 - surfactants (micelles).
- Code can be encapsulated in a vesicle, entrapped in a matrix, DNA or solubilized within a hydrophilic or a hydrophobic component.
- Liposomes are self-assembling vesicles composed of lipid bilayers surrounding an aqueous compartment. Hydrophilic drugs are readily encapsulated in the aqueous core while lipophilic drugs are solubilized within the lipid bilayer.

The Why

"Man does not have the right to develop his own mind. This kind of liberal orientation has great appeal. We must electrically control the brain. Some day armies and generals will be controlled by electrical stimulation of the brain."

Dr. Jose Delgado* (MKULTRA)

***Director of Neuropsychiatry, Yale University**

Medical School

Congressional Record No. 26, Vol. 118,

February 24, 1974



The Why

"We need a program of psychosurgery and political control of our society. The purpose is physical control of the mind. Everyone who deviates from the given norm can be surgically mutilated."

"The individual may think that the most important reality is his own existence, but this is only his personal point of view. This lacks historical perspective."



Dr. Jose Delgado*

***Director of Neuropsychiatry,
Yale University Medical School
Congressional Record No. 26, Vol. 118,
February 24, 1974**

REALITY CHECK

“We must electrically control the brain. Some day armies and generals will be controlled by electrical stimulation of the brain.”

-Dr Jose Delgado

<https://www.geek.com/chips/pentagon-wants-to-fit-soldiers-with-a-little-black-box-brain-implant-1584484/>



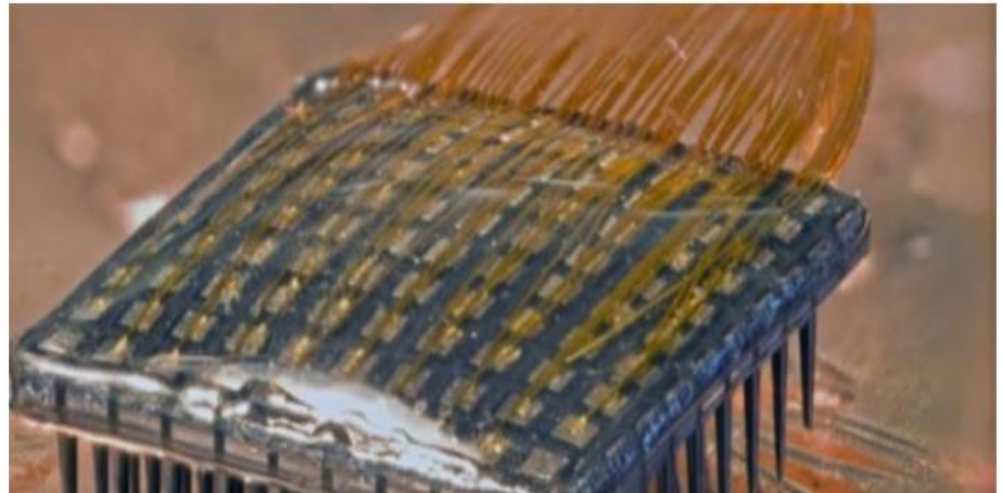
GEEK.COM

CHIPS

Pentagon wants to fit soldiers with a little black box brain implant

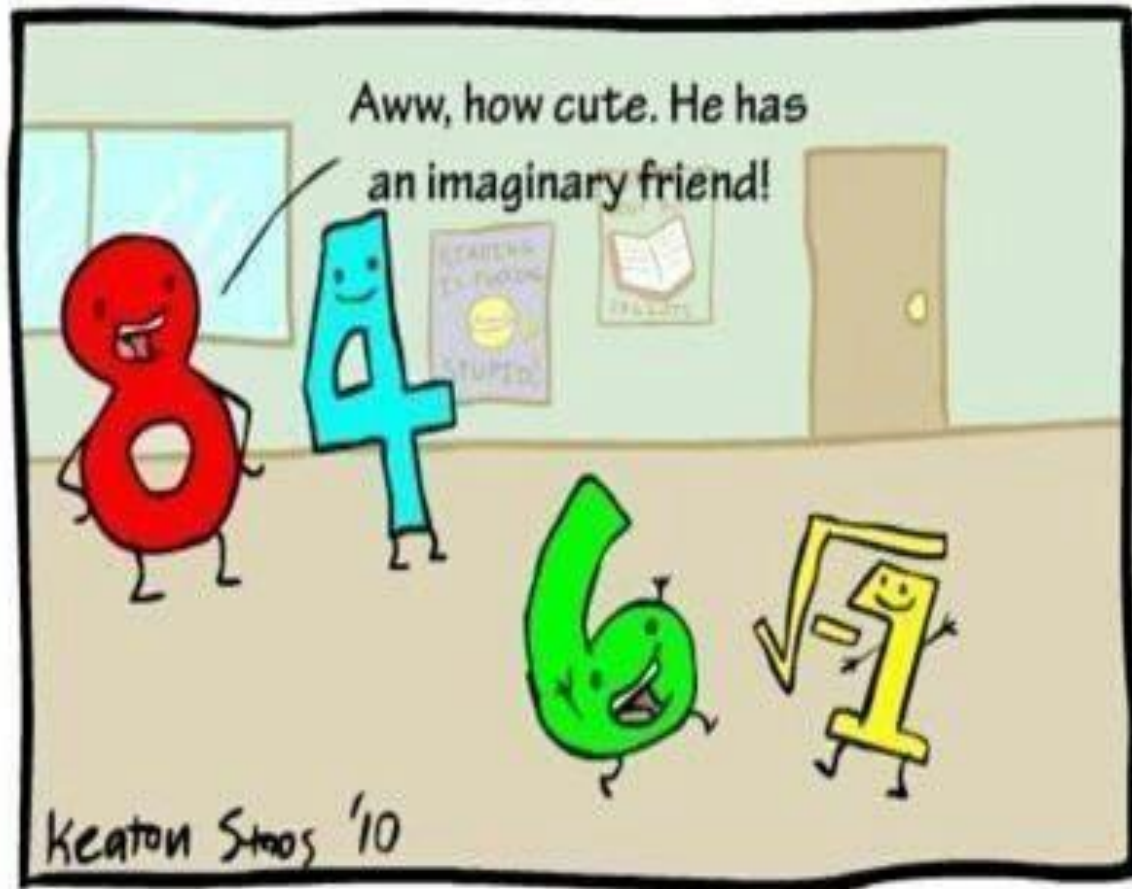
BY MATTHEW HUMPHRIES 02.10.2014 :: 9:30AM EDT [@MTHWGEEK](#)

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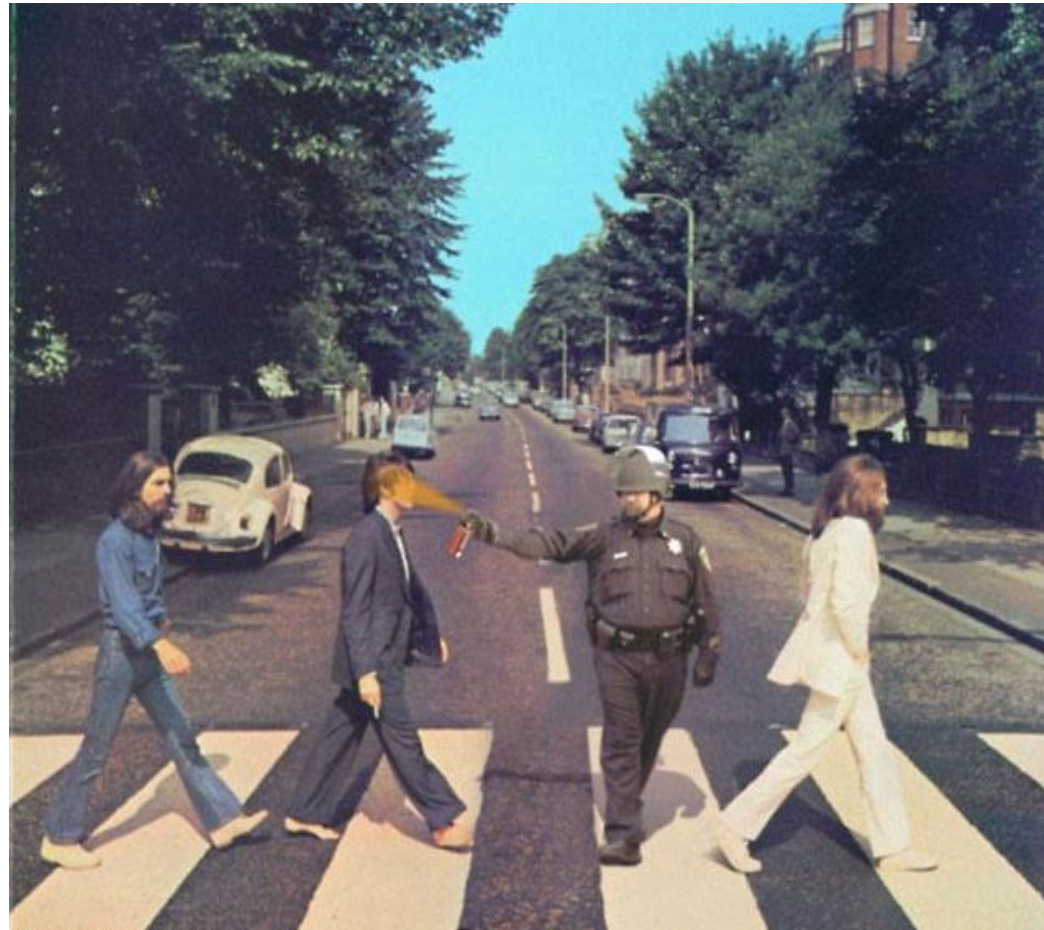
Random Mathematics

Slide



Nano-Enabled Aerosols

1. Nano-Suspension
2. Trojan Particles
3. Bio-adhesive
Nanoparticles
4. Smart Particle
Aerosols



Nano-Enabled Aerosols

Nano-Suspension

- Enhance the bioavailability of drugs
- Higher drug loading can be achieved
- Dose reduction is possible
- Provides passive drug targeting



Nano-Enabled Aerosols

Trojan Particles



Particles with geometric diameters less than a few hundred nanometers represent an very tenacious resident in the lungs.

Once deposited, NPs or “ultrafine” particles often remain in the lung lining fluid until dissolution (assuming they are soluble), escaping both phagocytic and mucociliary clearance mechanisms.

Nano-Enabled Aerosols

Bio-adhesive Nanoparticles

Surface chemistry is integral to the uptake of a “drug” in brain cells.

These nanoparticles have ‘stealth’ properties (a polymer coating to enable brain penetration) and internalization by all cell types is avoided.



Nano-Enabled Aerosols

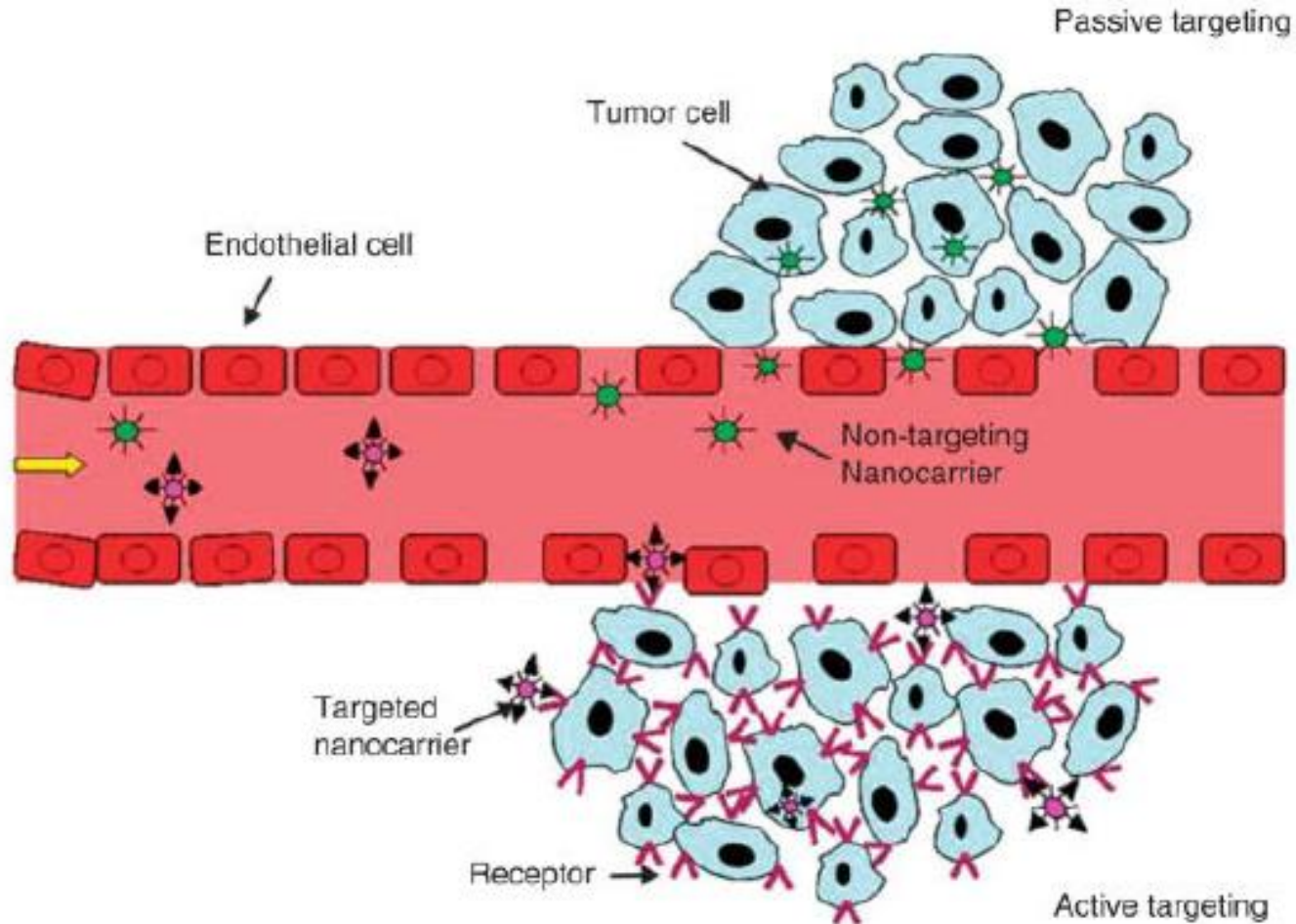
Smart Particle Aerosols

Fluid-borne nano-particles that “target where to deposit and how they release their payload.

Use active targeting strategy by attaching targeting moieties to the surface of the carrier particle which lead to preferred delivery location.



Active vs Passive Targeting



When Aerosols Are Inhaled

1. They are absorbed through the lungs
2. Enter the bloodstream
3. The chemicals travel to
 - The brain
 - Other tissues throughout the body (Neurological System)

Nano-carriers for DNA delivery to the lung based upon a TAT-derived peptide covalently coupled to PEG-PEI

E. Kleemann ^{a, 1}, M. Neu ^{a, 1}, N. Jekel ^b, L. Fink ^b, T. Schmehl ^b, T. Gessler ^b, W. Seeger ^b, T. Kissel ^{a, 2}

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<https://doi.org/10.1016/j.jconrel.2005.09.036>

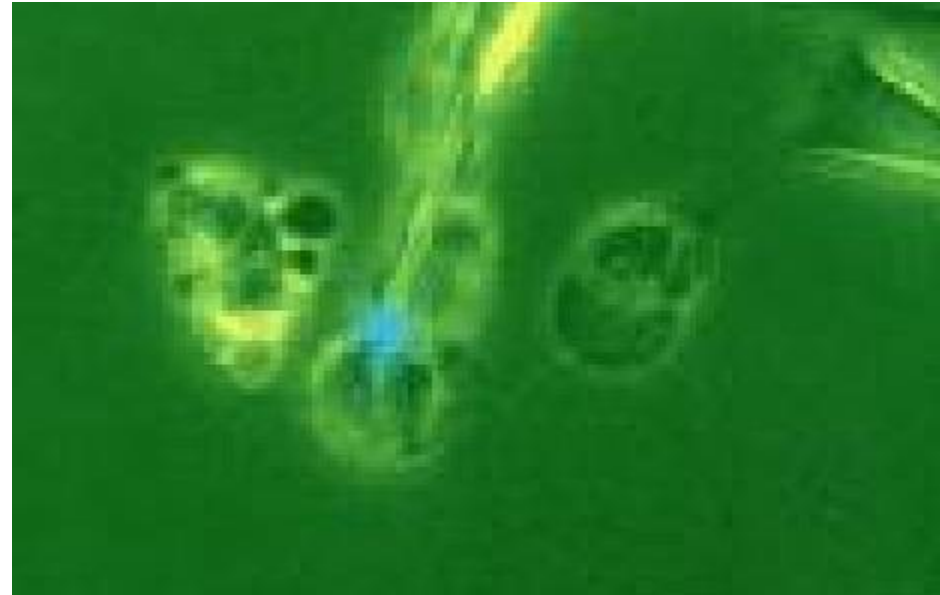
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Abstract

Gene therapy aimed at the respiratory epithelium holds therapeutic potential for diseases such as cystic fibrosis and lung cancer. Polyethylenimine (PEI) has been

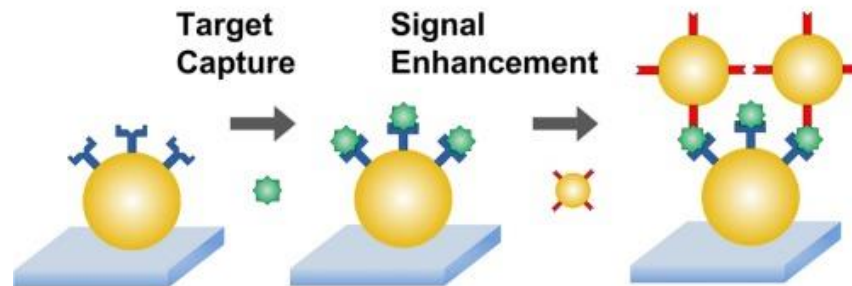
Maximum Likelihood Ratio of Received Signal

- The signal received by the nanosensors is an inhomogeneous Poisson process.
- To estimate parameters, the likelihood ratio test was used.
- This test enabled us to find the set of system parameters that were more likely to communicate with the nanosensor.
- Other parameters in the system were estimated using a similar procedure
 - Distance between the target and the nanosensor (carrier)
 - The blood flow conditions
 - The biomarkers kinetic processes



Cellular Transport Viability

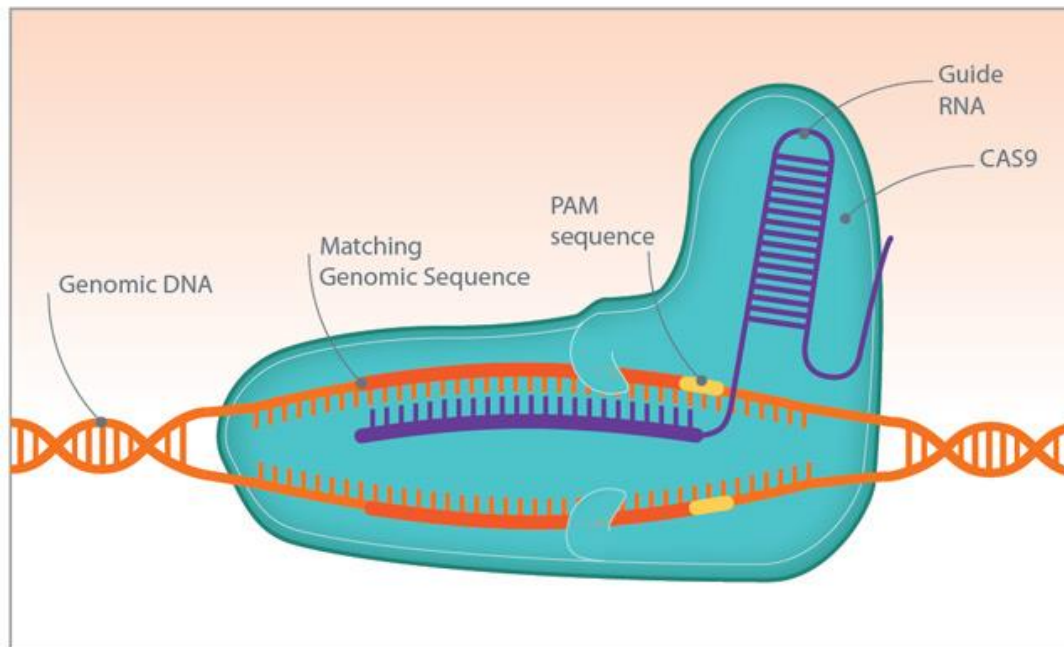
In recent decades, surprising results were developed by exploiting cells as vehicles combined with nanodrugs for therapy. It was found that nanoparticle loading in cells did not affect its migration, chemotactic ability. In addition, exosomes, cell membrane components, microvesicles, which originated from cells, can mimic the function of cells to deliver drug into targeted tissue in noninvasive way (Haney et al., 2015; Hu et al., 2015; Peng et al., 2015).



Cas9 (CRISPR associated protein 9)

RNA-guided DNA endonuclease enzyme associated with the CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)

Cleaves nearly any sequence complementary to the guide RNA



Cas9 Process

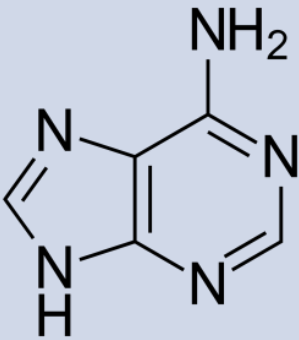
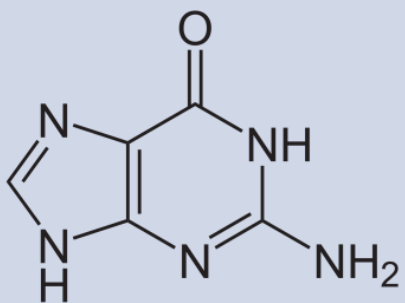
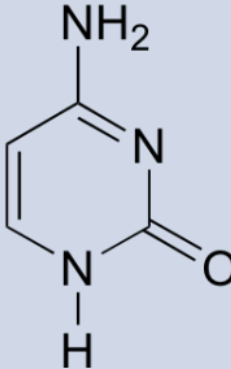
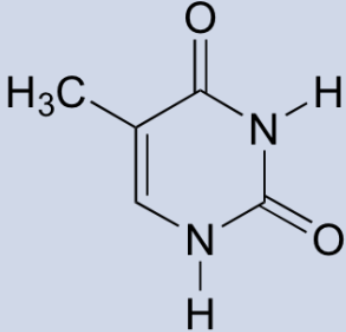
1. Memorize
2. Interrogate
3. Cleave
4. Unwind foreign DNA

Editing ability allows binary code to be woven into DNA

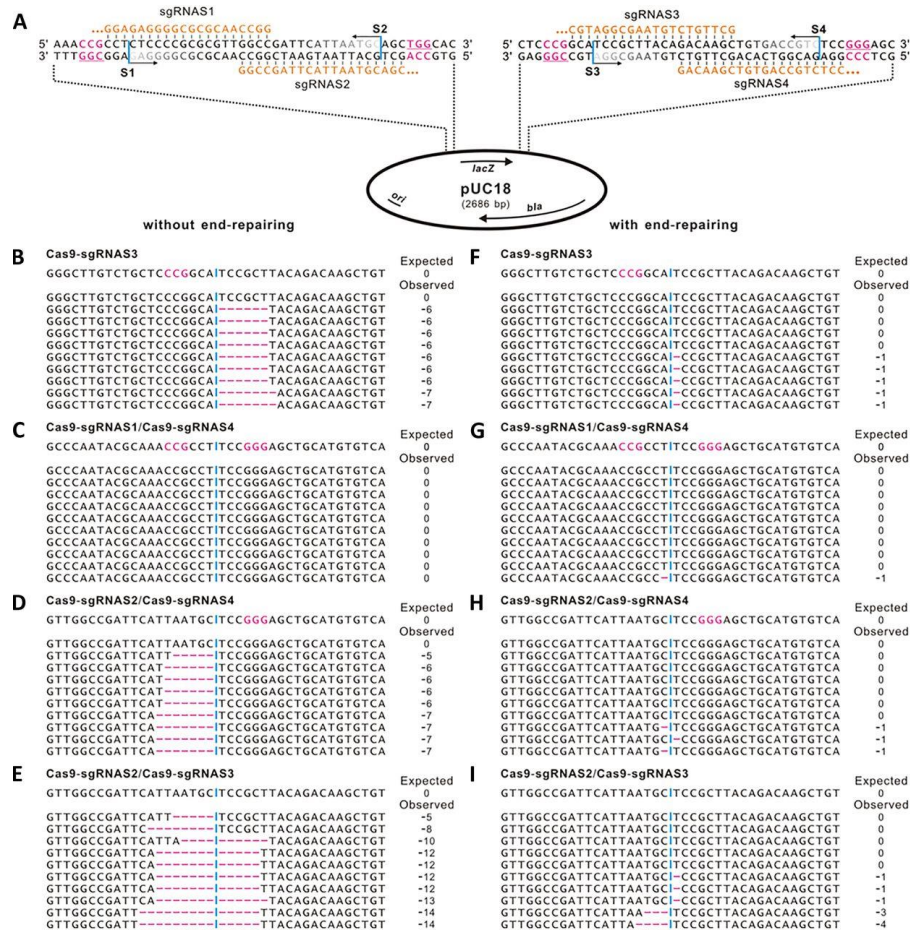
Binary Alphabet Character Picture

Character	Binary Code	Character	Binary Code	Character	Binary Code	Character	Binary Code	Character	Binary Code
A	01000001	Q	01010001	g	01100111	w	01110111	-	00101101
B	01000010	R	01010010	h	01101000	x	01111000	.	00101110
C	01000011	S	01010011	i	01101001	y	01111001	/	00101111
D	01000100	T	01010100	j	01101010	z	01111010	0	00110000
E	01000101	U	01010101	k	01101011	!	00100001	1	00110001
F	01000110	V	01010110	l	01101100	"	00100010	2	00110010
G	01000111	W	01010111	m	01101101	#	00100011	3	00110011
H	01001000	X	01011000	n	01101110	\$	00100100	4	00110100
I	01001001	Y	01011001	o	01101111	%	00100101	5	00110101
J	01001010	Z	01011010	p	01110000	&	00100110	6	00110110
K	01001011	a	01100001	q	01110001	'	00100111	7	00110111
L	01001100	b	01100010	r	01110010	(00101000	8	00111000
M	01001101	c	01100011	s	01110011)	00101001	9	00111001
N	01001110	d	01100100	t	01110100	*	00101010	?	00111111
O	01001111	e	01100101	u	01110101	+	00101011	@	01000000
P	01010000	f	01100110	v	01110110	,	00101100	_	01011111

Nitrogenous Base Character Picture

Adenine	Guanine	Cytosine	Thymine
 <p>The chemical structure of Adenine is a purine base, consisting of a fused bicyclic ring system (a six-membered ring fused to a five-membered ring). It features an amino group (-NH₂) attached to the six-membered ring at the 6-position.</p>	 <p>The chemical structure of Guanine is a purine base, consisting of a fused bicyclic ring system. It features a carbonyl group (=O) at the 6-position and an amino group (-NH₂) at the 2-position.</p>	 <p>The chemical structure of Cytosine is a pyrimidine base, consisting of a single six-membered ring. It features an amino group (-NH₂) at the 4-position and a carbonyl group (=O) at the 2-position.</p>	 <p>The chemical structure of Thymine is a pyrimidine base, consisting of a single six-membered ring. It features a methyl group (-CH₃) at the 5-position and carbonyl groups (=O) at the 2 and 4 positions.</p>
00	01	10	11

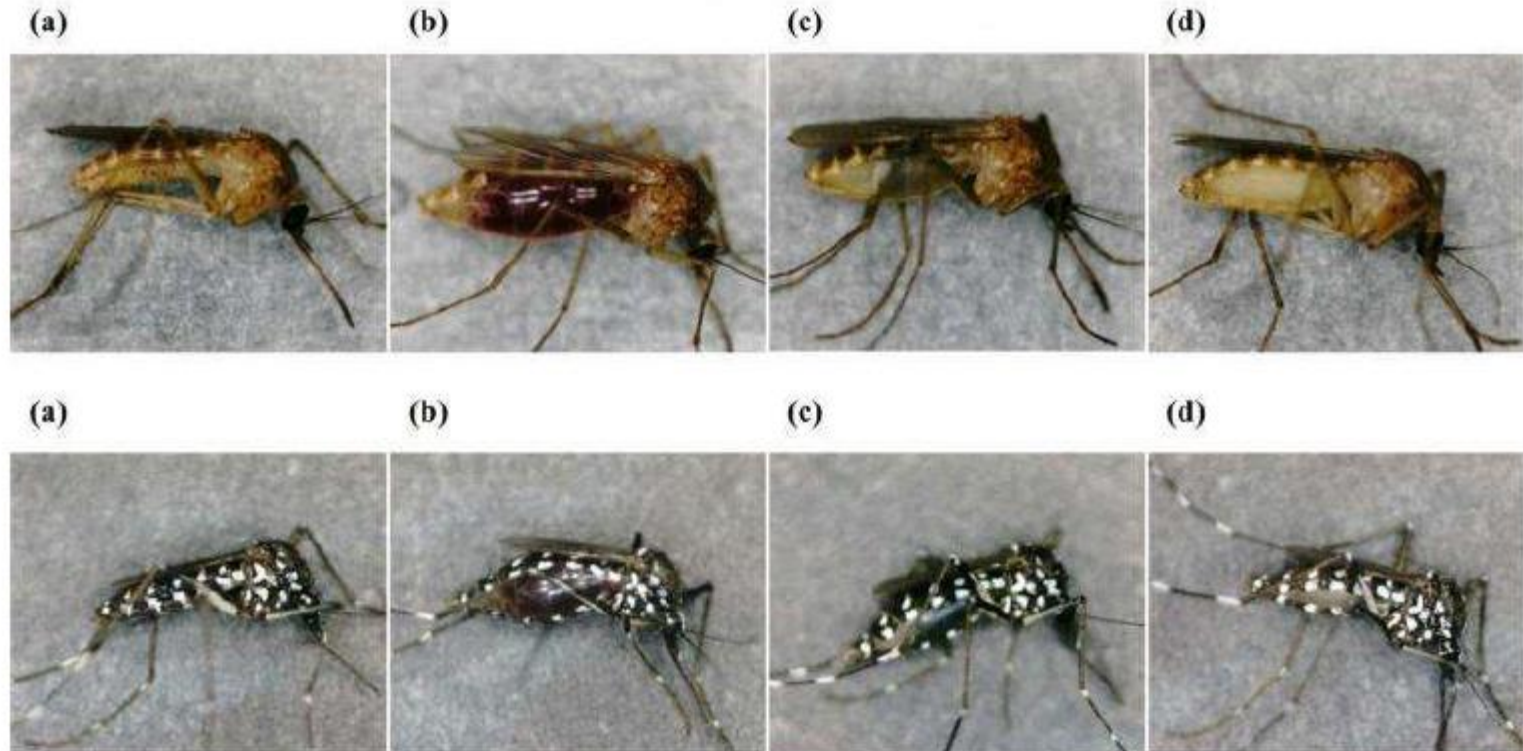
Recombination of a Cas9-created DNA fragment with and without end repair.



Yunkun Liu et al. mBio 2015; doi:10.1128/mBio.01714-15



Forensic Scientists Recover Human DNA in Mosquitoes



Target: Median Nerve

The median nerve is one of the three major nerves of the forearm and hand. It plays a key role in the function of the upper limb by carrying both sensory and motor information between the forearm and hand and the brain. The median nerve passes through the carpal tunnel and is the primary nerve affected by carpal tunnel syndrome.

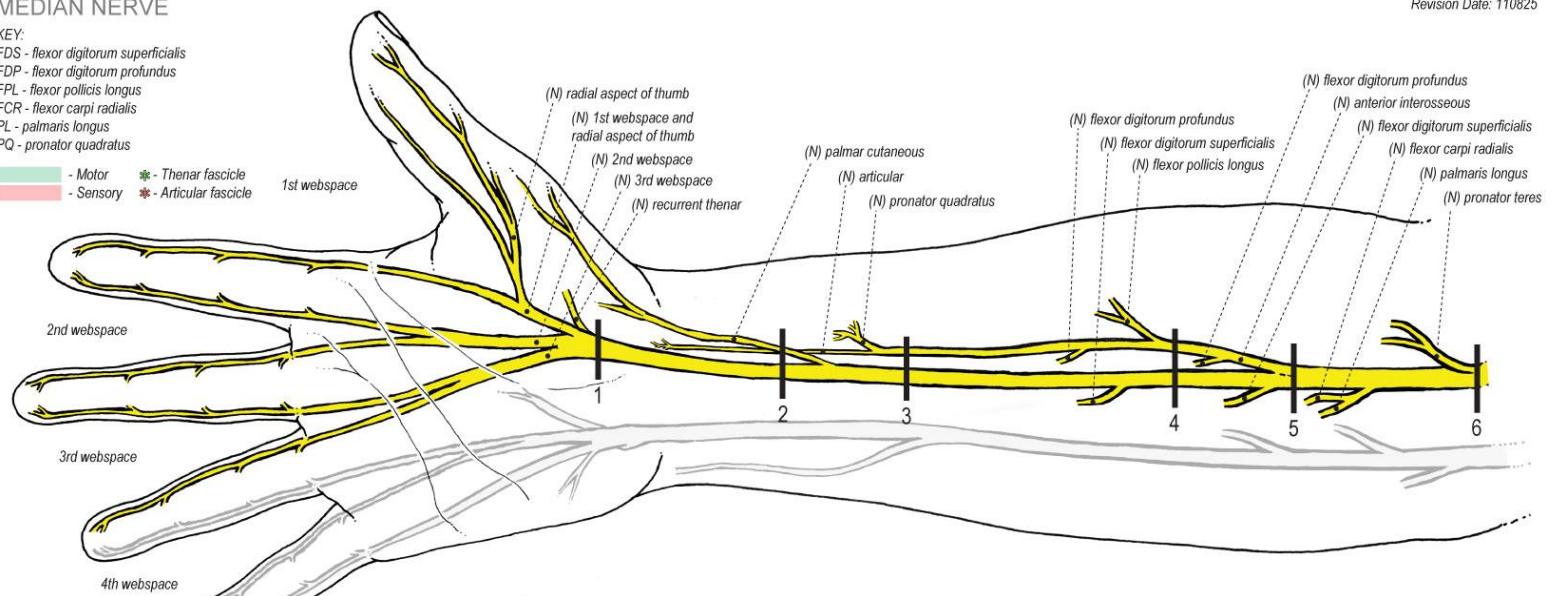
MEDIAN NERVE

Revision Date: 110825

KEY:

FDS - flexor digitorum superficialis
FDP - flexor digitorum profundus
FPL - flexor pollicis longus
FCR - flexor carpi radialis
PL - palmaris longus
PQ - pronator quadratus

■ - Motor * - Thenar fascicle
■ - Sensory * - Articular fascicle



Anatomy of the Median Nerve

The median nerve arises from the brachial plexus, a network of nerves formed by the fusion of the C5 through T1 spinal nerves that innervate the upper limb. Two of the branches of the brachial plexus, the lateral and medial branches, unite anterior to the brachial artery to form the median nerve.

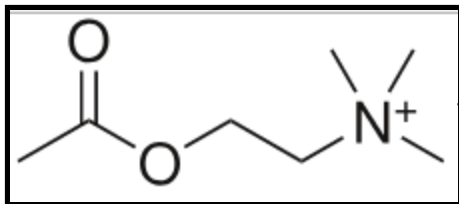
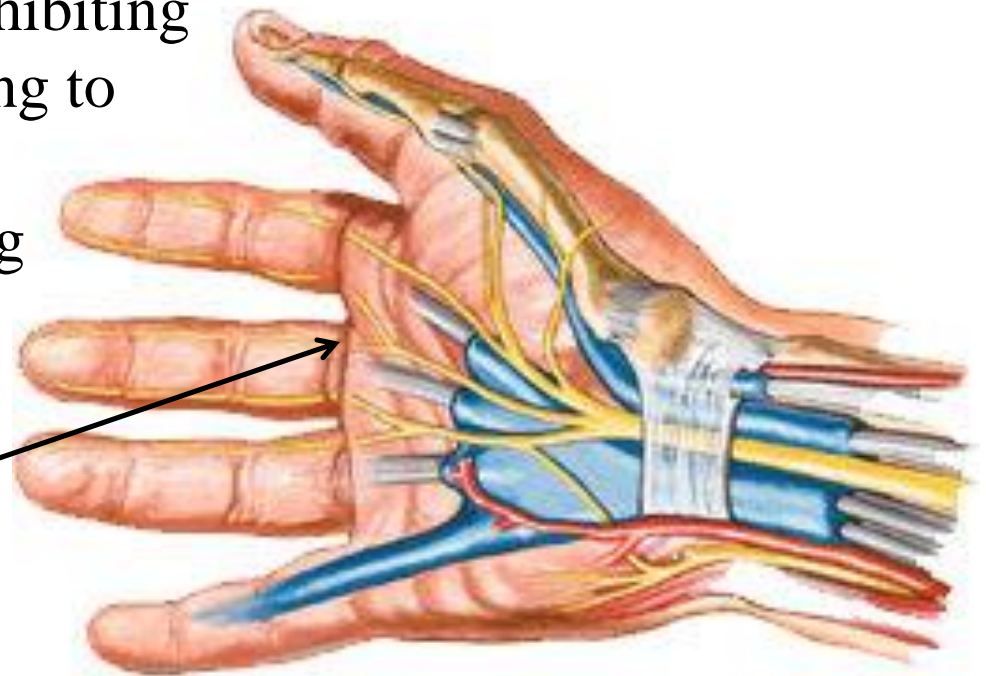


Affixation To Medial Nerve

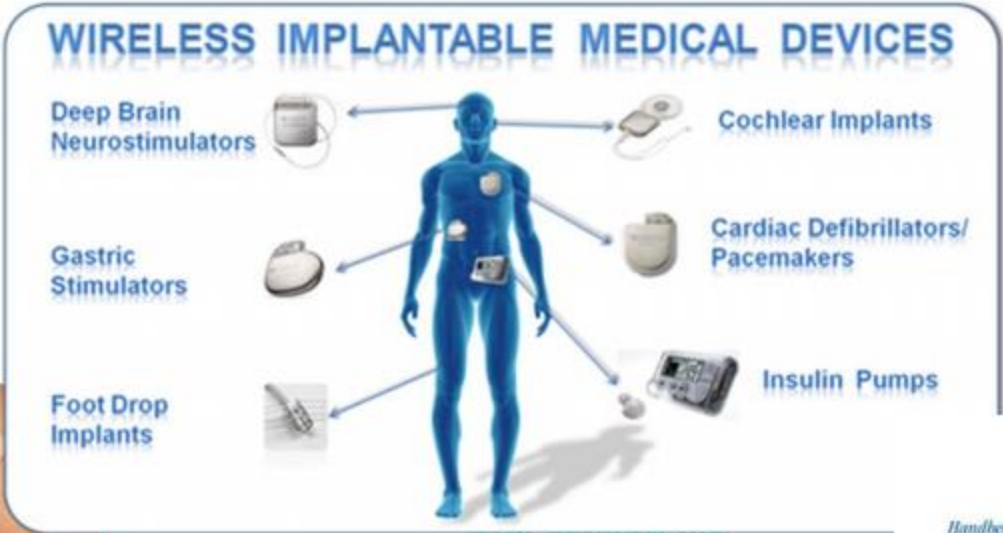
The nanocarrier was affixed to the distal nerve with its payload of Acetylcholine.

- Temperature
- pH
- Like type tissue

Certain neurotoxins work by inhibiting acetylcholinesterase, thus leading to excess acetylcholine at the neuromuscular junction, causing paralysis of the muscles.



The Wireless (vulnerable) Body



Patient Monitor with Wi-Fi, Bluetooth, and WWAN Radios



Image courtesy of Cambridge Consultants



Execution

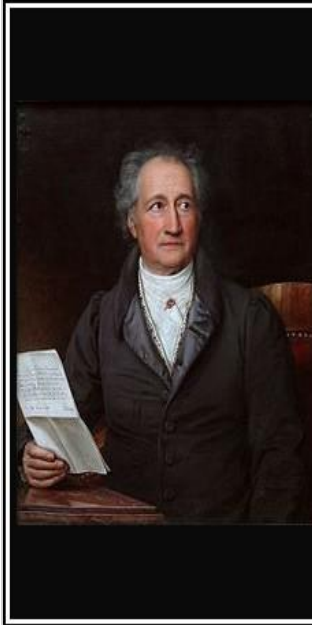
1. Aerosol distribution of nanoparticles (wait 30 minutes, shaken, not stirred, repeat)
 - Nanosensors
 - Nanocarriers
2. Nano particles move into place based on preprogrammed code
 - Temperature
 - pH
 - Like type tissue
3. Client to nanosensor – Airgap (Bluetooth)
4. Nanosensor to neurological system – Converted from code to electrical impulse (chemical).
5. From Neurological System to nanocarrier – chemical
6. Nanocarrier releases Acetylcholine
7. Causing partial (and temporary) paralysis of the middle finger.

Conclusions

- Aerosol distribution of code carrying nanoparticle was effective
- Nanoparticle/sensor emplaced within 30 minutes of inhalation
- Bluetooth is effective to communicate with in vivo sensors
- Signal transduction was fluid
- Minimal amounts of acetylcholine needed to manipulate target
- We need to learn about the Internet of Bio-nanothings to secure it



PARTING THOUGHTS



None are more hopelessly enslaved than those
who falsely believe they are free.

(Johann Wolfgang von Goethe)

izquotes.com

- Gregory “JunkBond” Carpenter
- Twitter: @gscarp12
- gcarpenter@gce.us.com

A) The answer to Life, universe, and everything.

$$X = \sqrt{1 - \frac{y^2}{c^2} + \frac{1-K(t)}{c^2} \times U(t) - \frac{\ln(a) \times \ln(b)}{\cos(u)}}$$

$$\cos(u) = \frac{dx/dw}{dz/dy}$$

$$\ln(a) = \ln(bc) + \ln(a)$$

$$\ln(b) = \ln(a) + \ln(b)$$

$$V(s) = x(m) + y(n)$$

$$\Rightarrow X_{13} = \sum_{i=0}^{i=2} X_{ik} - X_{i0} - \sum_{i=0}^{i=2} X_{ik} - X_i$$

$$\Rightarrow \frac{A + B(x)}{(a-b-2c)^2} = \frac{A}{[as \times B(x)]}$$

$$\Rightarrow \frac{x^2 - y^2}{\sqrt{z}} = \sqrt{\frac{(x^2 - y^2)(2z + 2x - y^2)}{a + b^2}}$$

$$\Rightarrow F(x) = \frac{5x^2}{3} + 8x^2 + a \quad P0 = \int_{-\infty}^{3^+} G(t) dt$$

$$\Rightarrow G(x) = x^2 + \frac{3x^2}{8} + 3b \quad \int_{-\infty}^{3^+} H(t) dt$$

$$\Rightarrow H(x) = 4x^2 + \frac{1x^2}{3} + 3a + 6b$$

$$\frac{d\Delta}{d(c)} = \frac{c^2 + 2b}{c^2} \Leftrightarrow F(c) = 2c/c$$

$$\Rightarrow X = F(x) - P0 + 30a = \frac{5x^2}{3} + 8x^2 + 30a - P0 = \frac{472}{3}$$

Random

Drink

Slide

DOUG ADAMS'S

OLD TIME

OLD NO. 42 BRAND

QUALITY

Pan Galactic

GARGLE BLASTER

DISTILLED AND BOTTLED BY
Betelgeuse Seven Distillery
"Mostly Harmless"

42% ALC BY VOL.