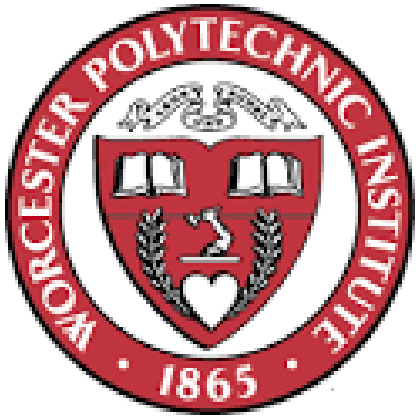


Mathematics and Science in Schools in Sub-Saharan Africa

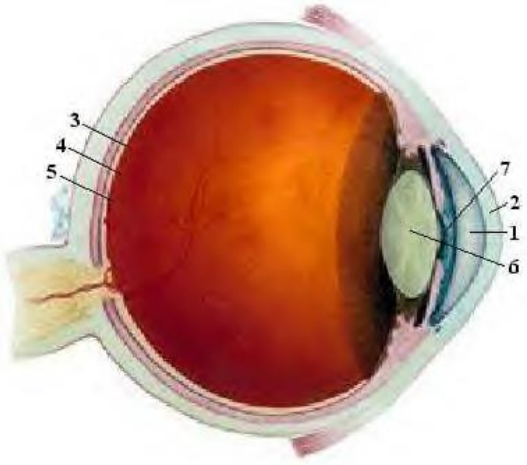
MATERIAL SCIENCE

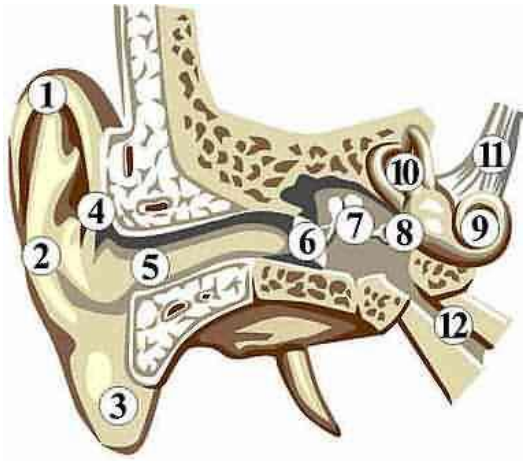
Introduction

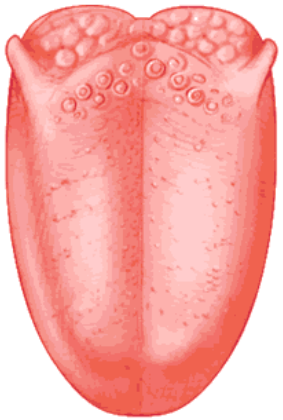
To

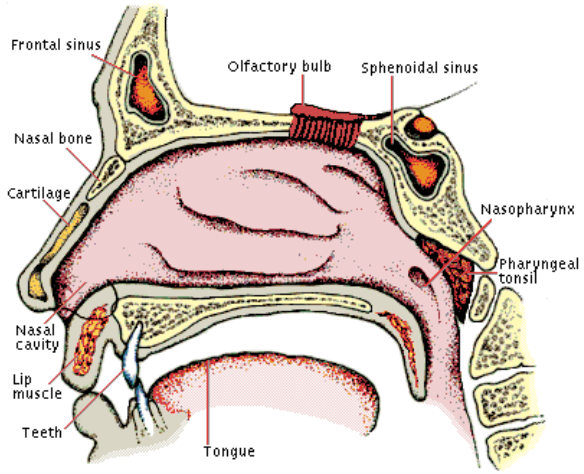
Smart Sensors

Our 5 Senses

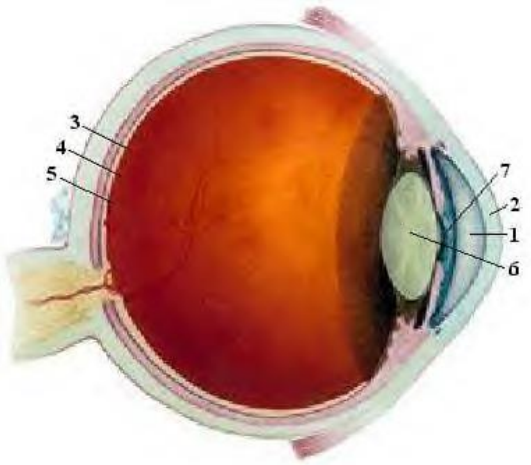

3
4
5
7
2
1
6


1
1
10
11
4
7
8
9
6
2
5
12
3

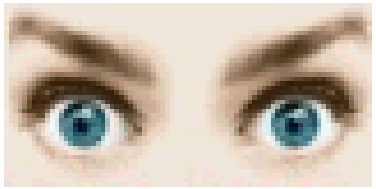



Frontal sinus
Olfactory bulb
Sphenoidal sinus
Nasal bone
Cartilage
Nasopharynx
Pharyngeal tonsil
Nasal cavity
Lip muscle
Teeth
Tongue

Our Senses Can Be Fooled!



What Do You See?



Donkey or Seal

Face or Liar

How Many F's Does the Following Passage Contain?

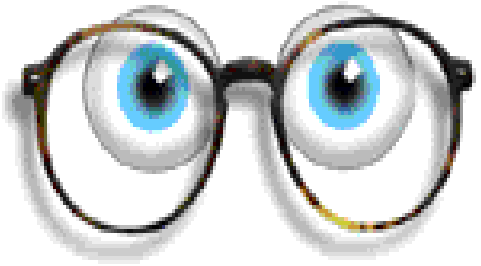
Finished files are the result of years of scientific study combined with the experience of years.

1 2 3 4 5 6 7

How Many F's Does the Following Passage Contain?

Finished files are the result of years of scientific study combined with the experience of years.

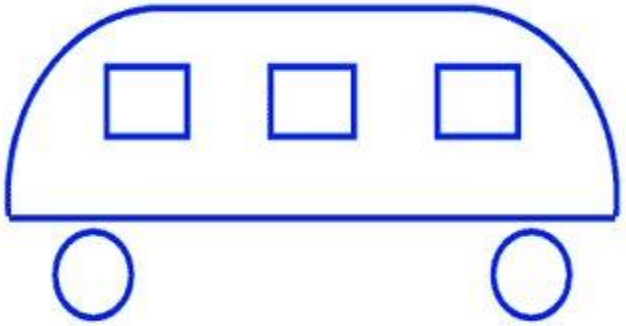
6



Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

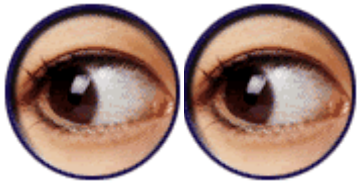
Does Age Effect What We See?

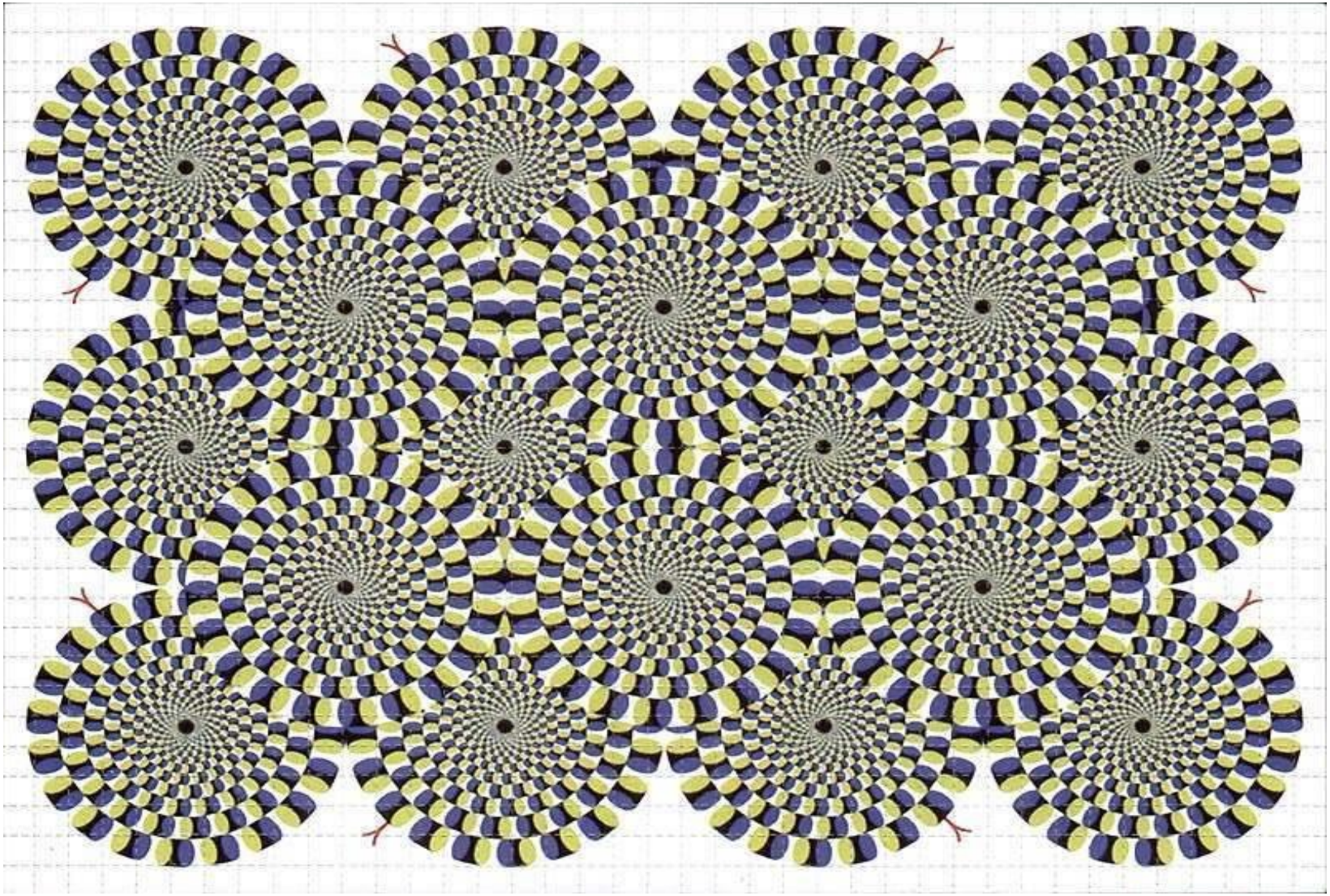
Which Way Is The Bus Going?



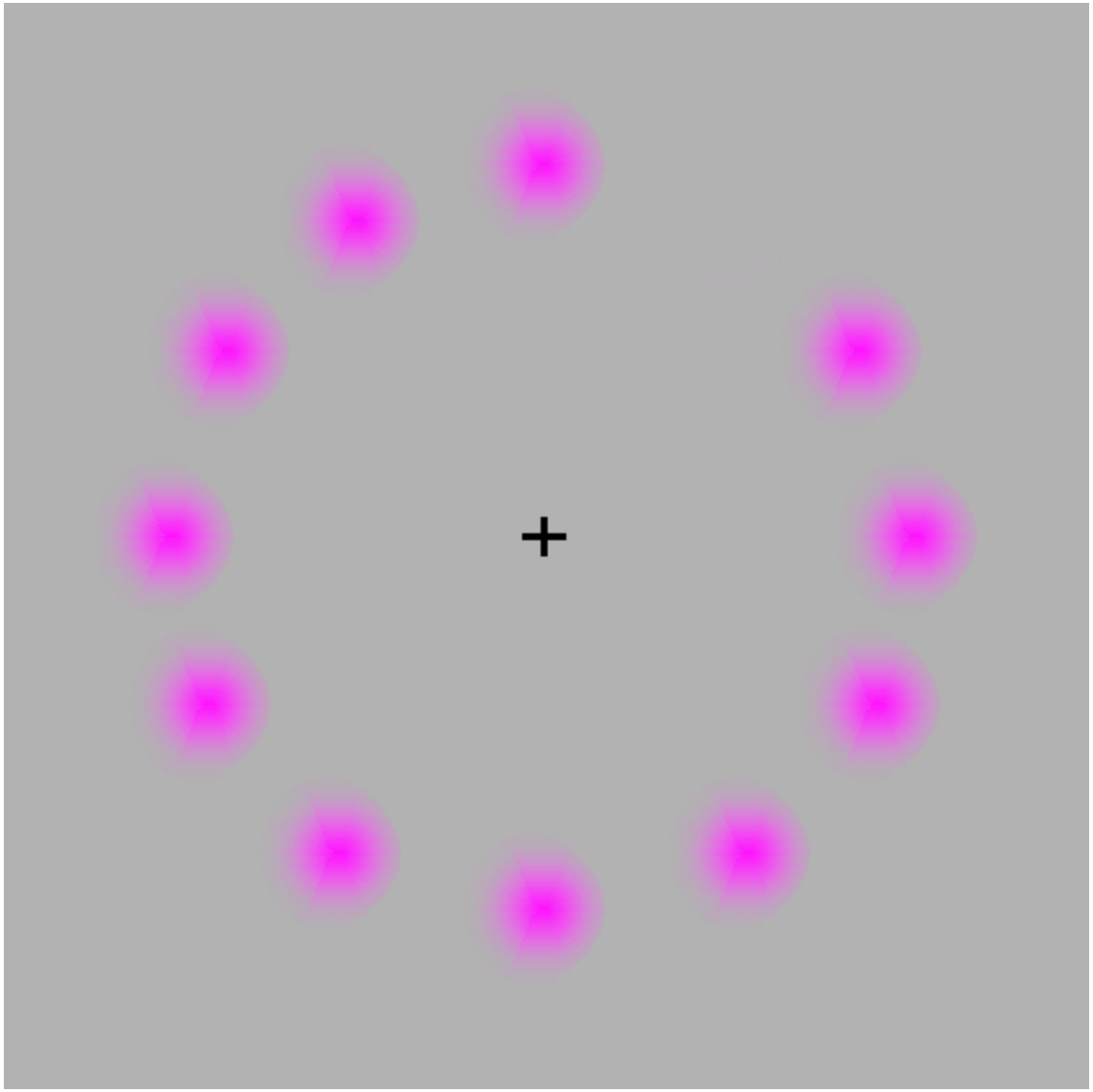
Left or Right?

90% of pre-schooler's gave the right answer!

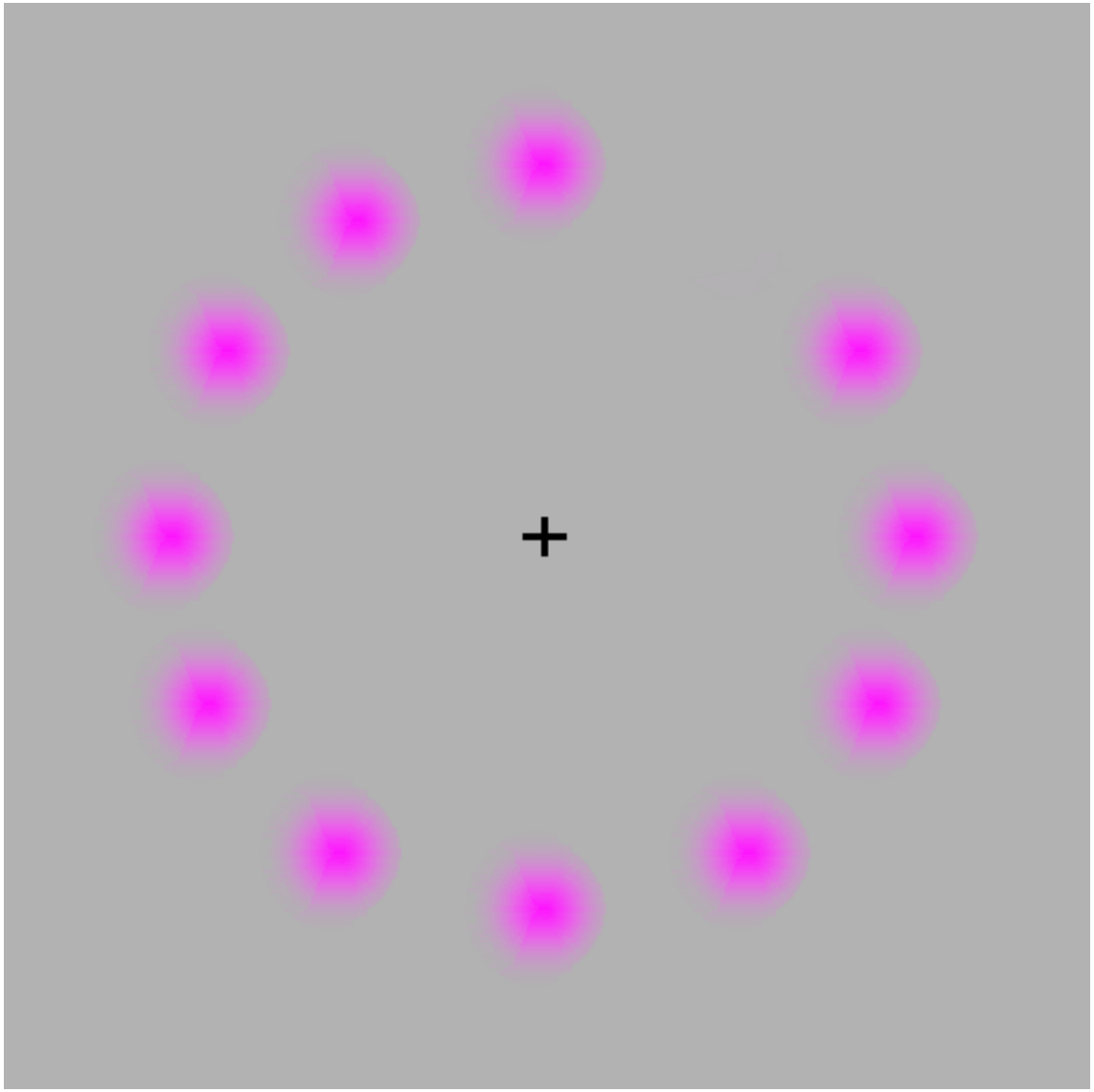




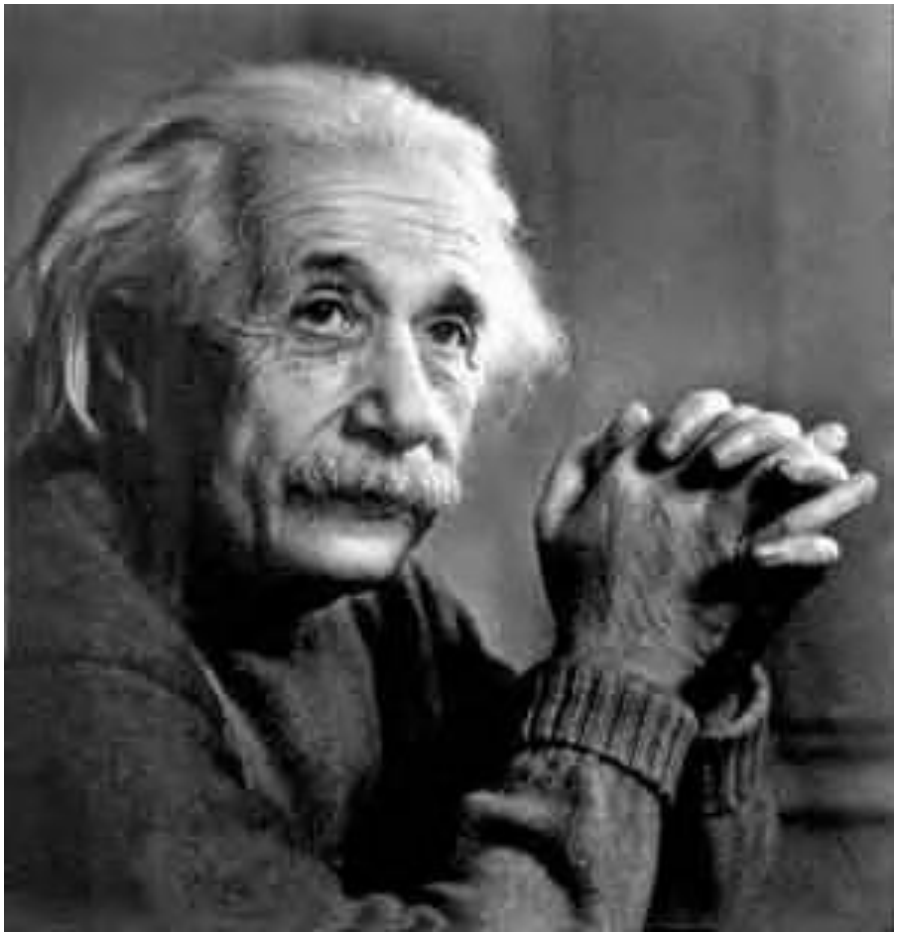
If your eyes follow the movement of the rotating pink dot, the dots will remain one color-PINK.

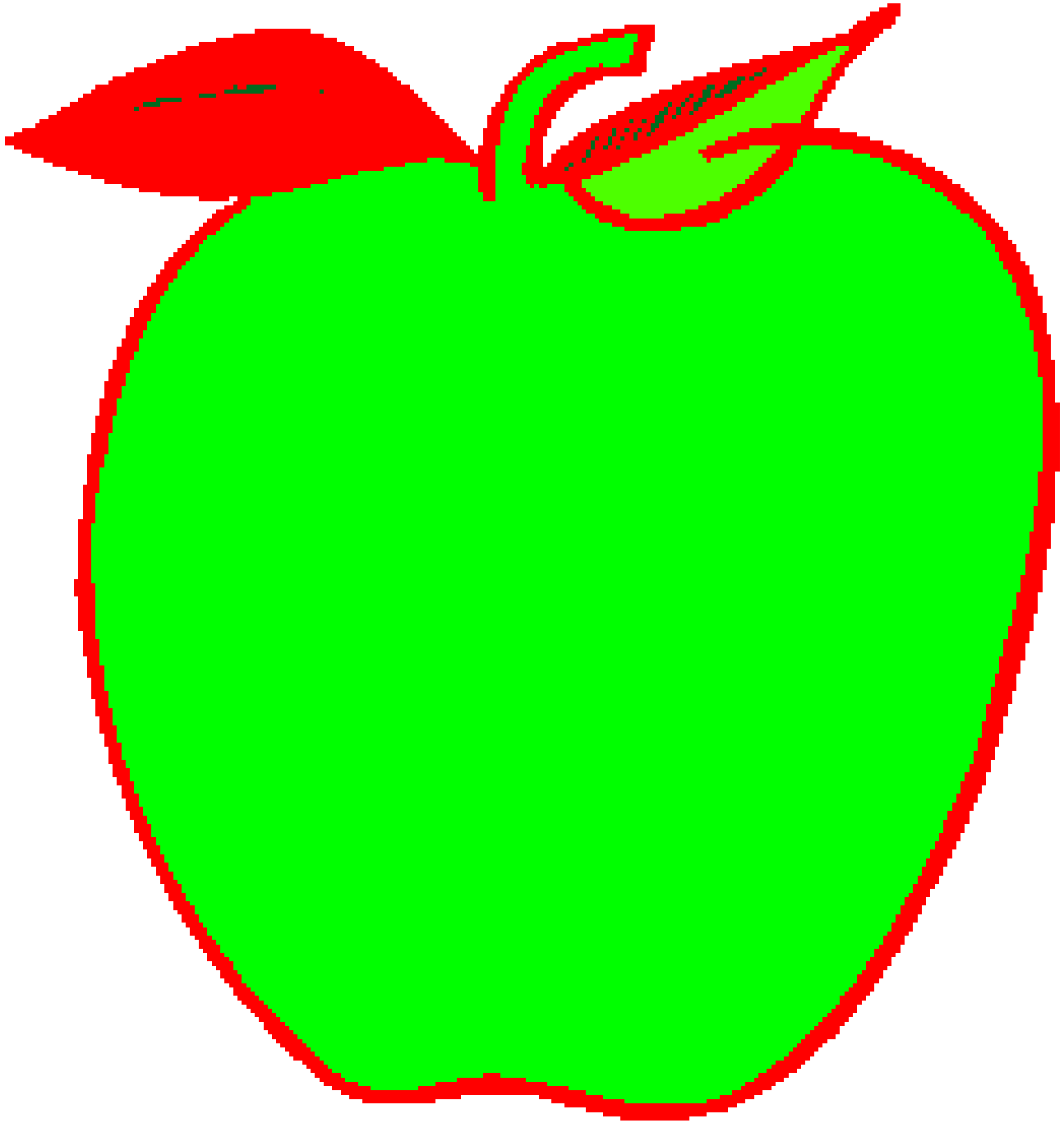


If your eyes stare at the black + in the center, the moving dots turn to GREEN.

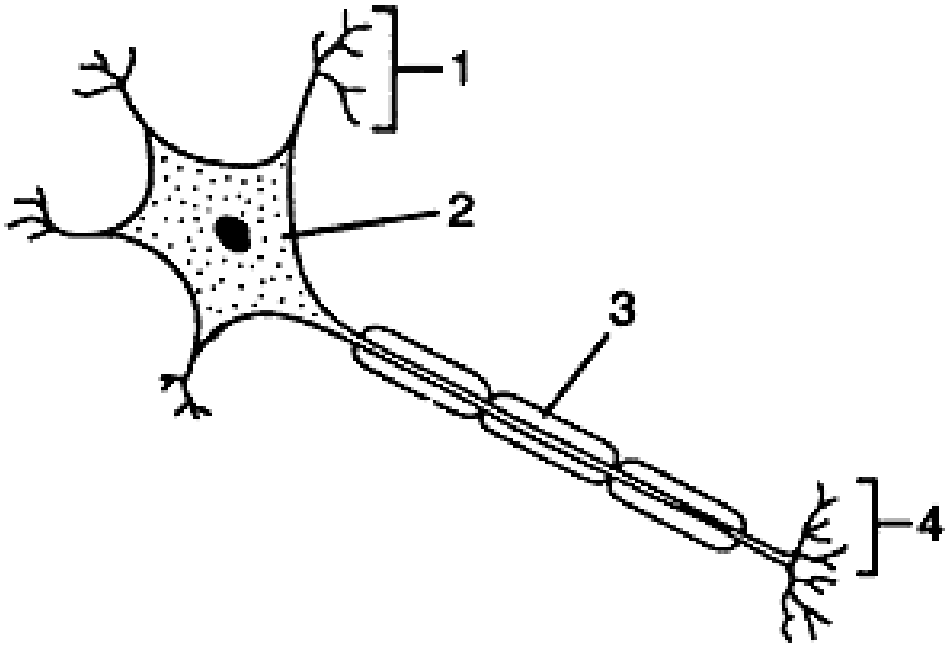


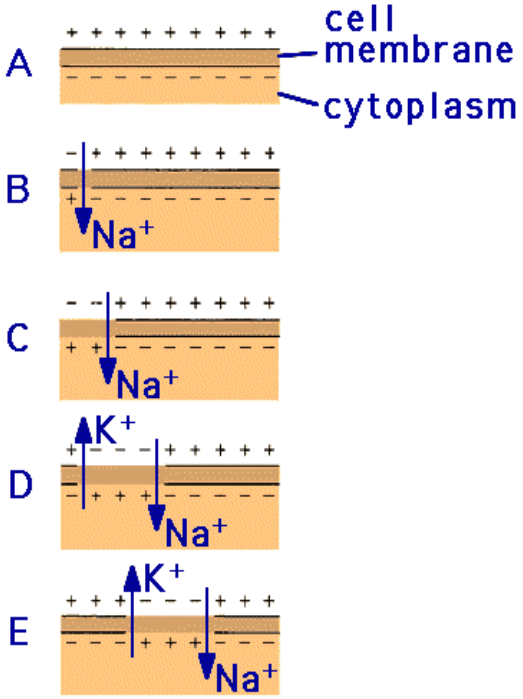
Lab: After Image



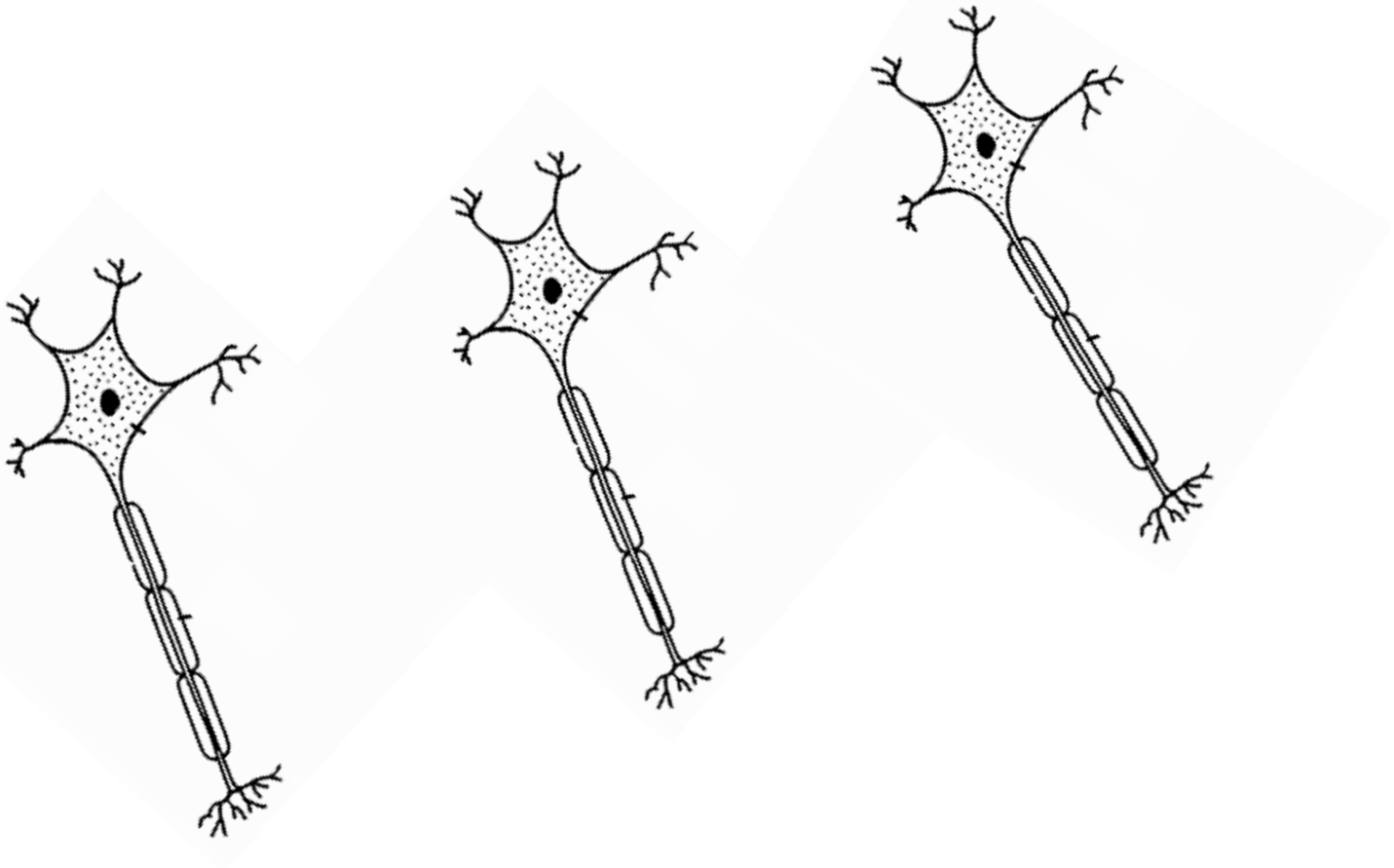


Nerve Impulse



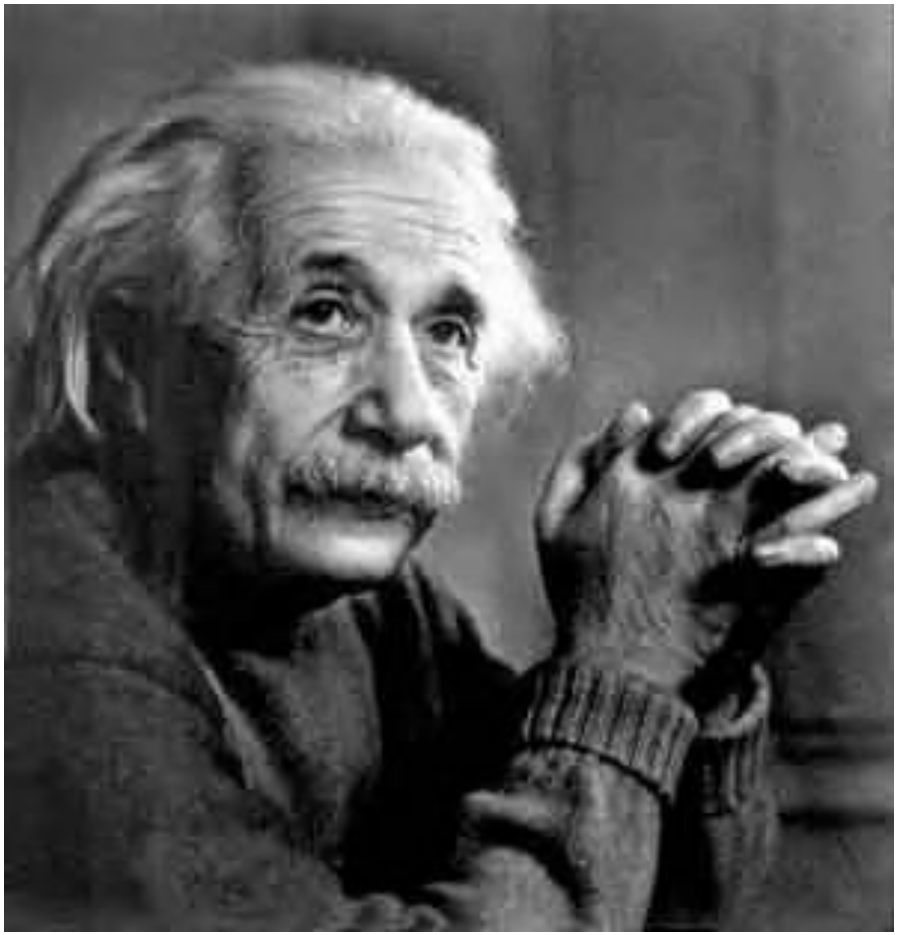


After Image Formation



“Smart” Sensor

Lab: Evading a Motion Detector

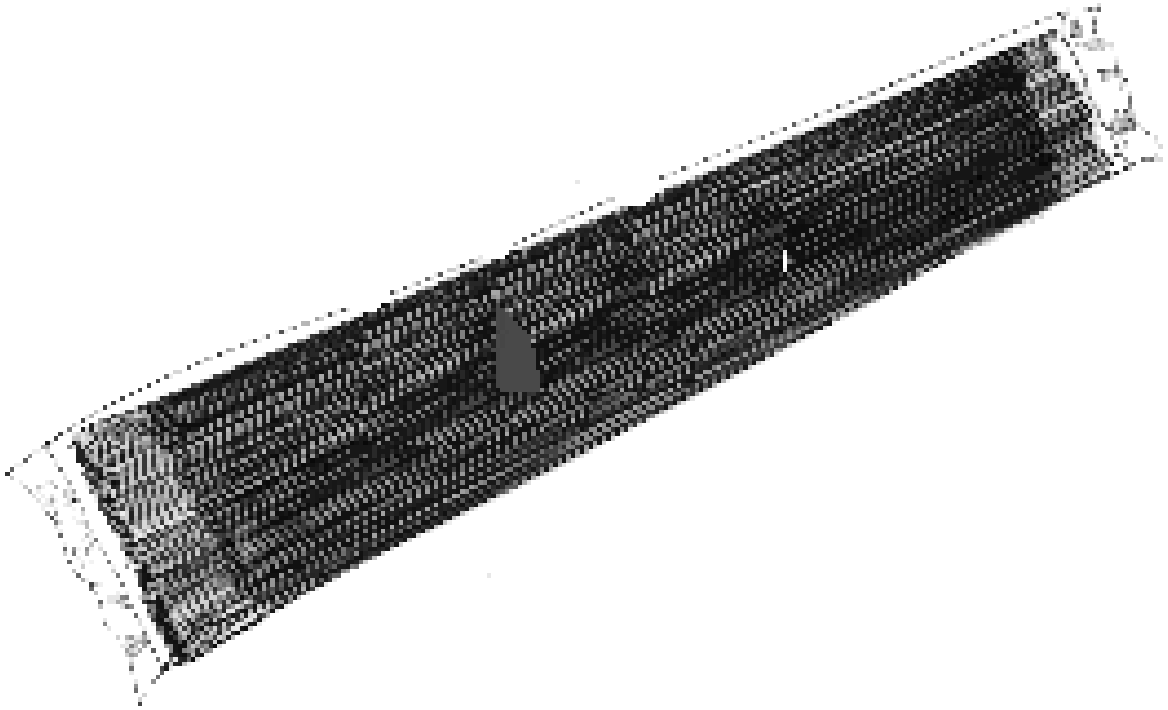


Lab: Evading a Motion Detector

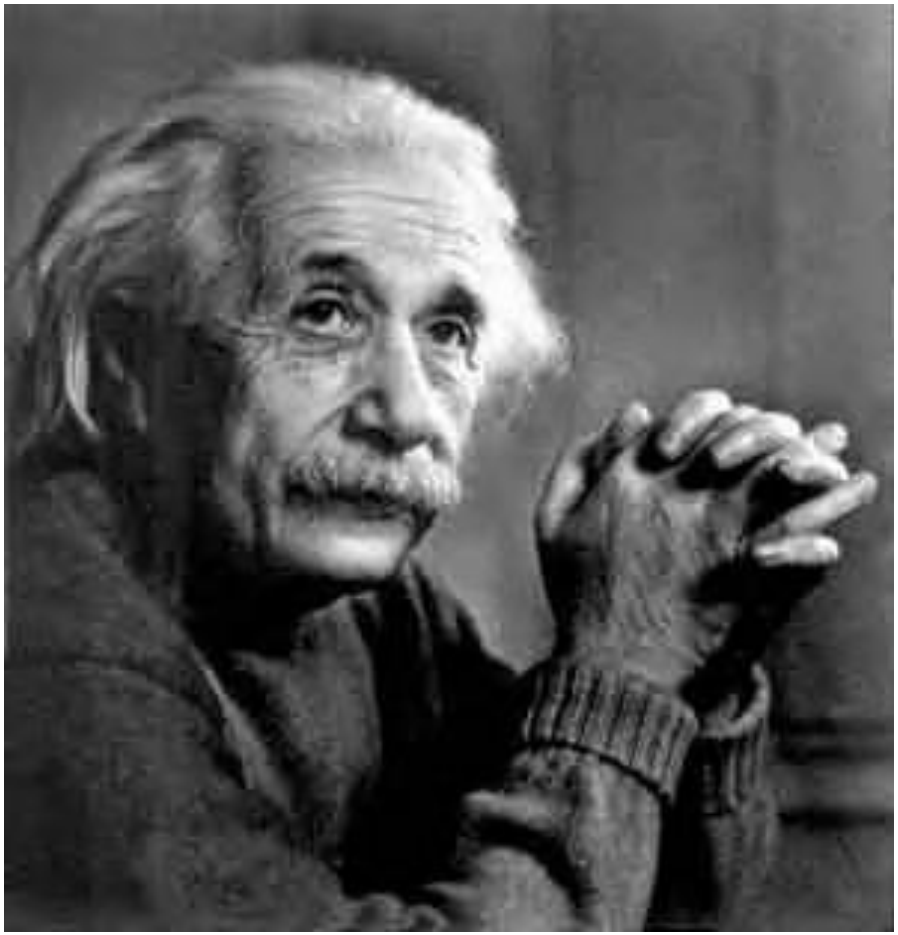
Data Chart

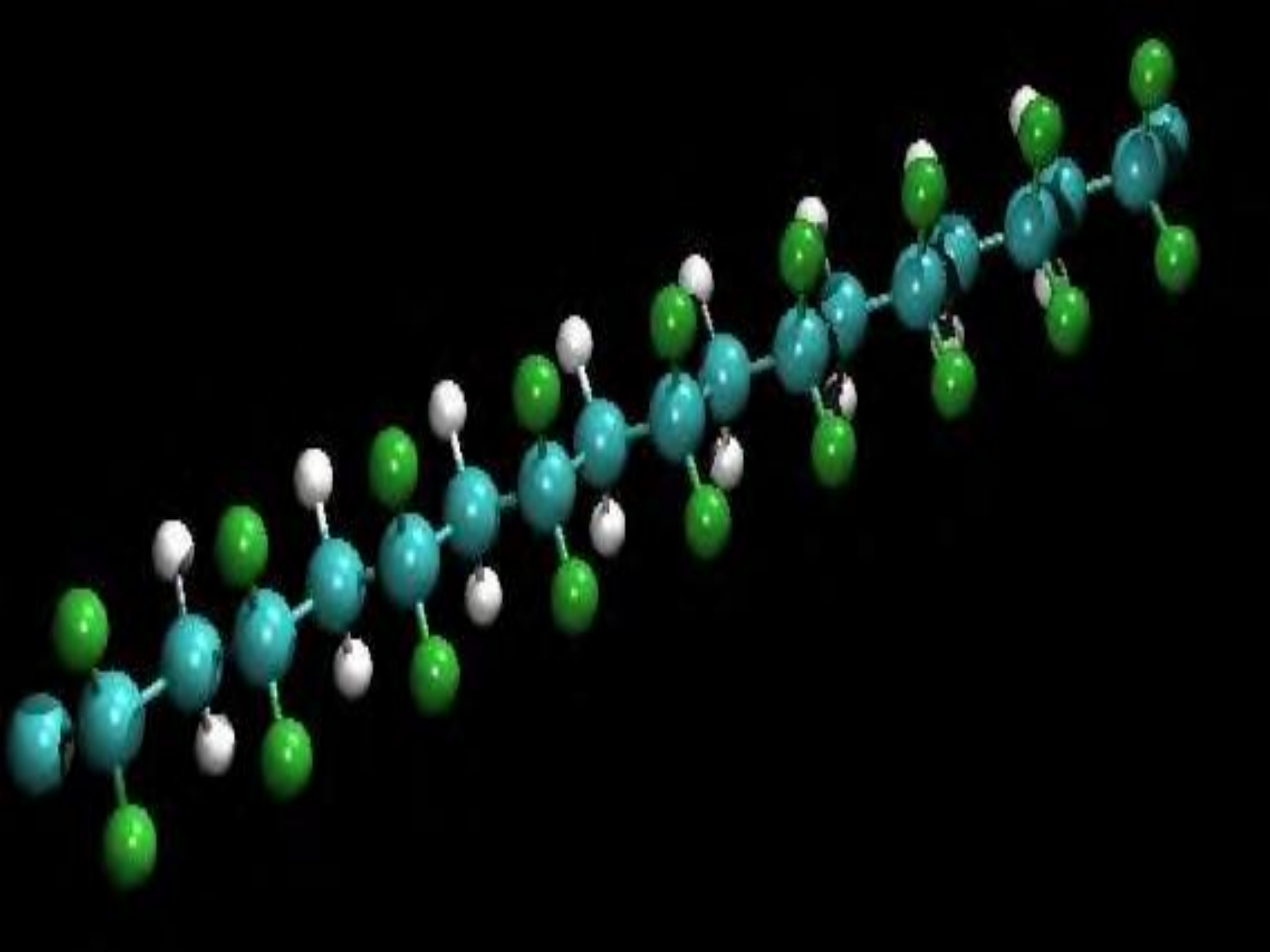
Detector's Linear Range	
Detector's Angular Range	

Kynar



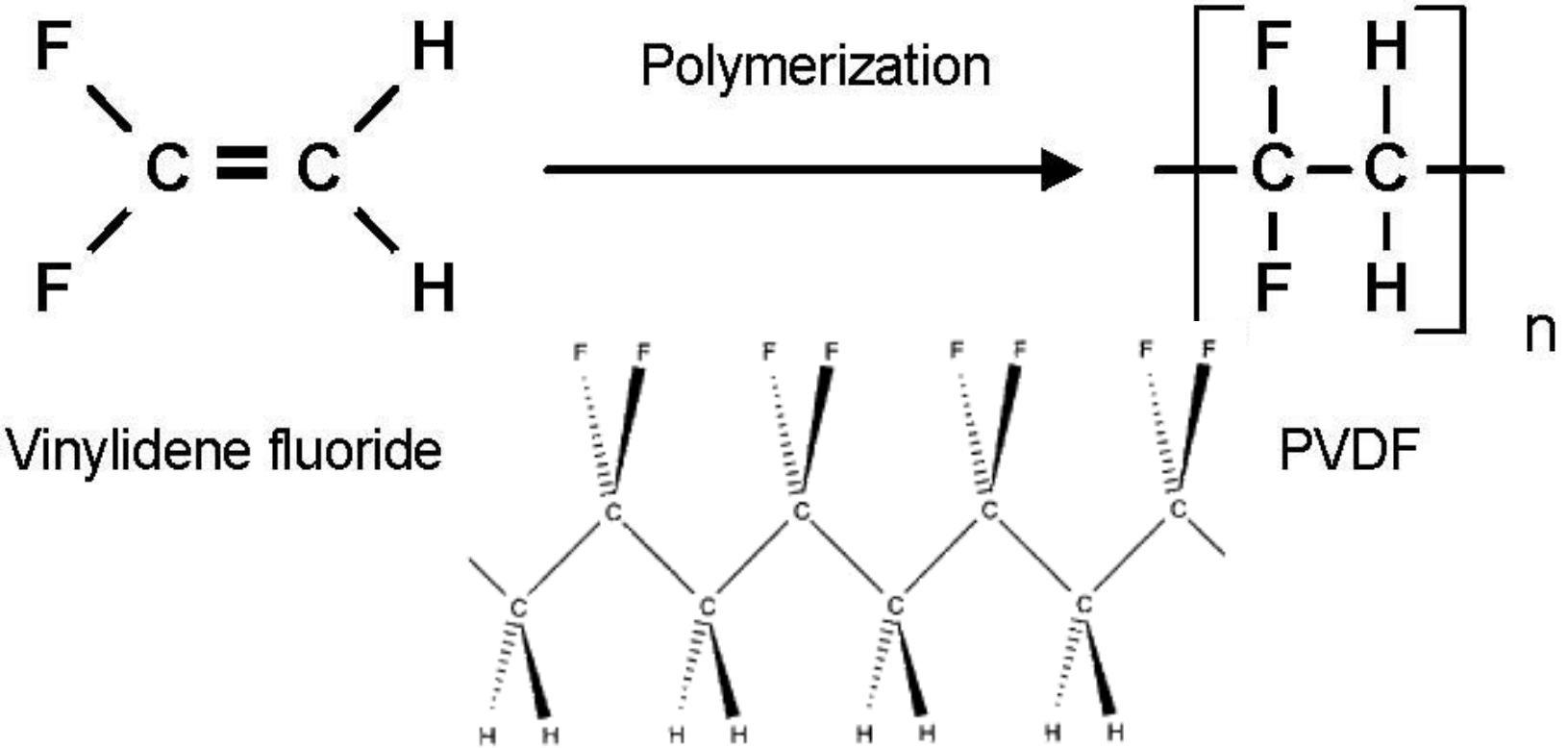
Lab: PVDF-The Inside Story



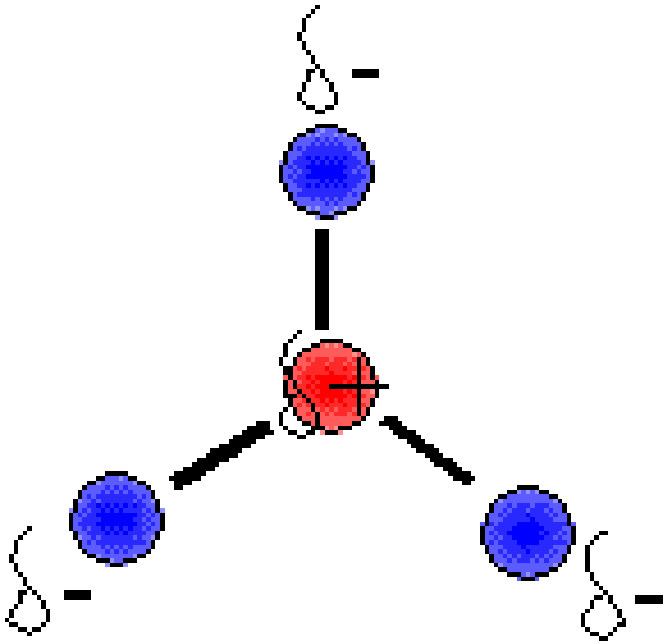


PVDF

Polyvinylidene Fluoride

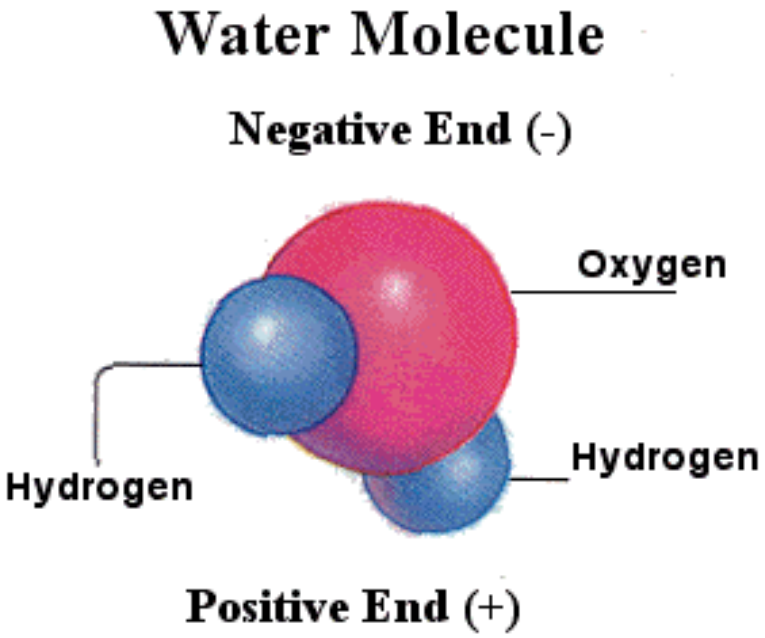


Non-Polar Molecule

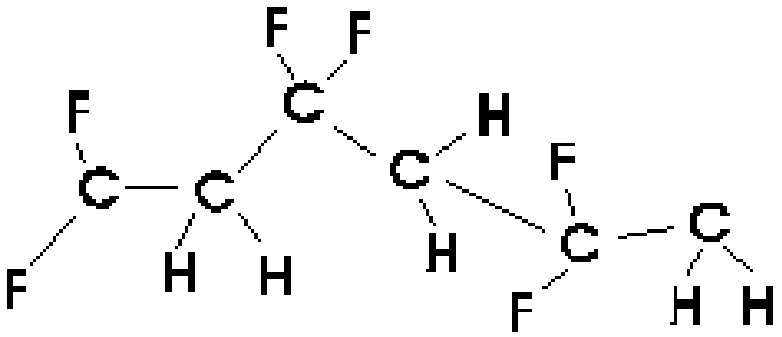


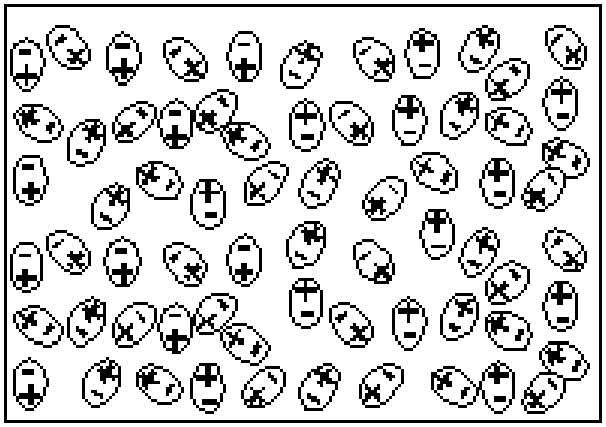
Balanced Distribution of Charges

Polar Molecule

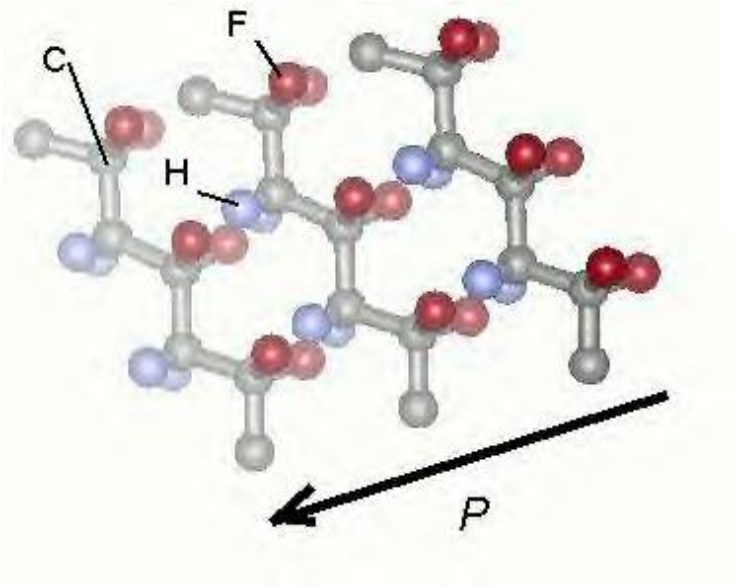


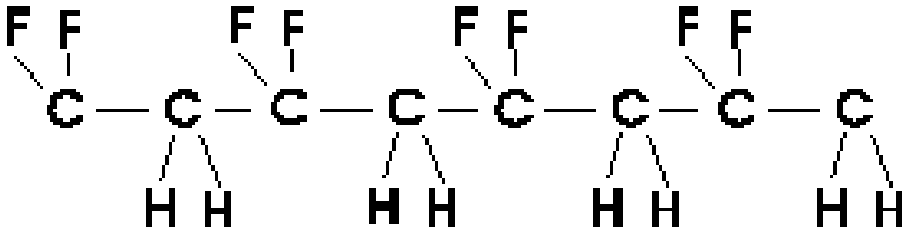
Random Arrangement

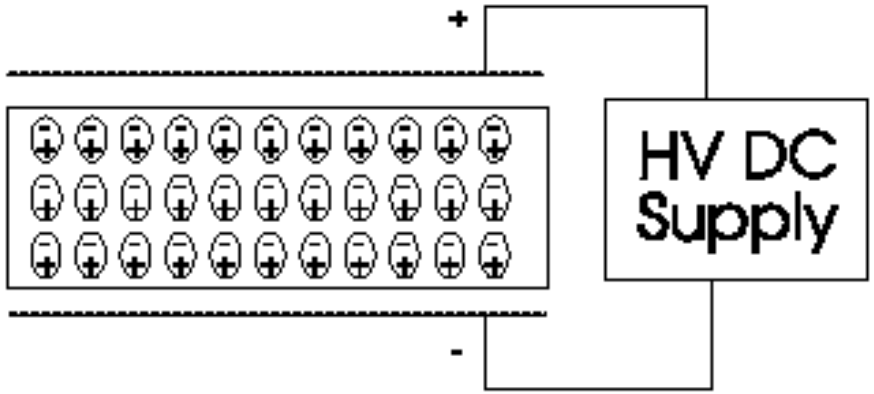


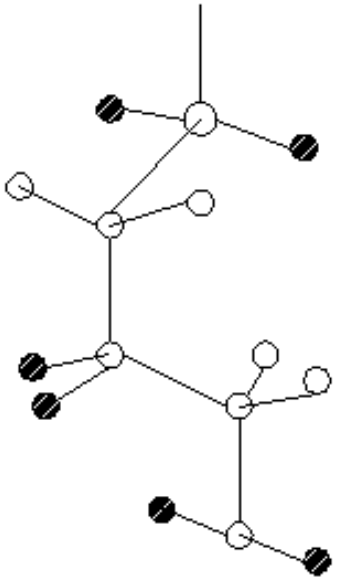


Polarized Arrangement

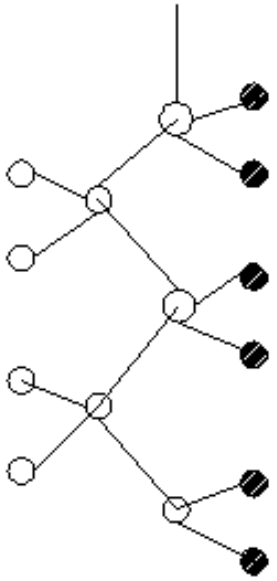




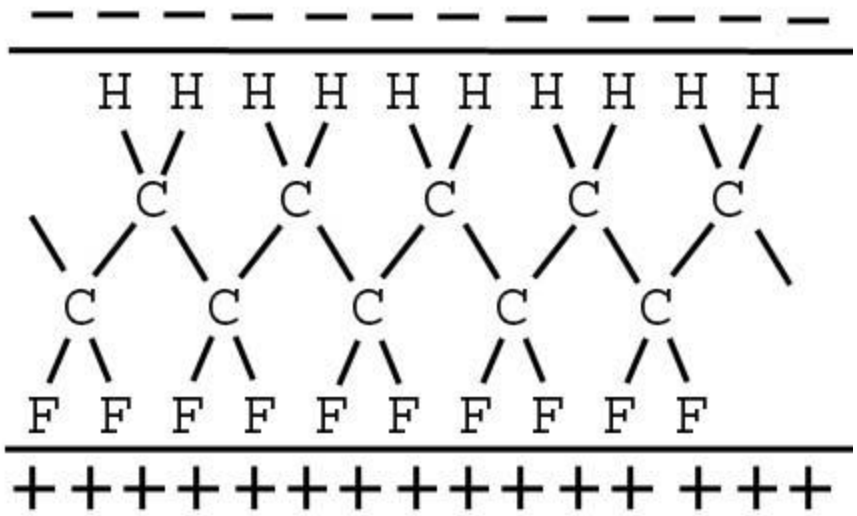




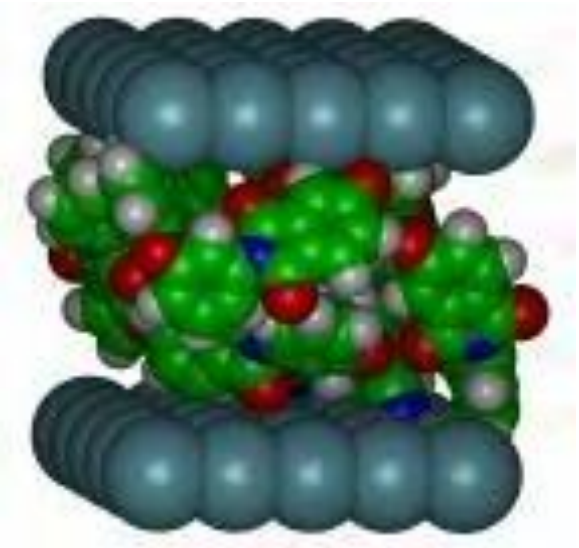
α-phase

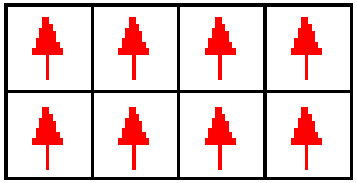


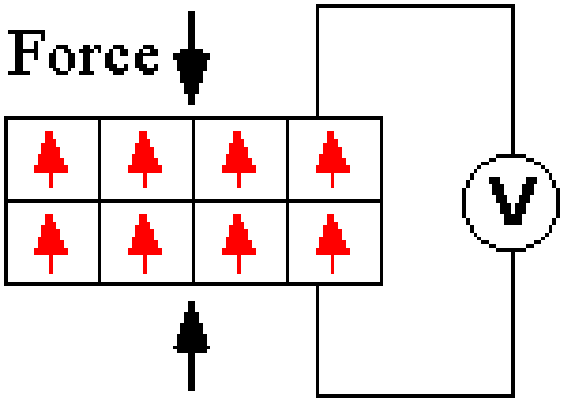
β-phase



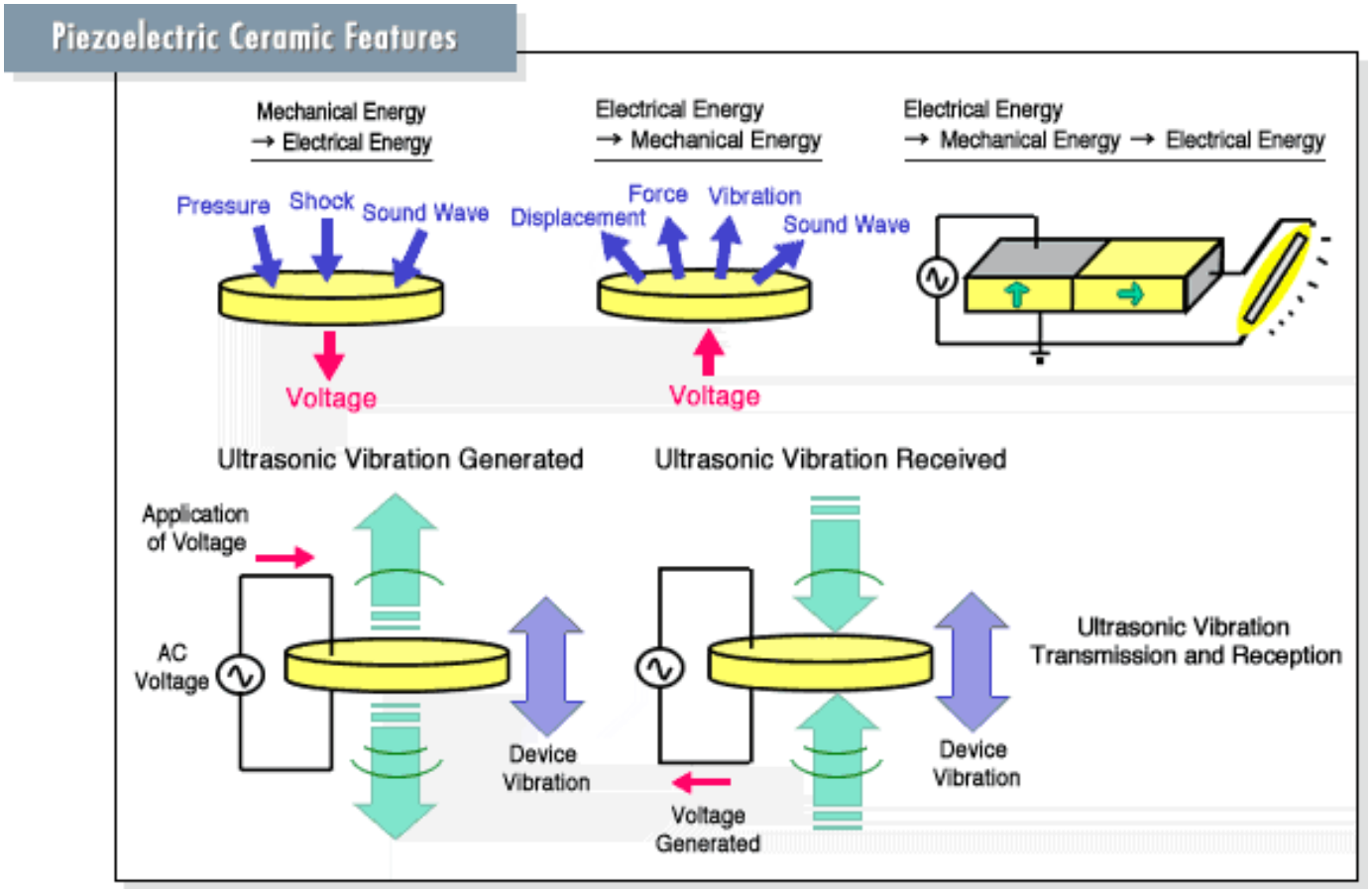
Piezoelectric Materials

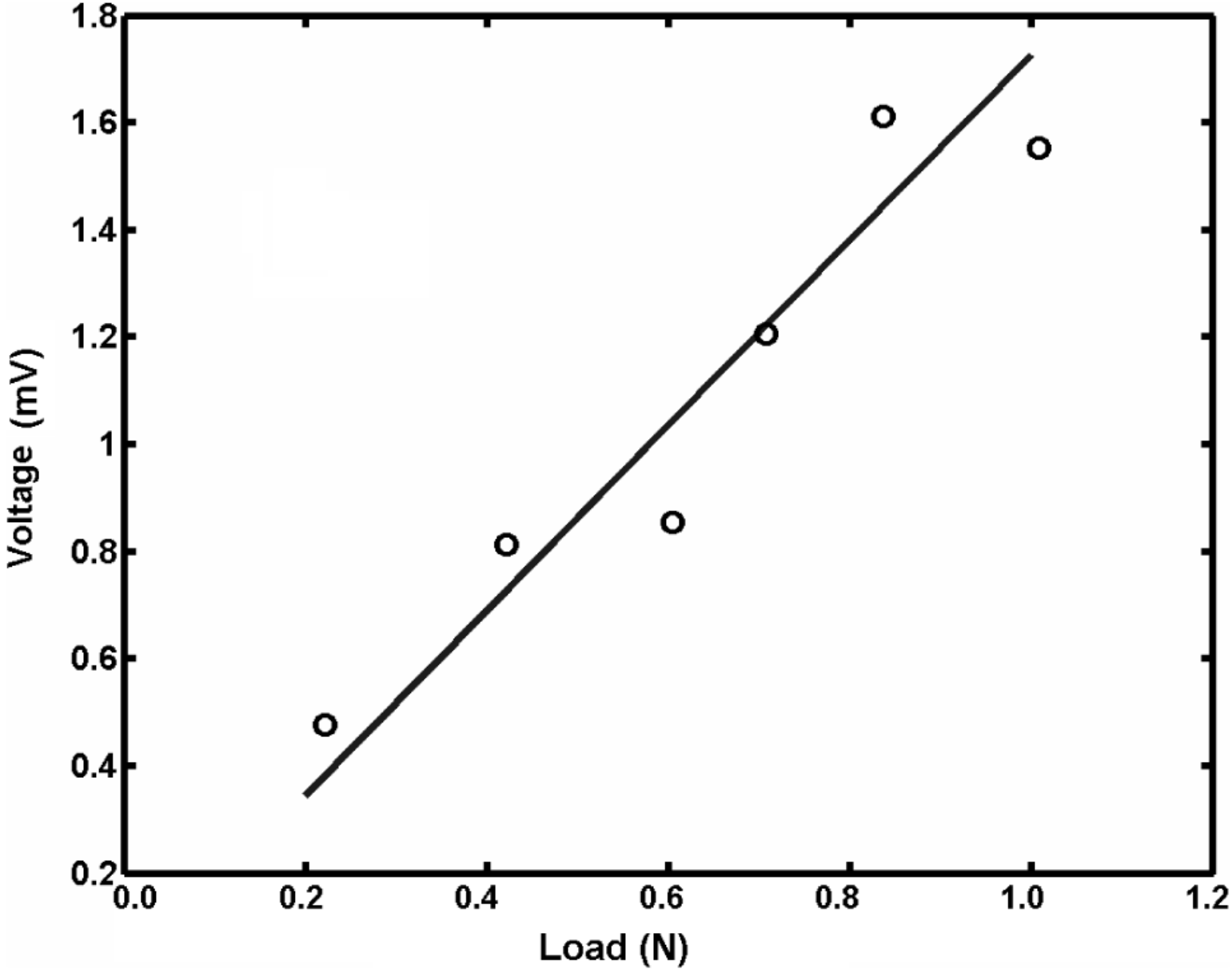




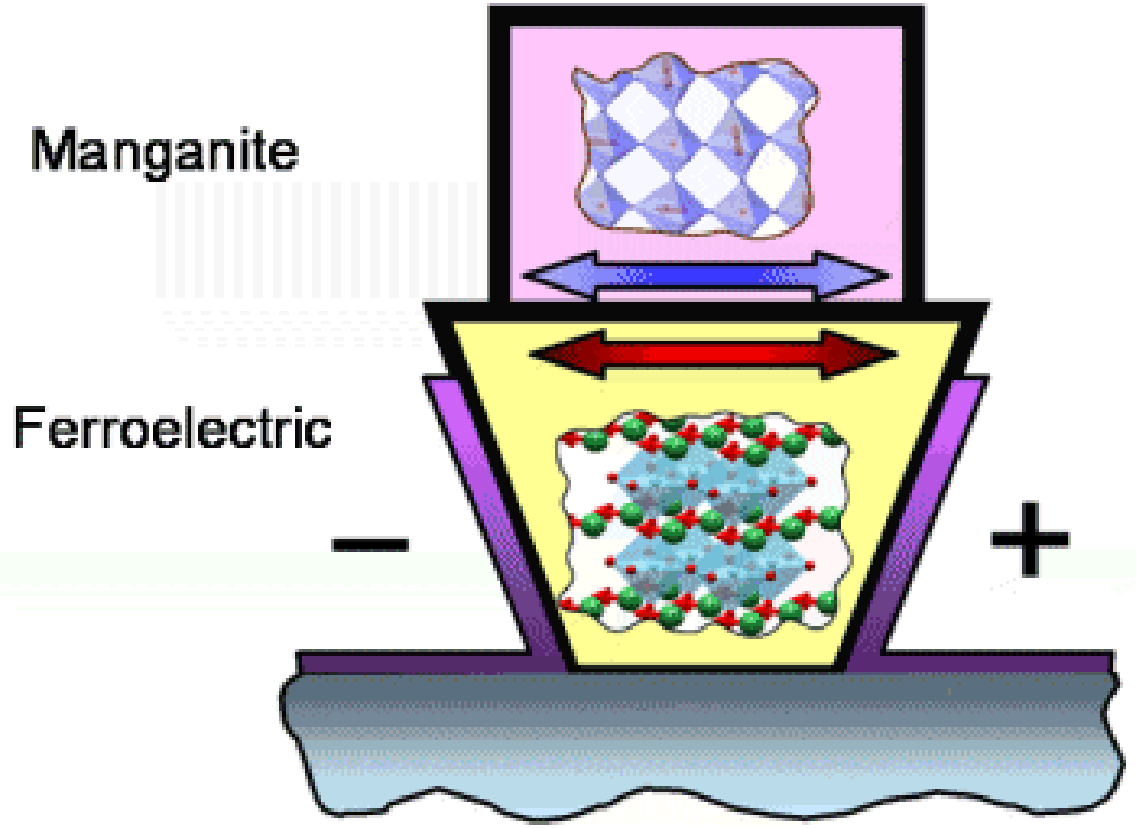


Piezoelectric Effect




Voltage (mV)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Load (N)

Piezoelectric Manipulation



Carbon Monoxide & Smoke Detectors

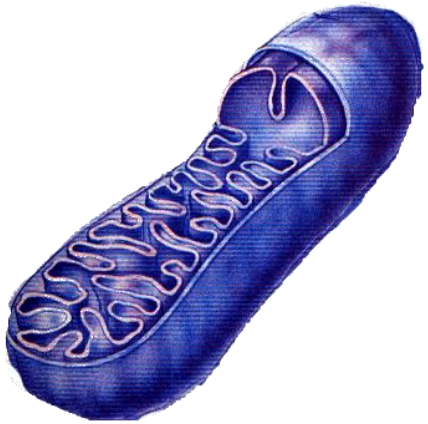
Home Security

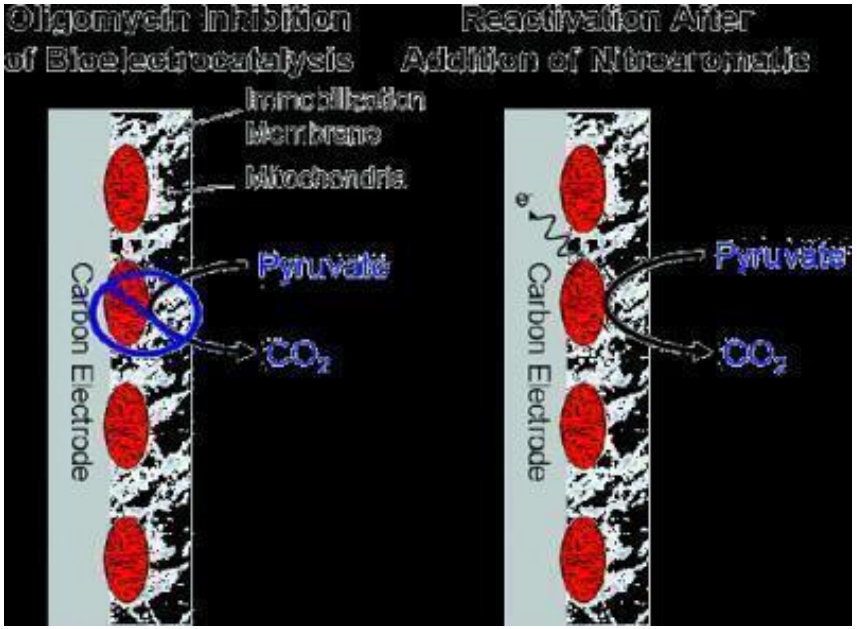
Piezoelectric and Electromagnetic Device Comparison

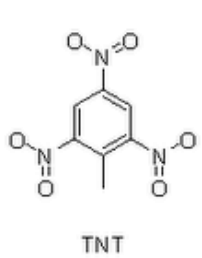
	Electromagnetic	Piezoelectric
Generated force	×	○
Displacement accuracy	×	○
Response speed	×	○
Energy efficiency	×	○
Heat Generation	×	○
Noise	×	○
Size	△	○
Cost	○	△
Displacement	○	×
Overall Evaluation	△	◎

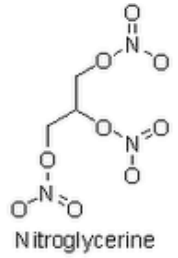
× = below average △ = average ○ = good ◎ = superior

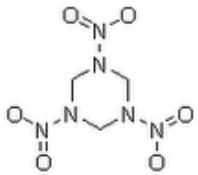
Mitochondria Powered Explosives Detector

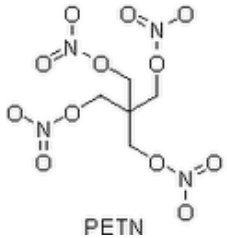


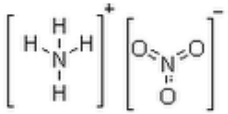


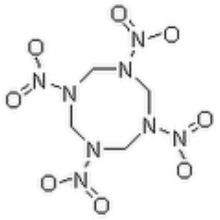

TNT


Nitroglycerine


RDX

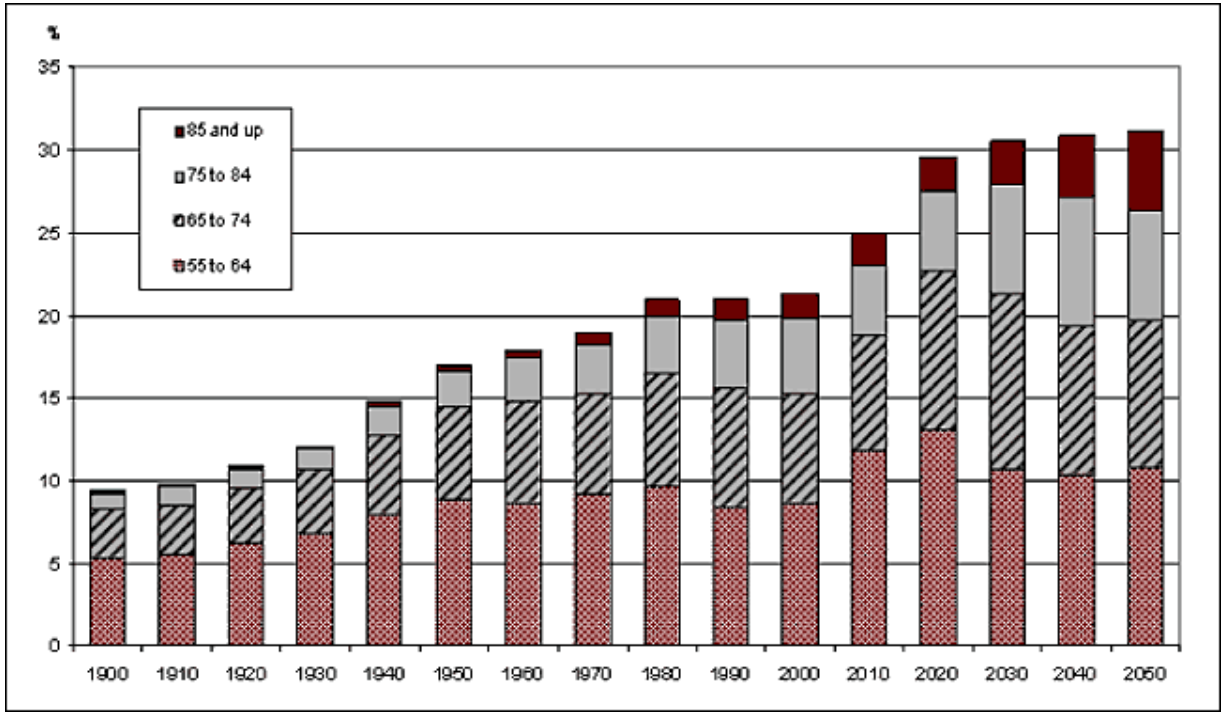

PETN


Ammonium Nitrate


HMX

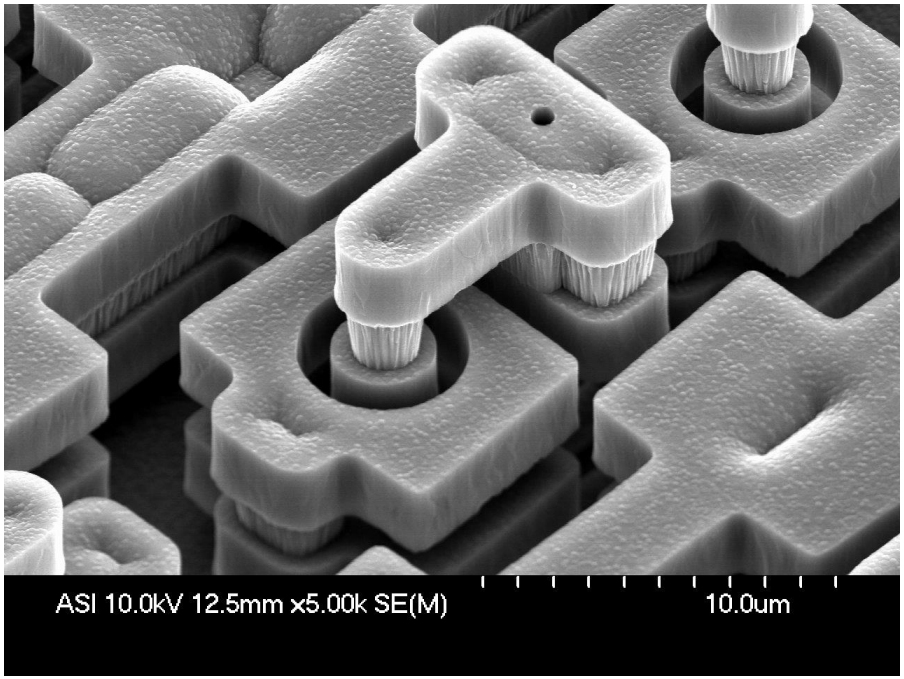
Medical Applications

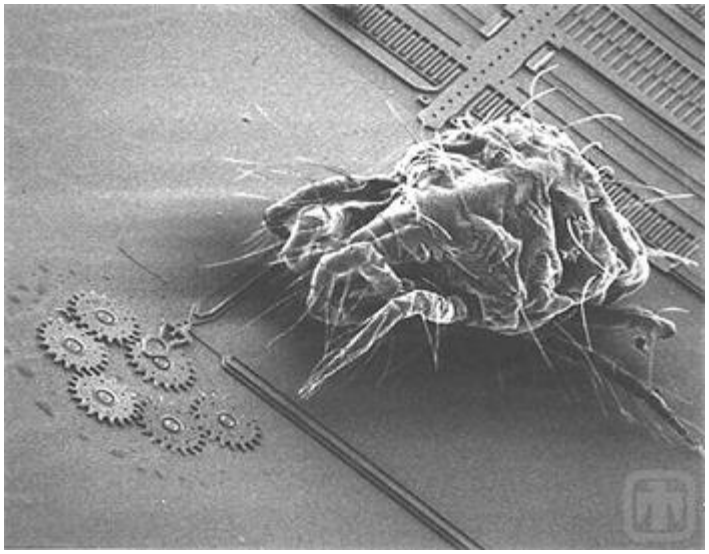
Aging America



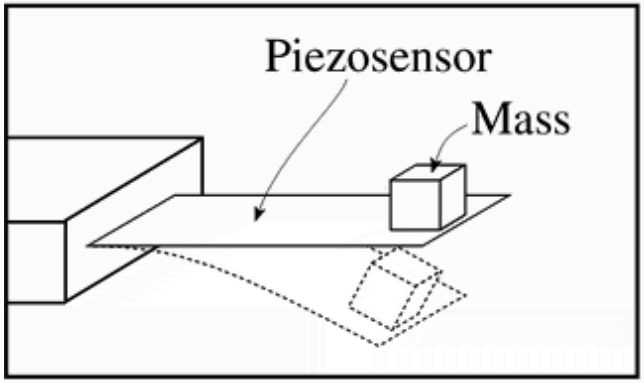

Age 20
Age 30
Age 40
Age 50
Age 60
Age 70

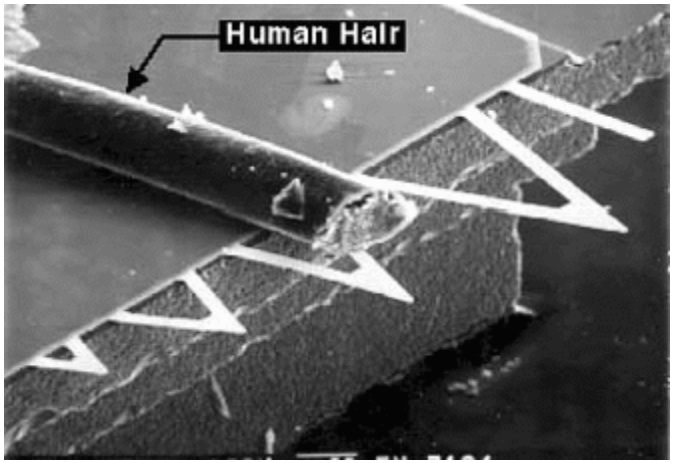
Micro-Electro-Mechanical Systems



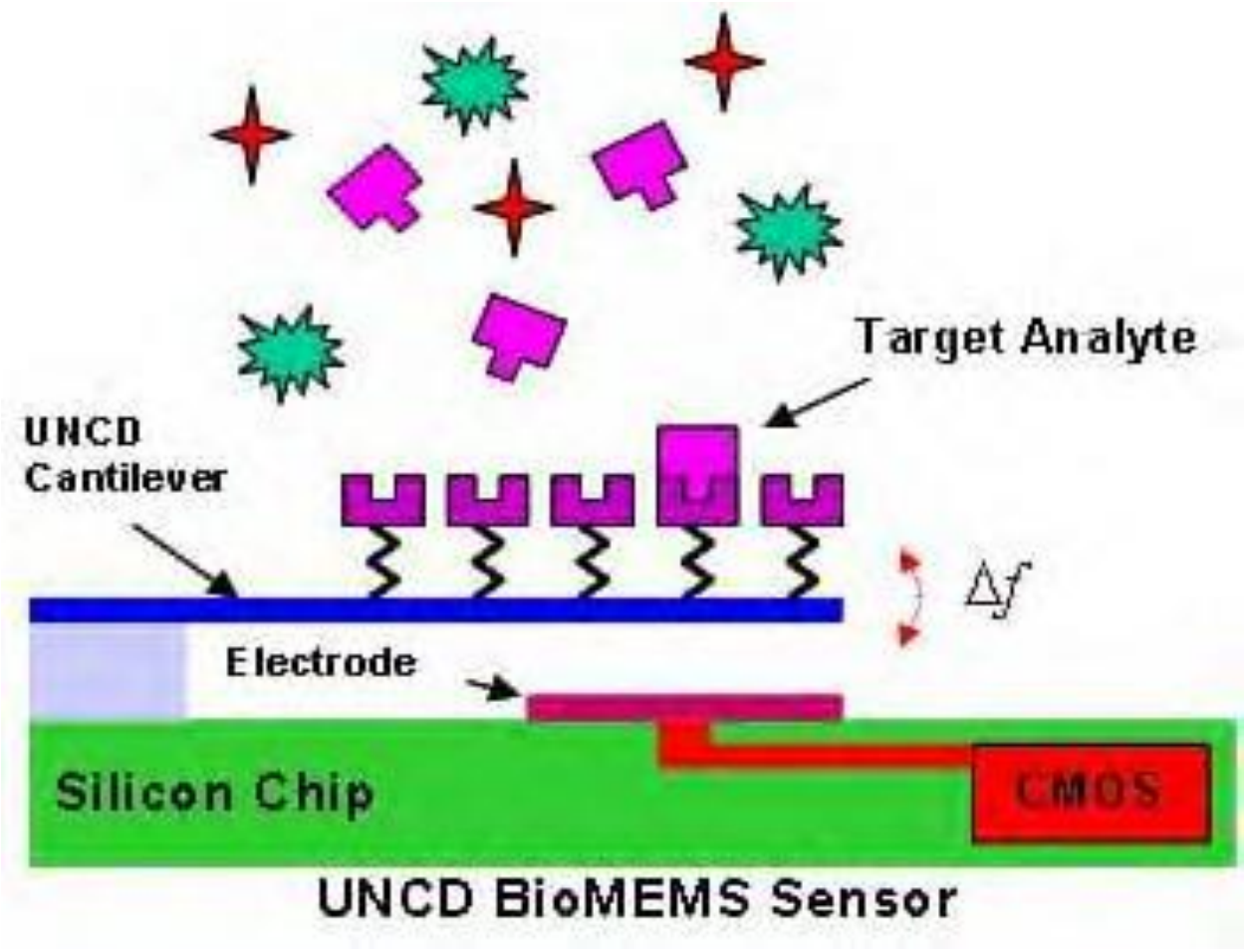


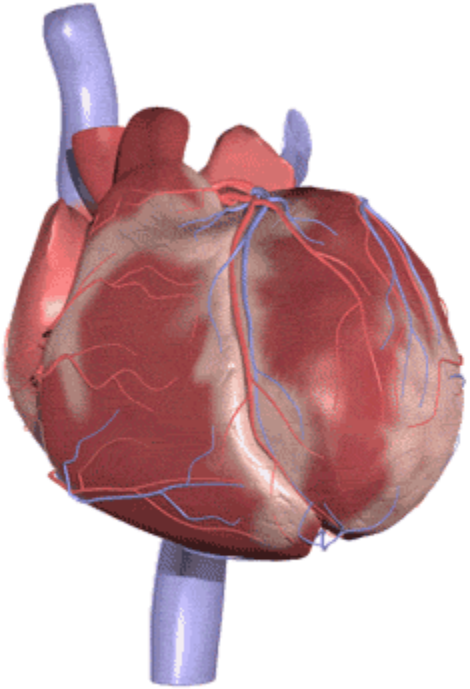
Medicine

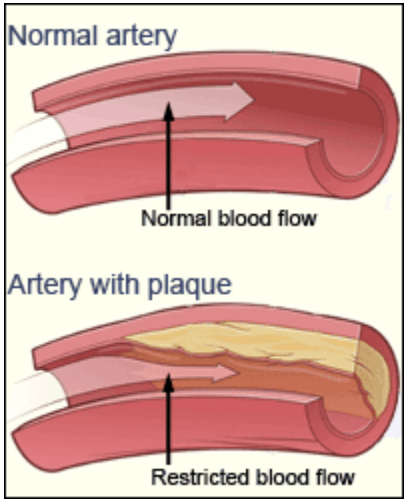


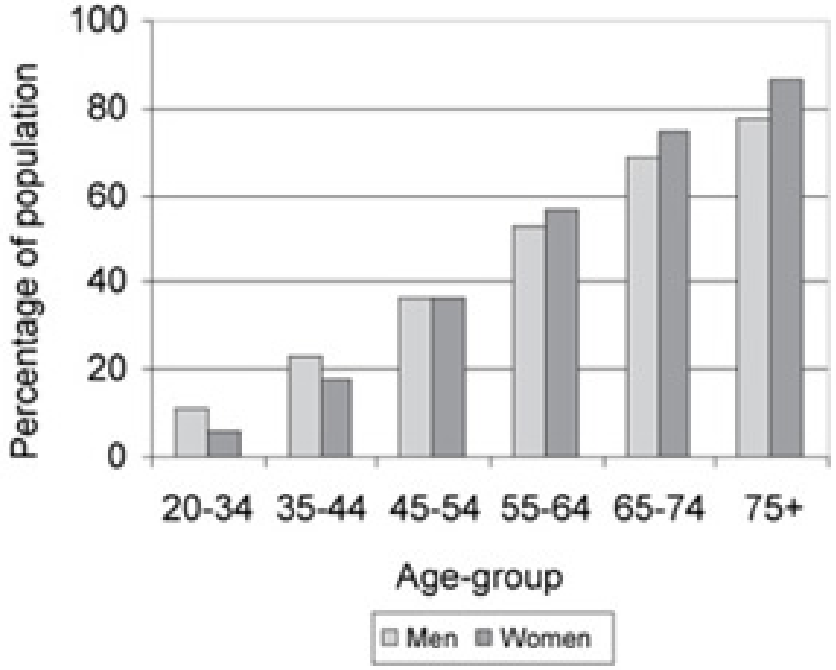


Medicine

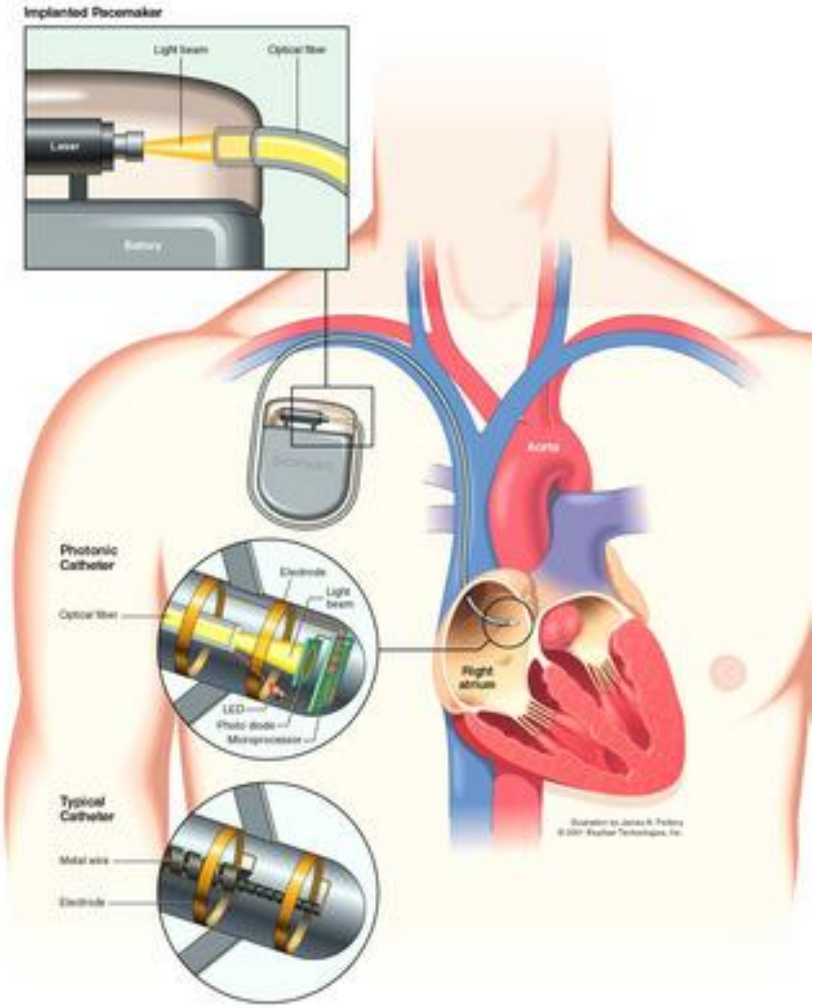

Target Analyte
UNCD
Cantilever
Δf
Electrode
Silicon Chip
CMOS
UNCD BioMEMS Sensor

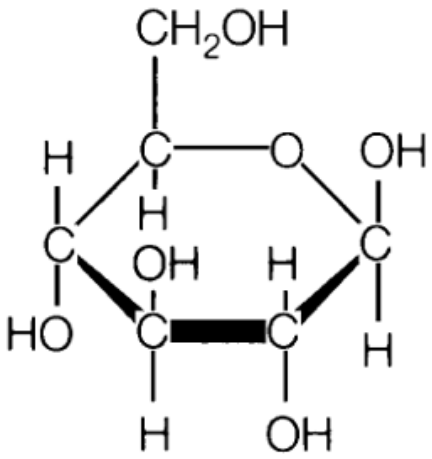



Normal artery
Normal blood flow
Artery with plaque
Restricted blood flow

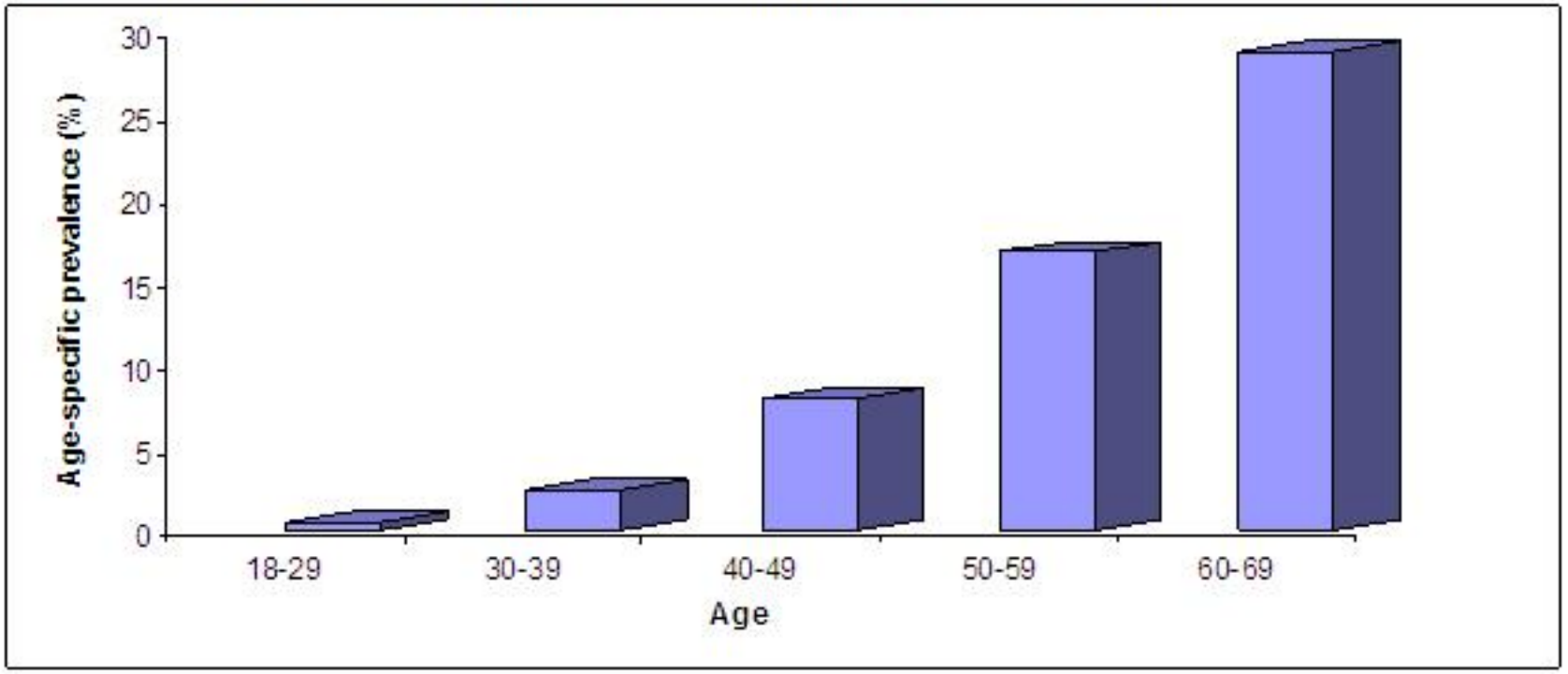

Percentage of population
100
80
60
40
20
0
20-34
35-44
45-54
55-64
65-74
75+
Age-group
Men
Women

Pacemaker


Implanted Pacemaker
Light beam
Optical fiber
Laser
Battery
Photonic Catheter
Optical fiber
Electrode
Light beam
LED
Photo diode
Microprocessor
Typical Catheter
Metal wire
Electrode
Aorta
Right atrium

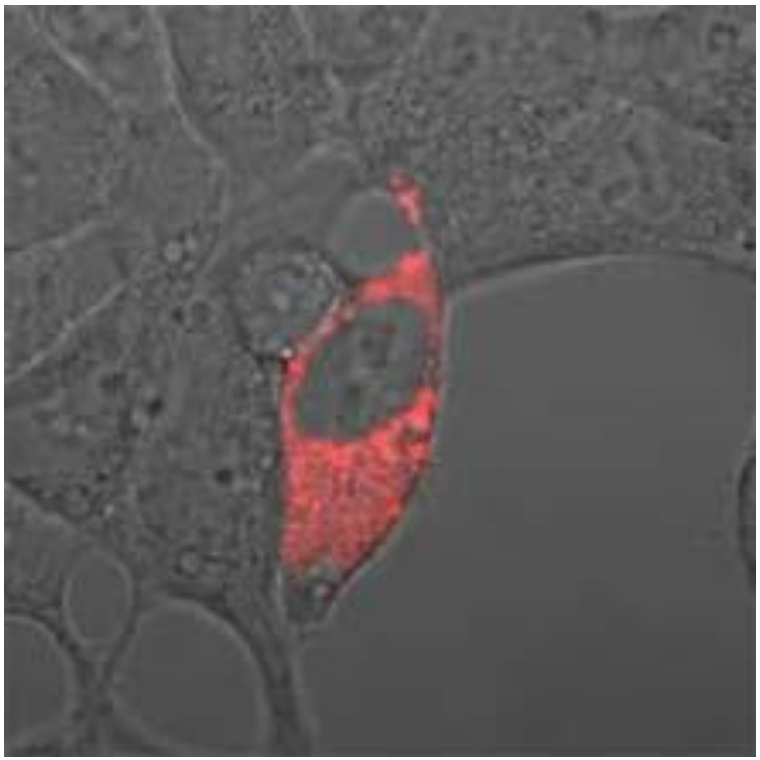


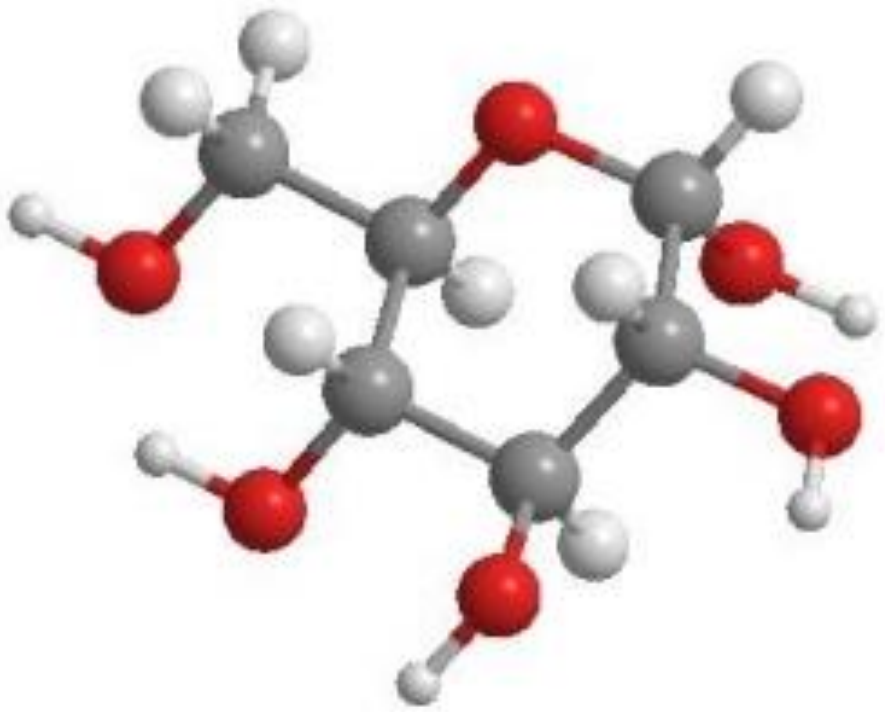
Trends in Type 2 Diabetes Mellitus[1] in Singapore by Age group

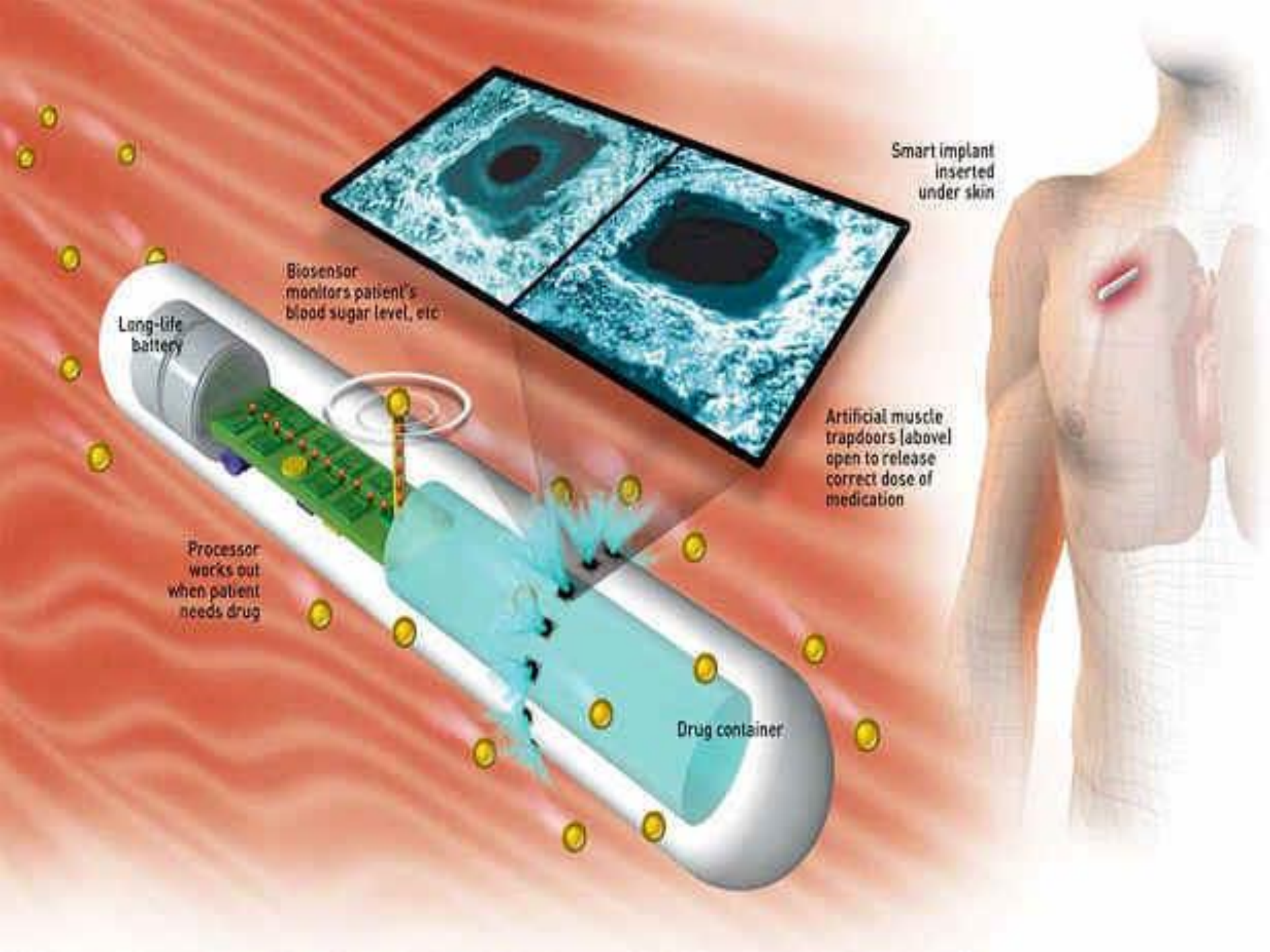


Diabetics

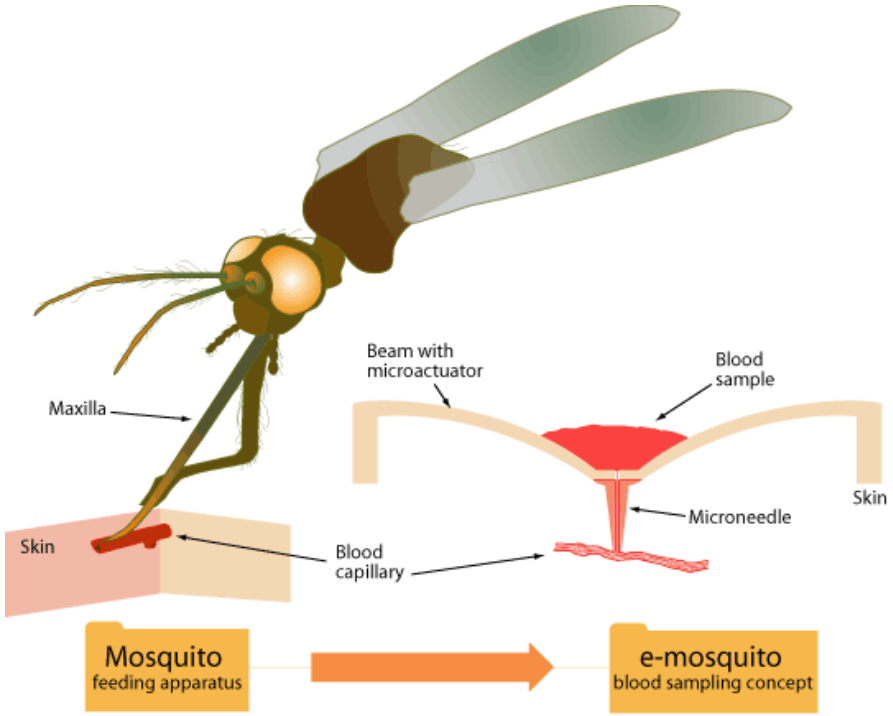
Nano-Glocose-Specific Sensor





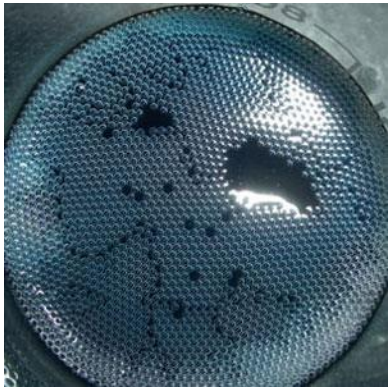

Smart implant inserted under skin
Biosensor monitors patient's blood sugar level, etc
Long-life battery
Artificial muscle trapdoors (above) open to release correct dose of medication
Processor works out when patient needs drug
Drug container

Electronic Mosquito



WEALTHY

Wearable Health Care System



Temperature
Respiration
Movement

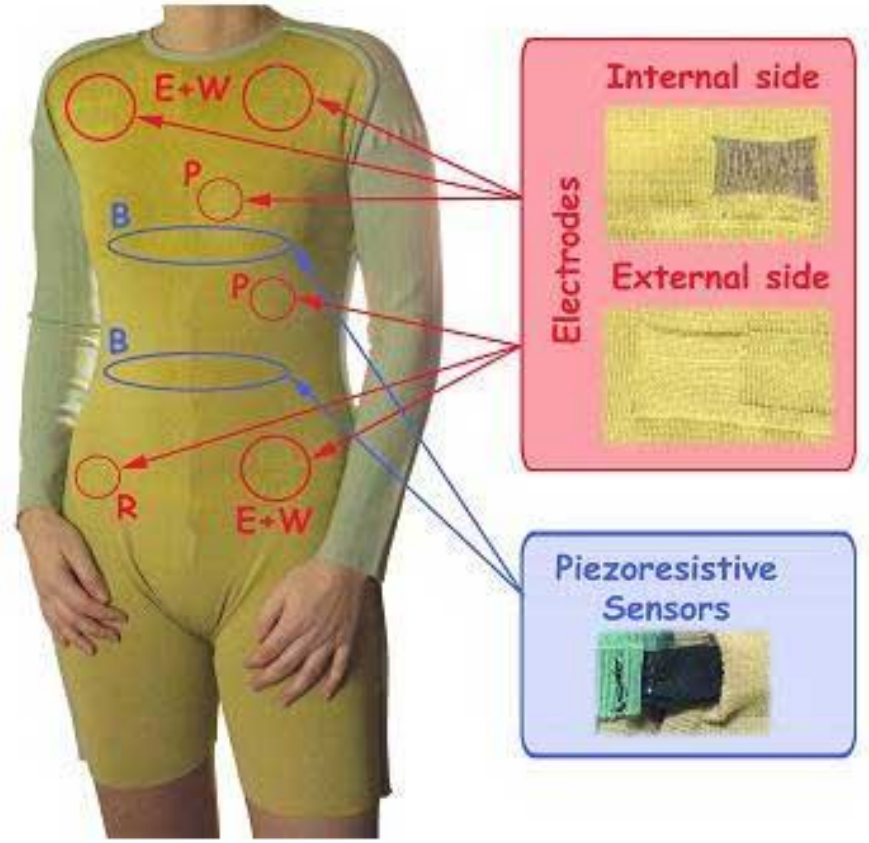
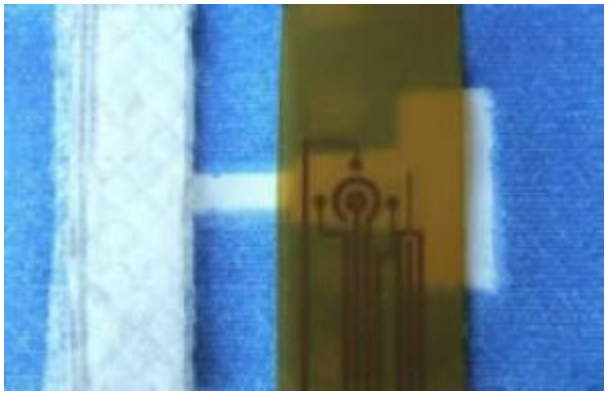
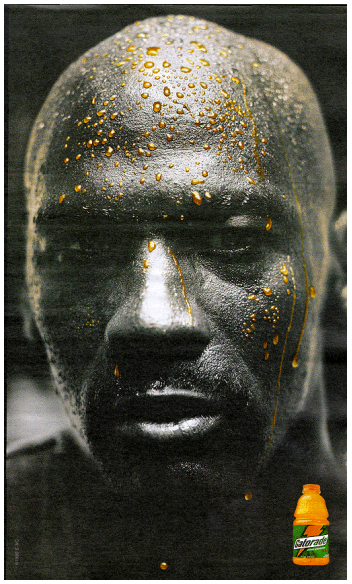
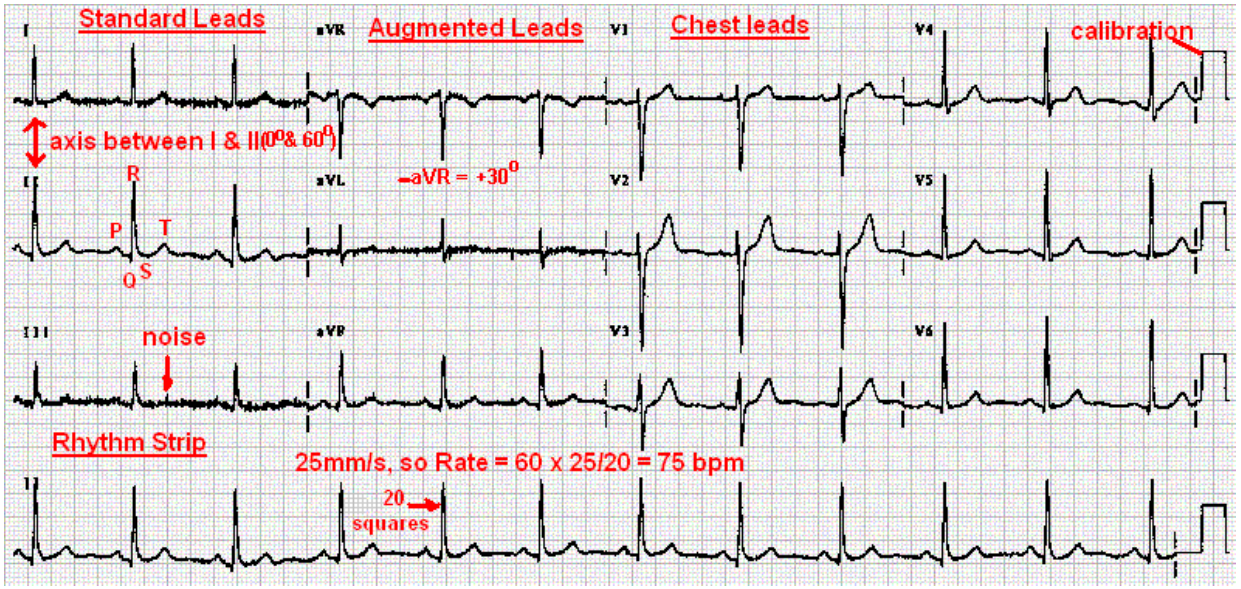


Figure 1. Prototype model, E+W Einthoven and Wilson , R Referee, P Precordial leads, B Breathing sensors. (Prototype A)

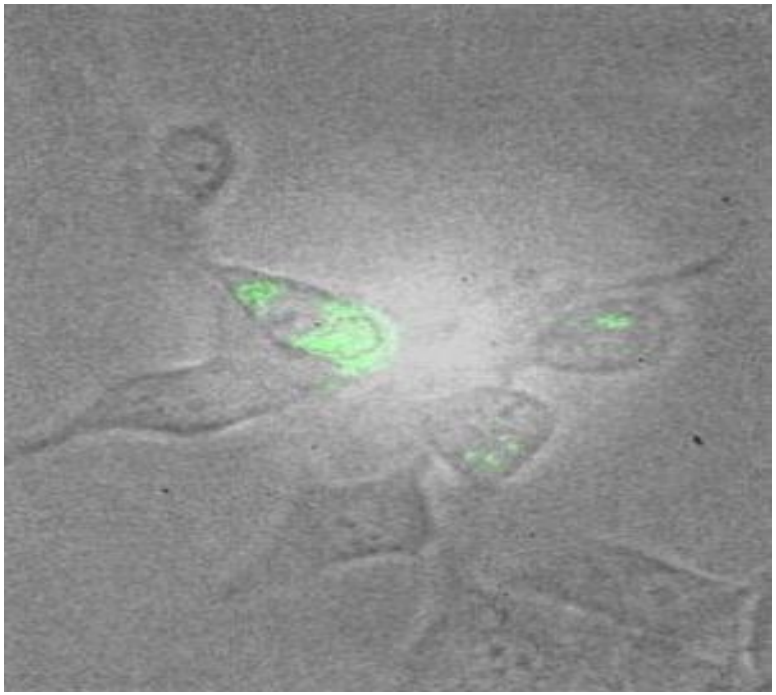
Smart Sweats

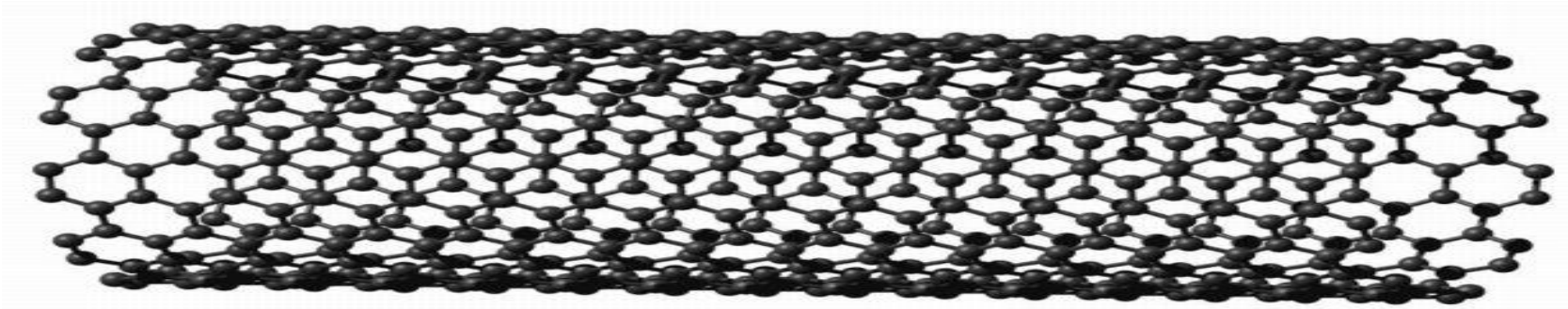




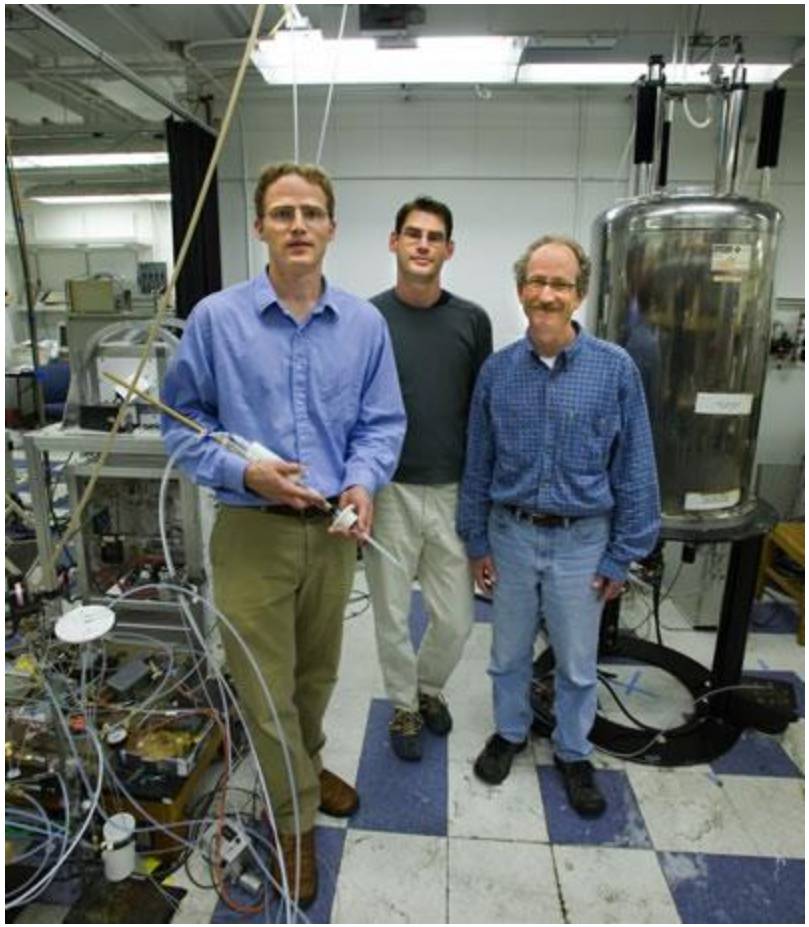


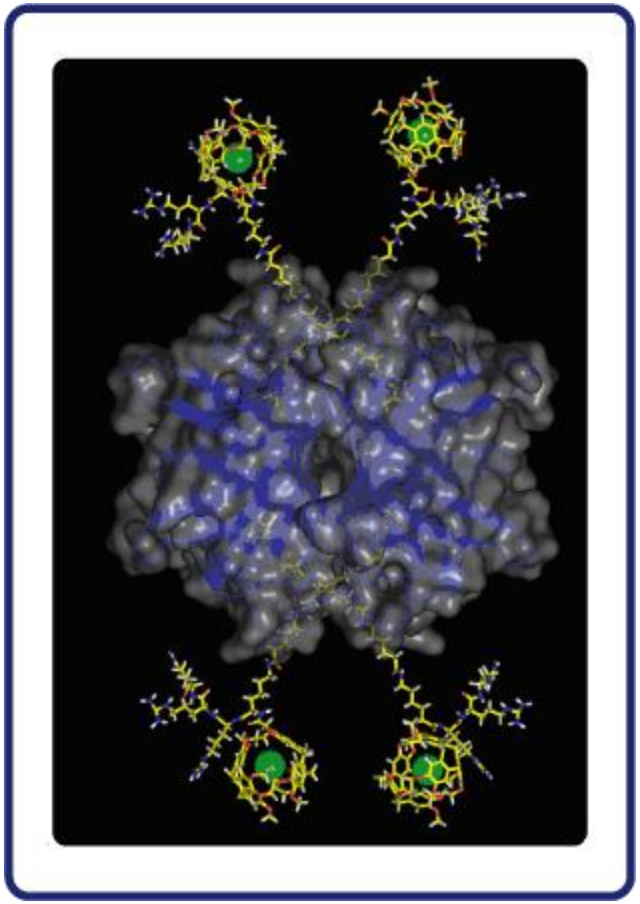
Chemo-Detectors



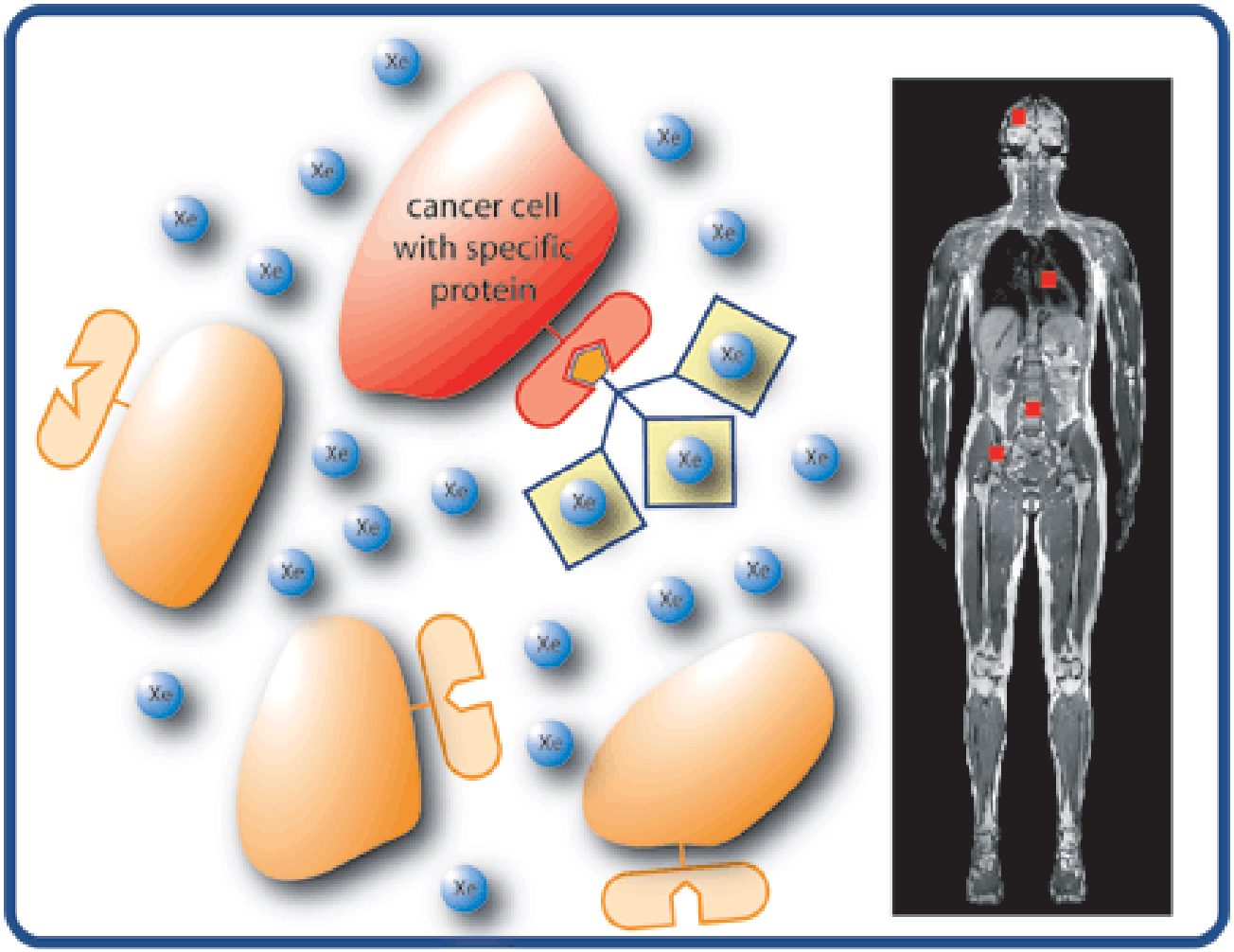


Xenon Biosensors

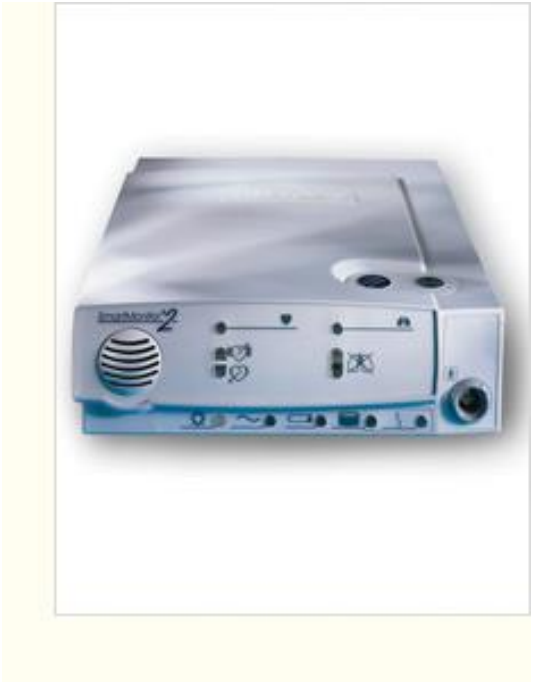


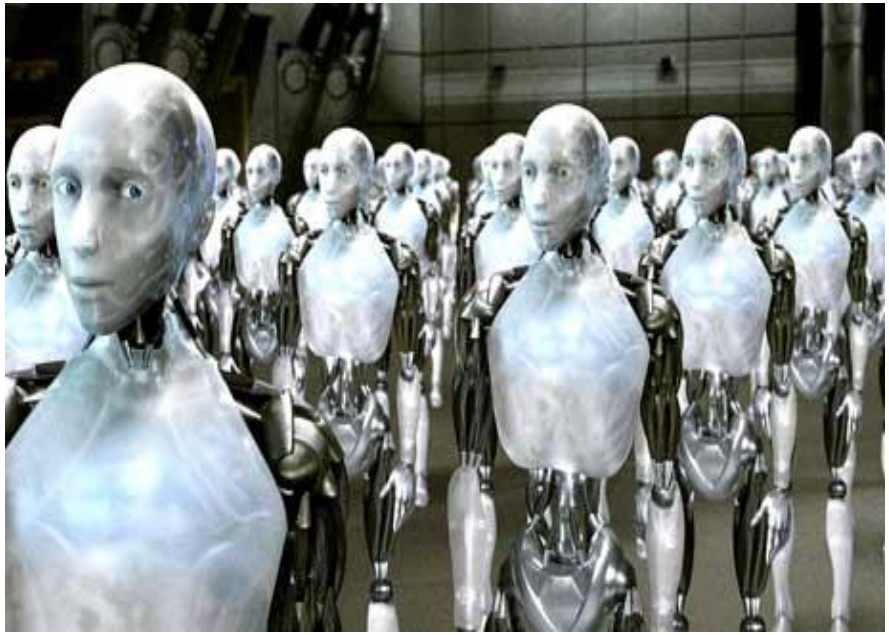


Xenon Biosensors

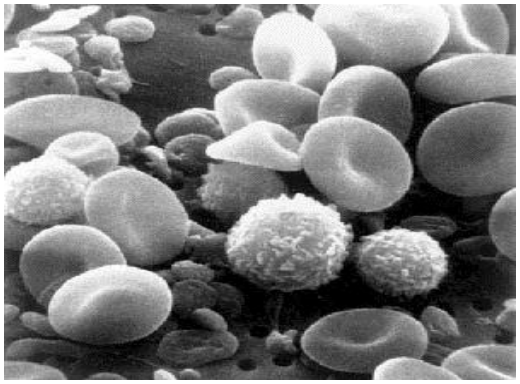


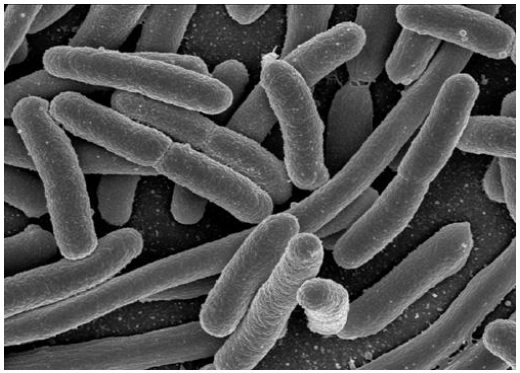
Apnea Monitors

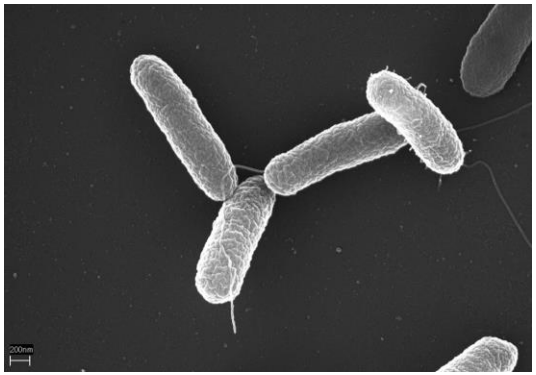


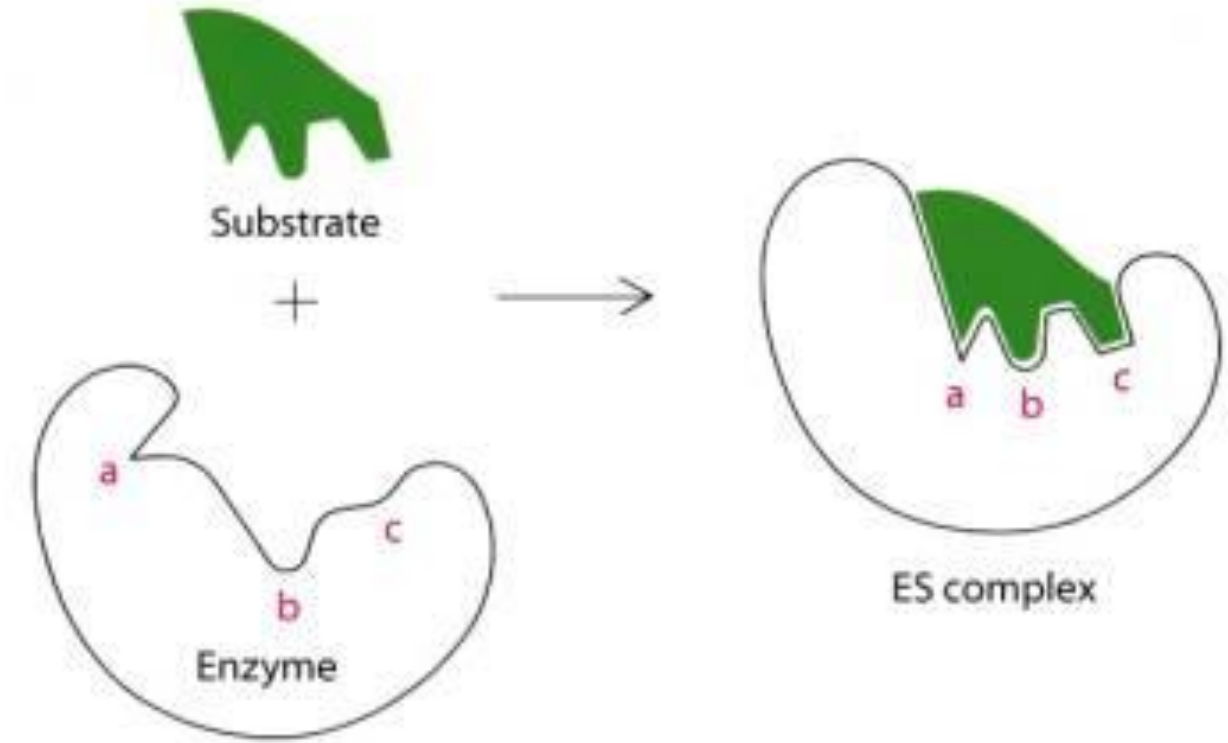


Food Testing

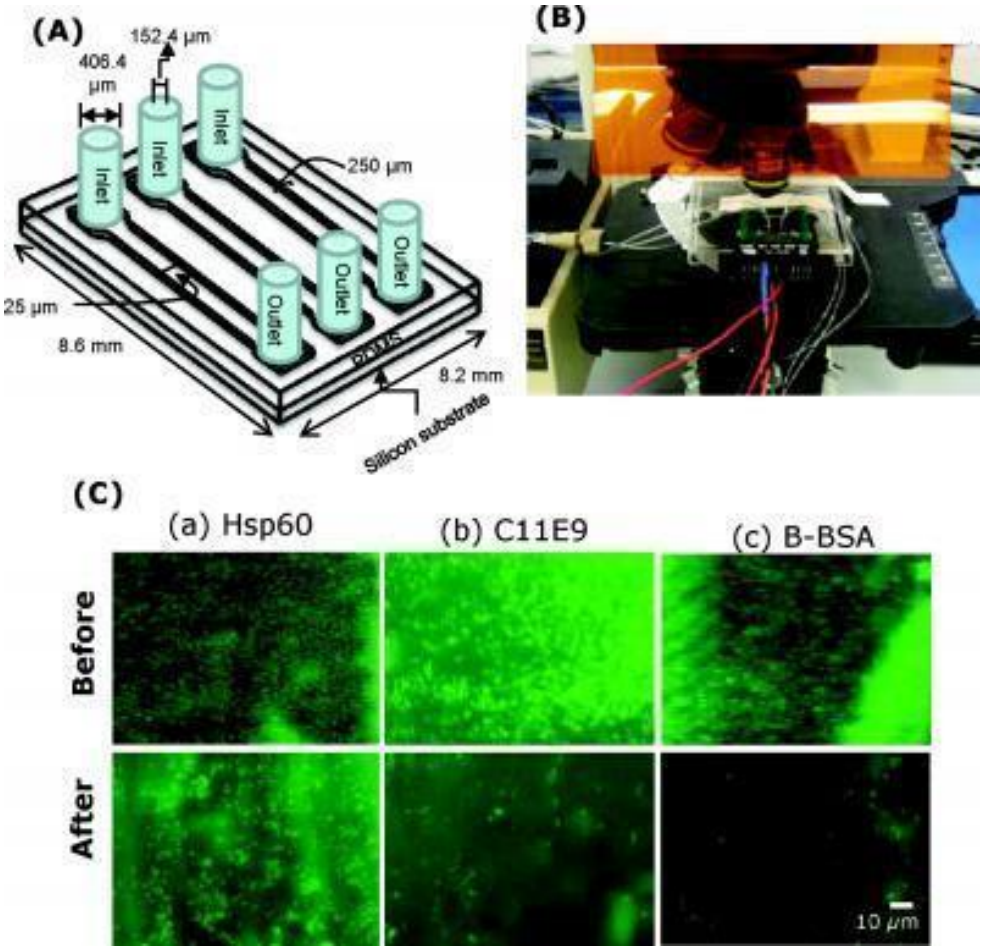




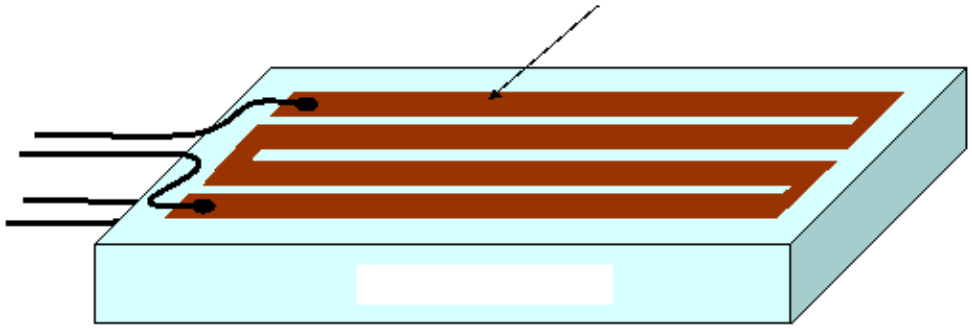



Substrate
+
a
b
c
Enzyme
a
b
c
ES complex

New Biosensor For Listeria Food Poisoning Bacteria

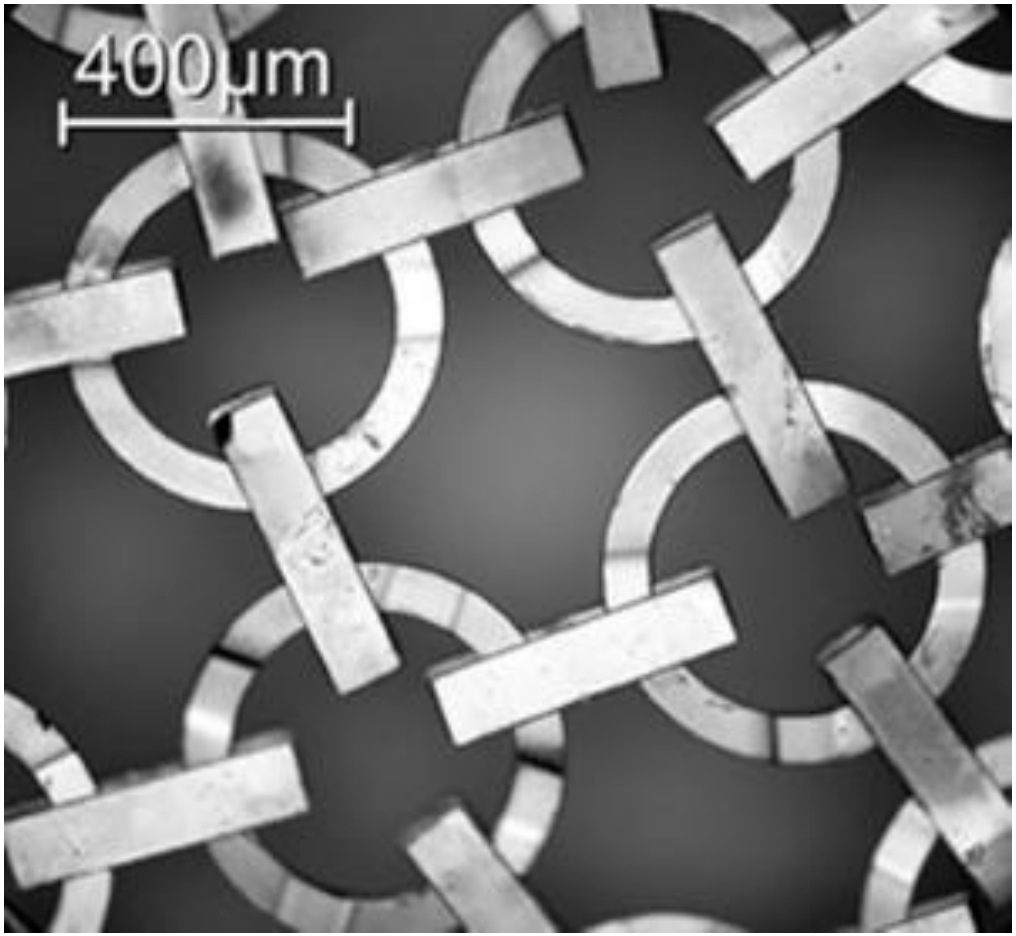


Construction

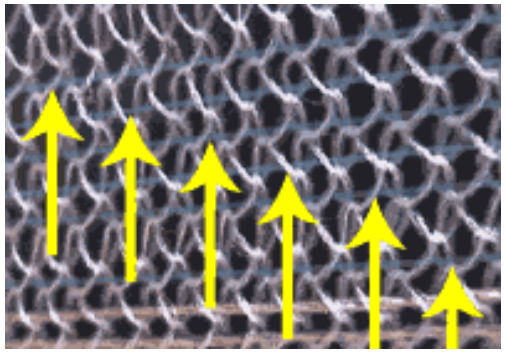


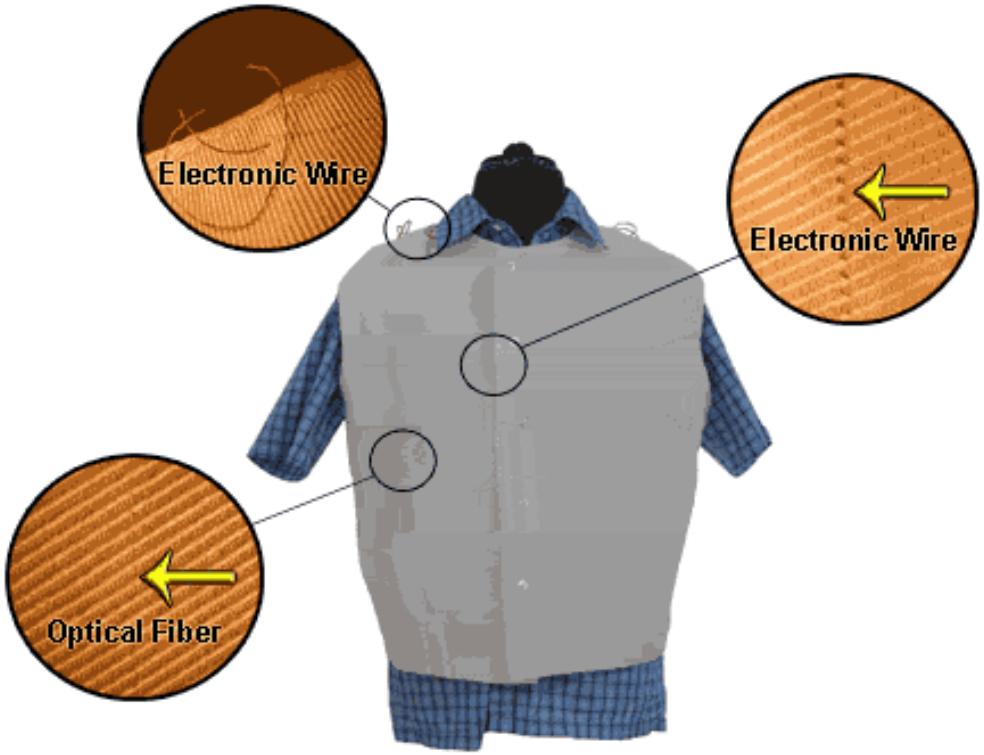
Smart Brick

“*Smart*” Clothing



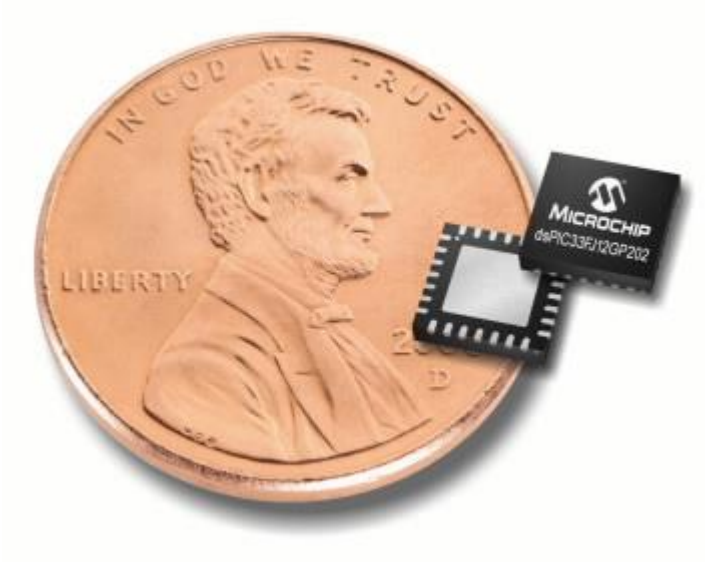
"Smart" Clothes



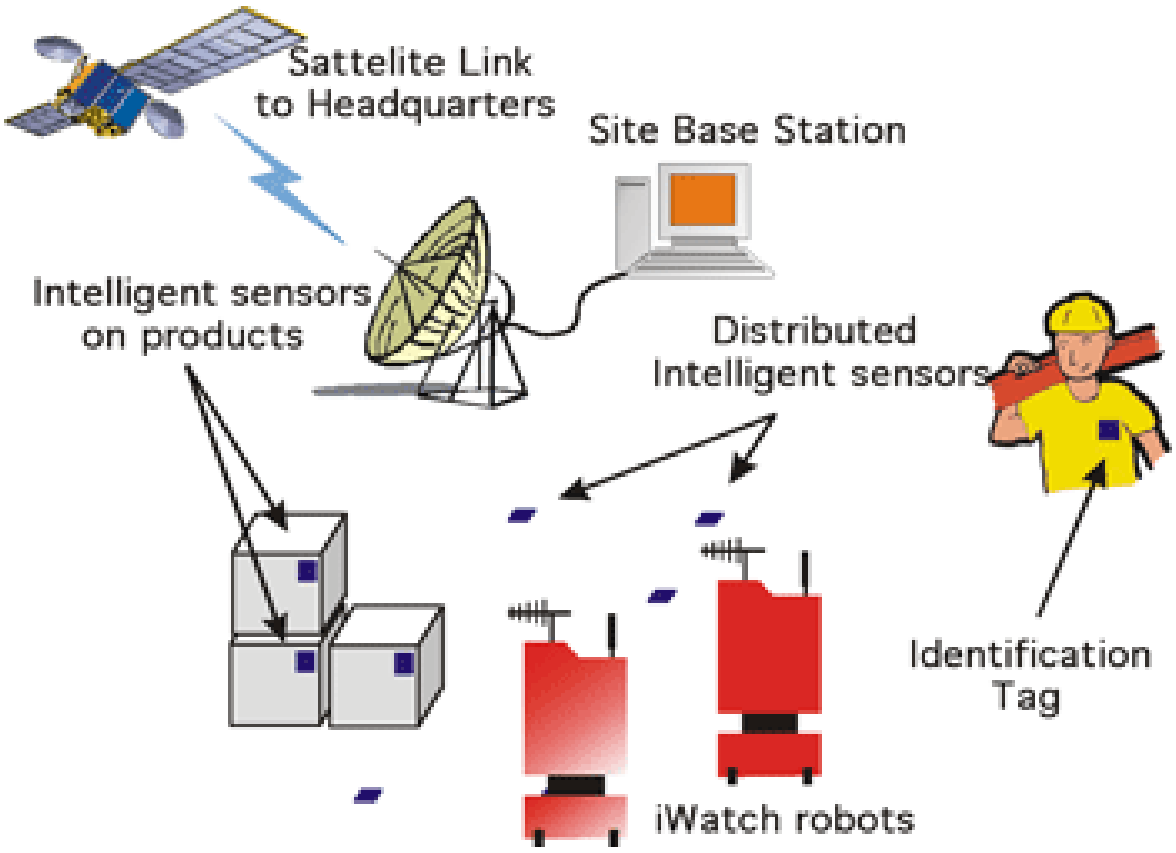


“Glitterati ”

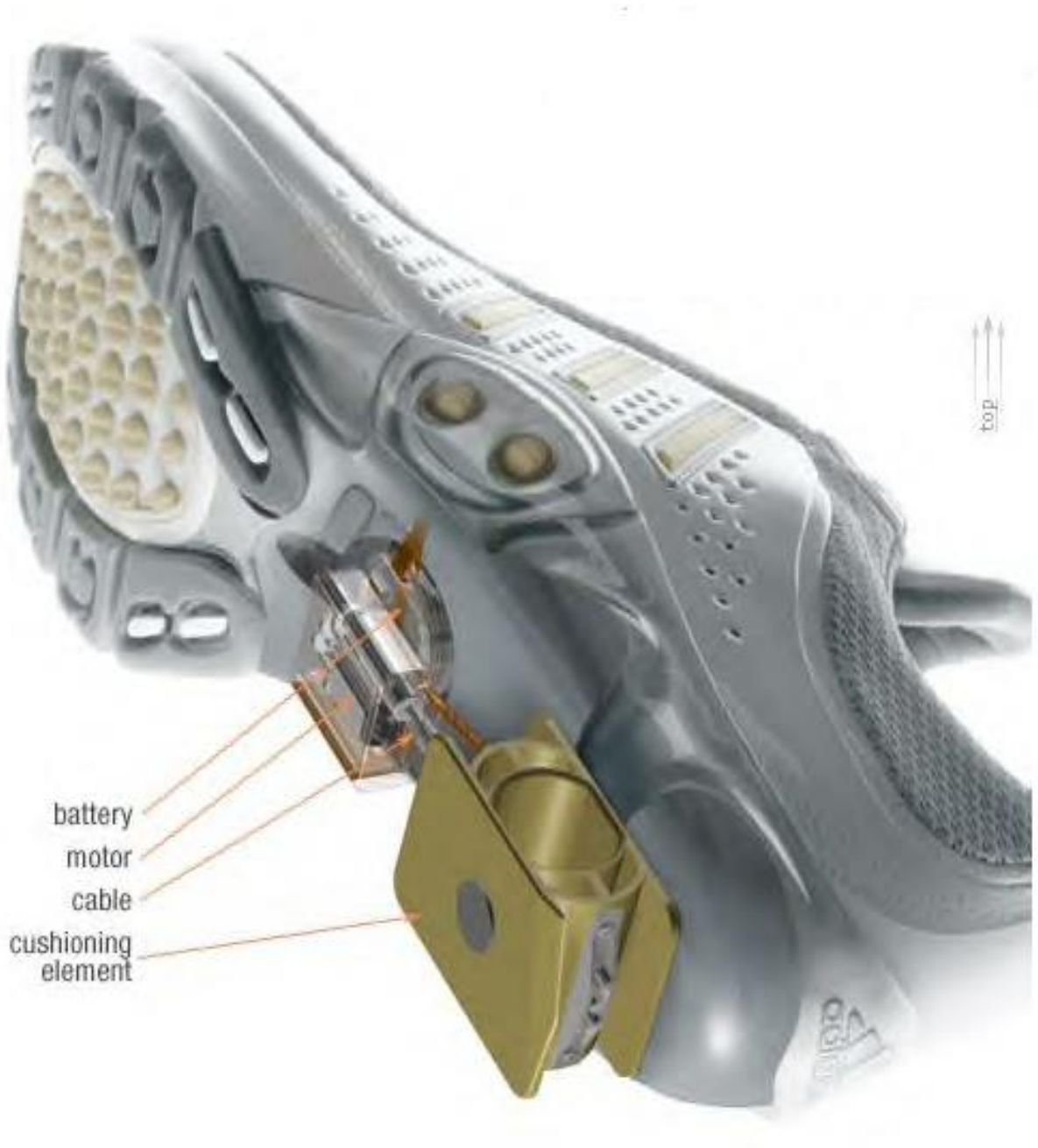
iWATCH



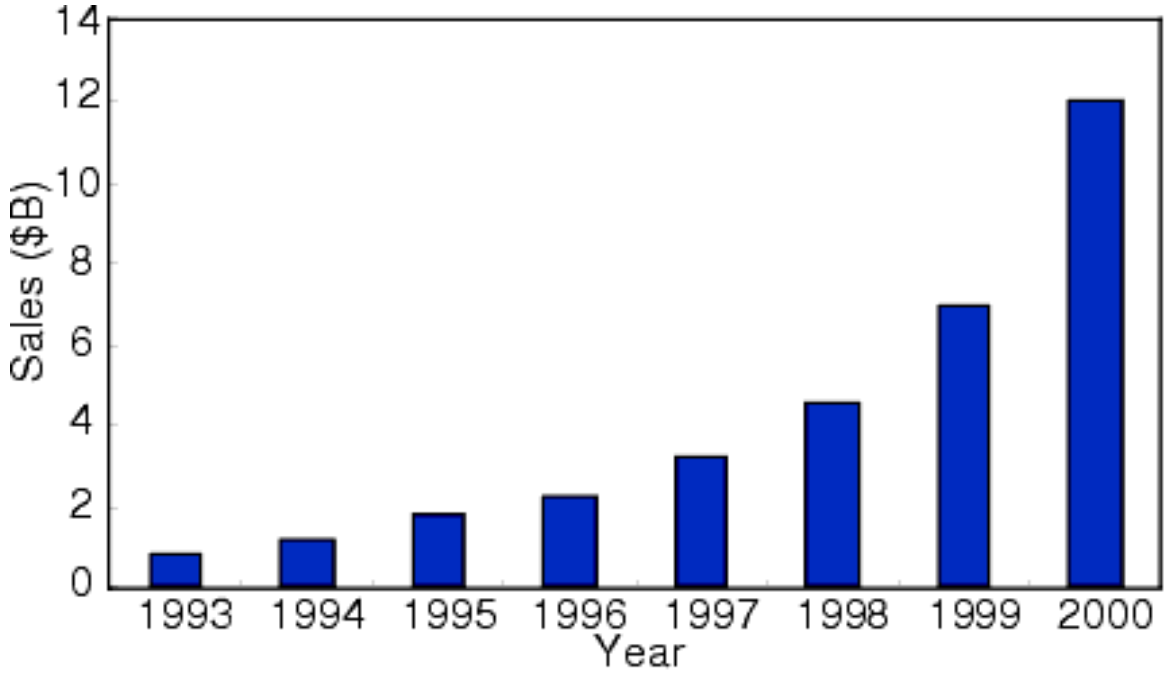
iWATCH

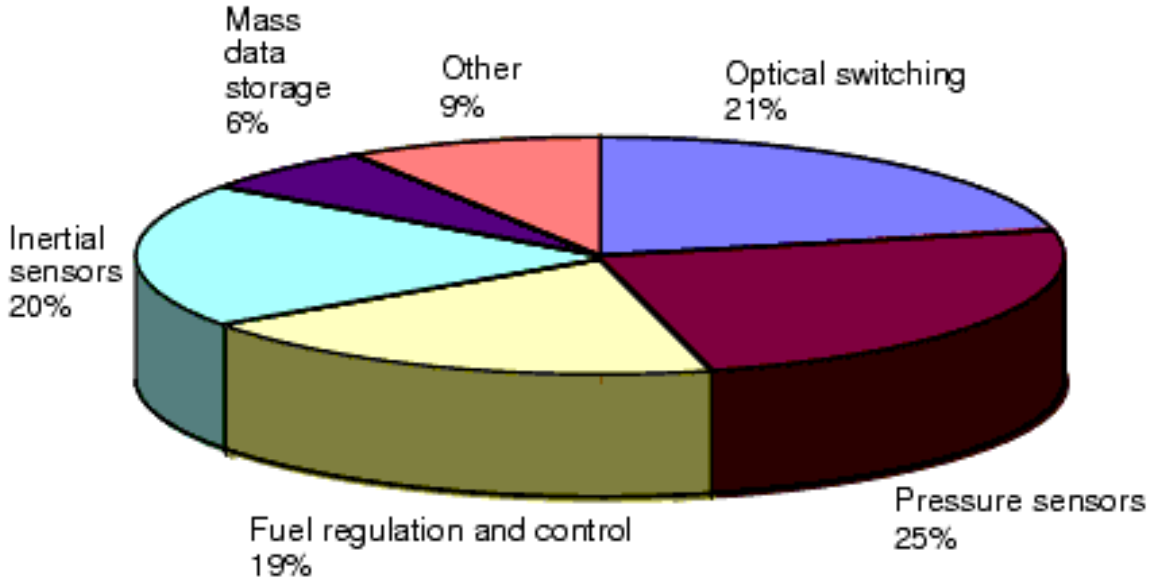

Sattelite Link
to Headquarters
Site Base Station
Intelligent sensors
on products
Distributed
Intelligent sensors
Identification
Tag
iWatch robots

SMART SHOES



Dr Richard Helmer


14
12
10
8
6
4
2
0
Sales ($B)
1993
1994
1995
1996
1997
1998
1999
2000
Year


Mass data storage 6%
Other 9%
Optical switching 21%
Inertial sensors 20%
Fuel regulation and control 19%
Pressure sensors 25%

(b)