



臺灣大學

National Taiwan University

Medical Revolution - Nanobots

Team 5 楊宗翰 龐元綺 謝明倫

Produced by National Taiwan University, Department of Electrical Engineering
Electrical Engineering Lab of Biomedical Engineering ,2012

Outlines

- **Motivation**
- **Introduction**
- **Application**
- **Movement**
- **Example**
- **Comparison**
- **Problems**

- ❑ A drug is a chemical substance used in the treatment, cure, prevention, or diagnosis of disease.
- ❑ Drugs can be orally, topically taken or injected as solution.



- ❑ Drugs enter human body and travel through the circulatory system.
- ❑ They make a curative effect if they operate at the right place. However, side effects occur otherwise.
- ❑ The most common side effects includes feeling dizzy, getting headache, vomiting and so on.



- ❑ Among the variety of side effects, the most terrifying one is the side effect from chemotherapy.
- ❑ The cancer cells are characterized by the quick cell division. Chemotherapy is targeted at those cells with this characteristic.
- ❑ Nevertheless, some cells born to have this property will be severely harmed by the drug.



Is it possible to have a tiny robot inserted into our body carries drugs to the correct region?

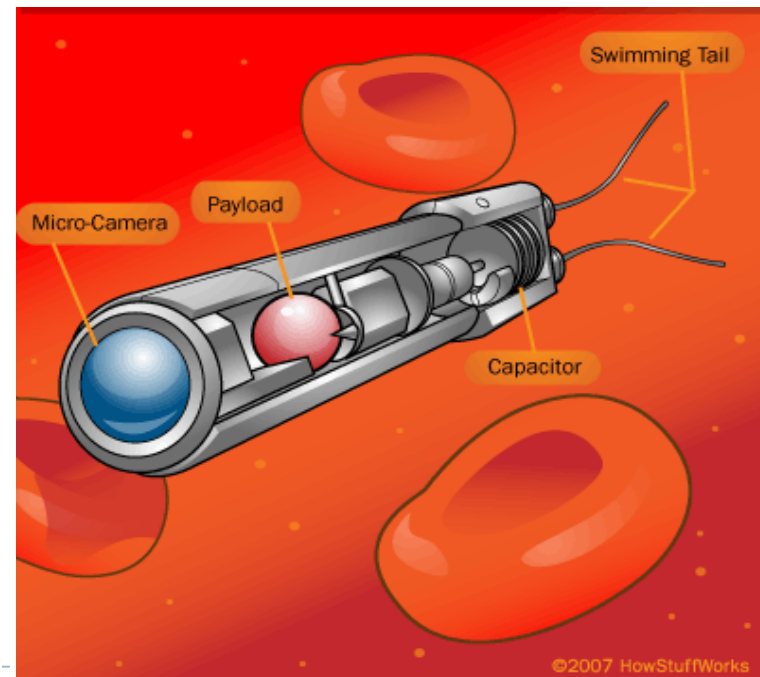


NANO ROBOTICS!

*As a matter of fact, technically speaking nanorobots, or nanobots, don't do anything yet —they haven't been formally invented.

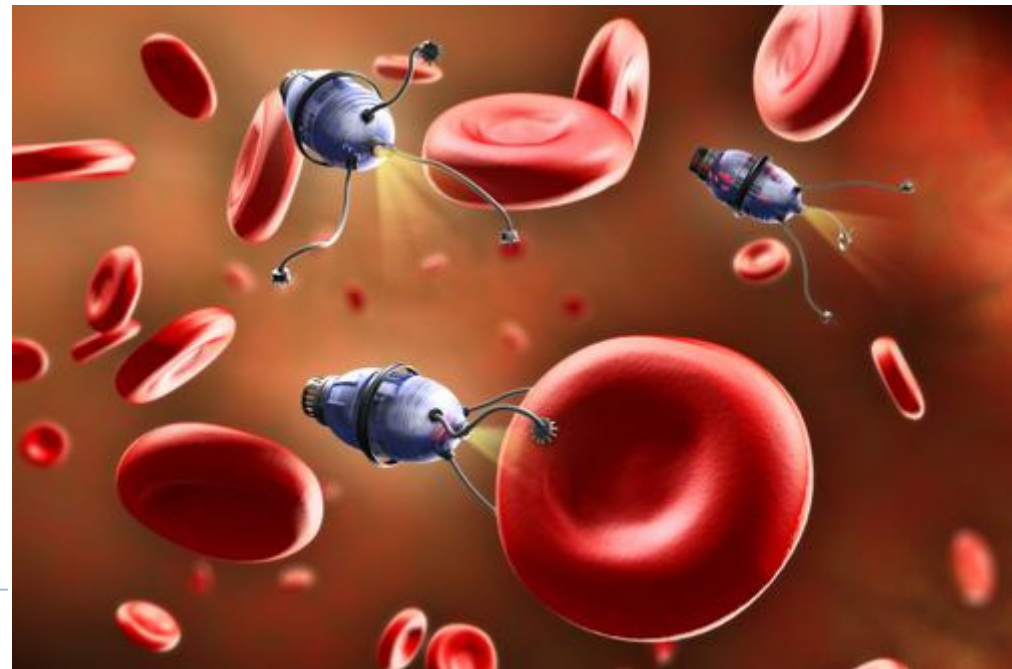
What is Nano-robot?

- ❑ Design of robots with overall dimensions below the mm range and made of nm-scale components.
- ❑ Programming and coordination of large numbers of such Nano robots.
- ❑ Programmable assembly of nm-scale components either by manipulation with macro or micro devices, or by directed self-assembly



Advanced design target

- ❑ Self-assembly, reproduction or communication
- ❑ Strong moving ability toward resistance in human body
- ❑ Adaption of highly dynamic environment
- ❑ Being equipped with some artificial intelligence
- ❑ DNA therapy



-
- ❑ Cancer-killing nanobots
 - ❑ Remove particles from the bloodstream
(such as cholesterol molecules)
 - ❑ Perform micro-surgery
 - ❑ Heal basic tissue damage
(such as contusions or wounds in the flesh)
 - ❑ Act as artificial helper-T cells
(could be the answer of autoimmune diseases)
 - ❑ Research and discovery inside the human body

- Three main considerations

- 1) Navigation

- 2) Power

- 3) How the nanobots move through blood vessel

- External systems or Onboard systems

- **Navigation**
- External navigation System
 - 1) Ultrasonic signals
 - 2) Magnetic Resonance Imaging (MRI) device
 - 3) Injecting a radioactive dye
 - 4) X-rays, radio waves, microwaves or heat.
- Onboard navigation system
 - 1) Chemical sensors
 - 2) Miniature television camera



□ Power

Using the patient's own body as a way of generating power [External]

Include a small power source on board the robot itself [Internal]

□ Internal power system

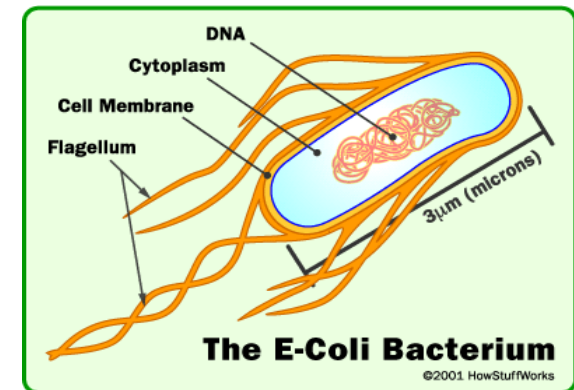
- 1) Form a battery using the electrolytes found in blood
- 2) Create chemical reactions with blood to burn it for energy
- 3) Use the patient's body heat to create power
- 4) Nuclear power?

□ External power system (tethered or not)

Tethered : wire , strong , move effortlessly without causing damage

Not tethered : microwaves , ultrasonic signals or magnetic fields.

- ❑ **Locomotion**
- ❑ The propulsion system has to be relatively strong for its size
- ❑ Inspiration from microscopic organisms
- ❑ Use capacitors to generate magnetic fields
(like a electromagnetic pump)
- ❑ Vibrating membrane
(by tightening and relaxing tension on a membrane)



Motivation

Introduction

Application

Movement

Example

Comparison

Problems

□ Recent Research Examples:

Cell-targeted, payload-delivering DNA nanorobot

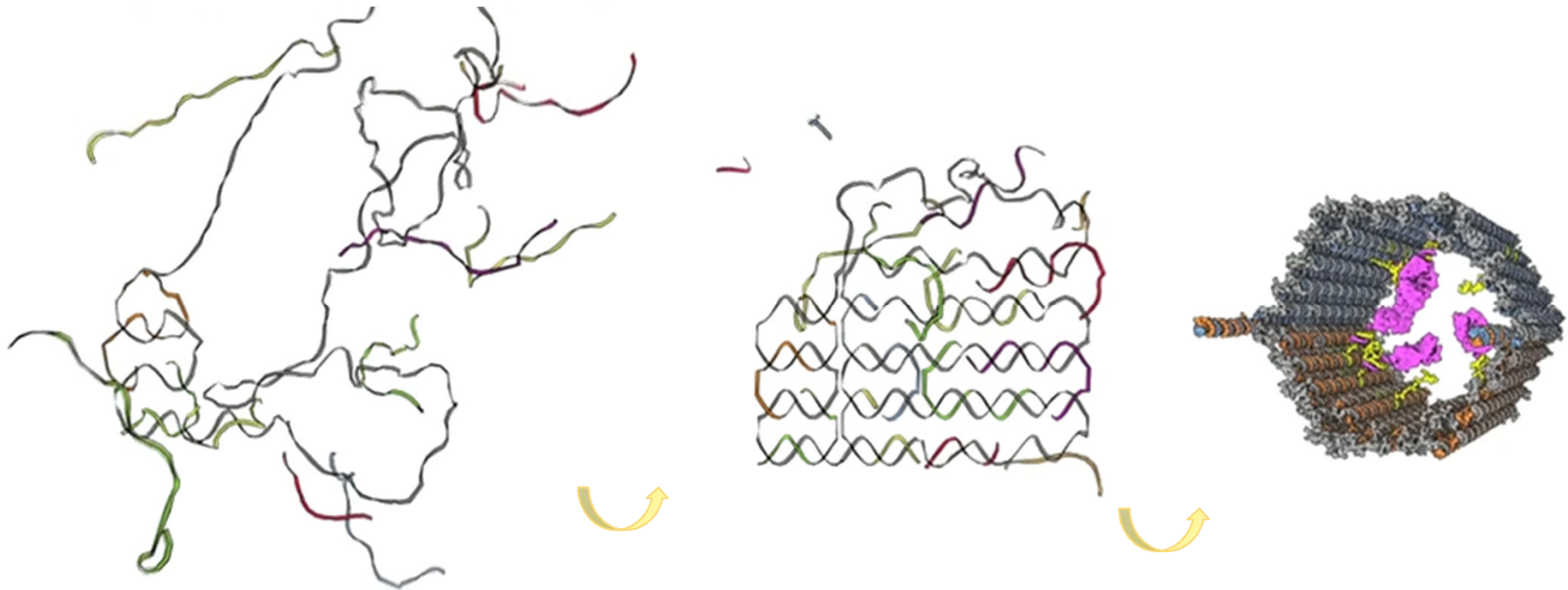
- Wyss Institute for Biologically Inspired Engineering at Harvard University

Video:



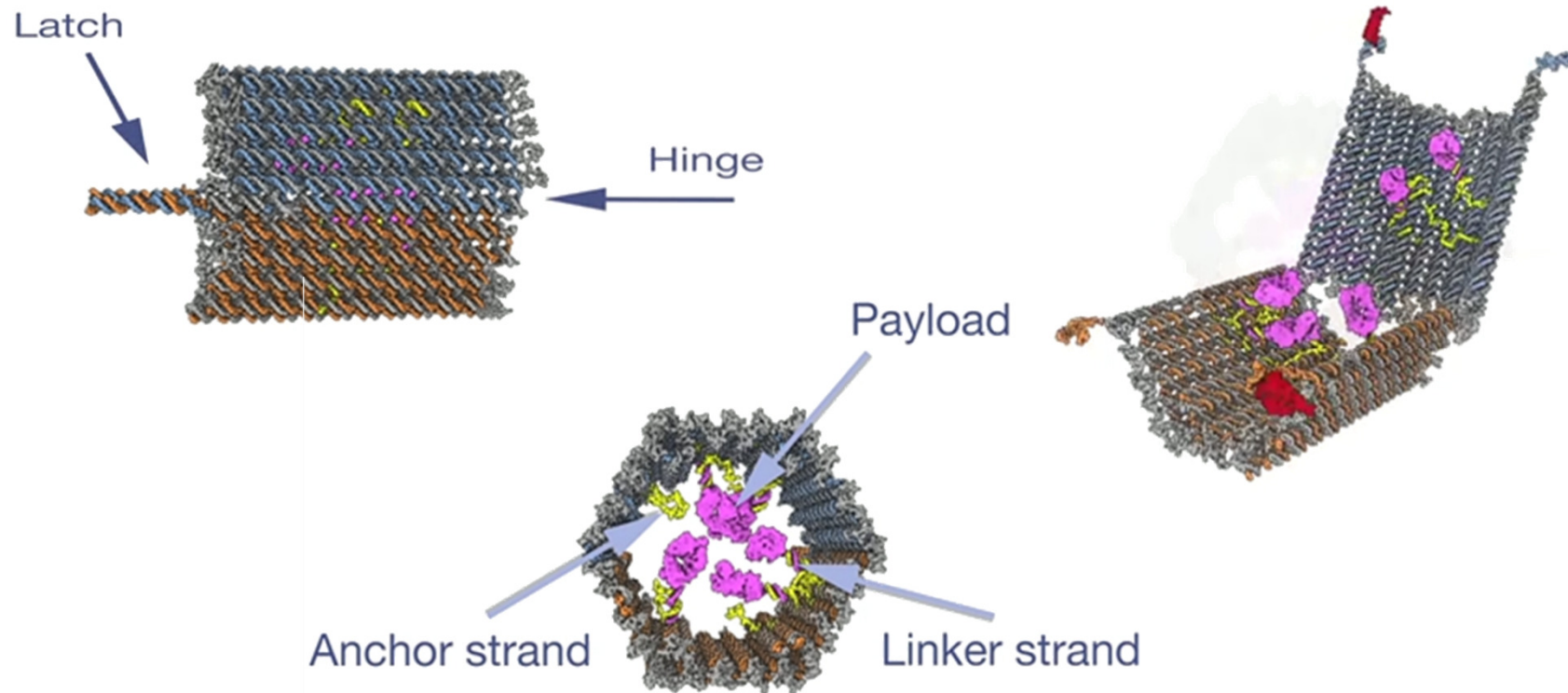
Recent Research Examples:

Cell-targeted, payload-delivering DNA nanorobot



Recent Research Examples:

Cell-targeted, payload-delivering DNA nanorobot



-
- ❑ Several cancer treatment nowadays
 - ❑ Chemotherapy
 - Strong side effect
 - Kills not only bad but also good
 - However, equally effective remedies have not yet been found
 - ❑ Cancer surgery
 - Highly invasive and traumatic procedure
 - Oftentimes less effective than we would hope
 - ❑ Target therapy
 - Need for long-term treatment can affect compliance
 - Cancer cells often become resistant to the drug
 - ❑ **Nanobots**
 - So tiny that they could be easily injected into the bloodstream
 - Much less traumatic, do it in a very non-invasive, non-traumatic way


□ Design Challenges

requirements of [size](#), [sterility](#), [safety](#) and [dynamic nature of patient's body](#).

□ Inorganic Nanobots v.s. Organic Nanobots

MRI generates high magnetic field (1.5-3 Tesla) and RF pulses, in which traditional robotic components fail.

Nanobots are very expensive to build

- Because of their complexity and very small size.
 - But it needs large numbers of them working together for microscopic tasks
 - If we need a lot of, the problem is how to [replicate](#) them.
-
- 

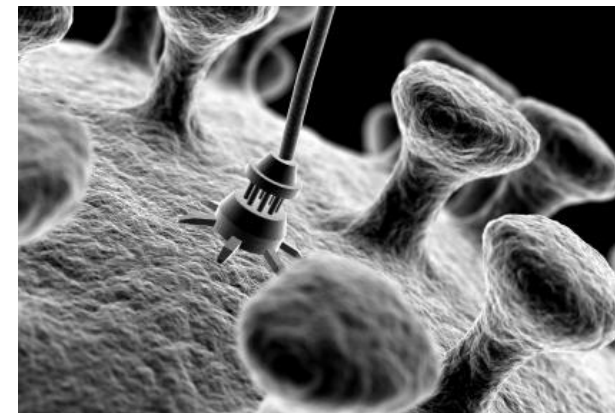
□ Advantages and Disadvantages of Inorganic Nanobots

Advantages:

- ✓ well-understood component behaviour
- ✓ ease of programming
- ✓ ease of external control

Disadvantages:

- ✓ difficult and expensive to make
- ✓ not self-reproducing
- ✓ difficulty of communicating with organic systems
- ✓ carry limited payload



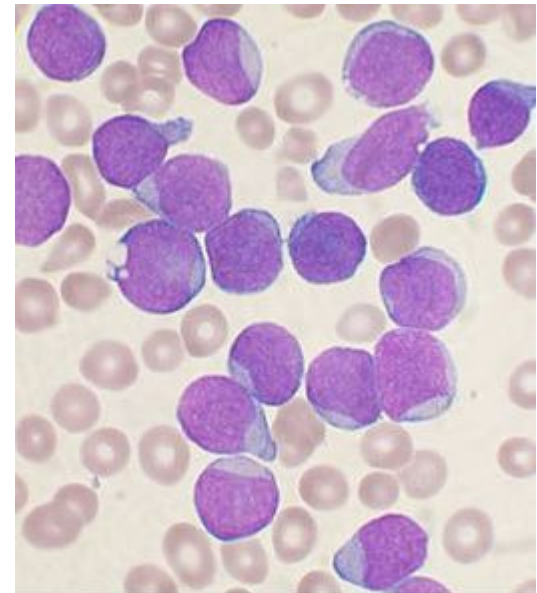
□ Advantages and Disadvantages of Organic Nanobots

Advantages:

- ✓ easy to make using genetic engineering
- ✓ self-reproducing (cheaper)
- ✓ easily communicate with other organic systems
- ✓ protein factories manufacture payload

Disadvantages:

- ✓ poorly understood component behaviour (proteins)
- ✓ hard to program
- ✓ limited external control mechanisms



□ Possible risks

- ✓ This technology could be misused
- ✓ Sometimes cause by short-sighted company
- ✓ In the scenario known as “grey-goo” nano-robots disassemble everything on earth to produce copies of themselves
- ✓ Prey(奈米獵殺):
 - DNA→RNA→蛋白質→奈米元件→『自我組裝』、『自我複製』
 - 『奈米機器人』→自我學習→有智慧的群組→自我演化
 - 『失控的奈米機器人』

Size Matters

- ▶ It's not just how big you are
- ▶ It's what you can do with it



Reference

- 你「藥」的知識：98年度行政院衛生署編
 - Molecular-targeted Therapy in Cancer, 陳若白, 黃敬倫, 鄭安理, 台大醫院腫瘤醫學部
- How Stuff Work
<http://electronics.howstuffworks.com/nanorobot.htm>
- 中國經濟網
http://big5.ce.cn/gate/big5/sci.ce.cn/fxqy/201005/14/t20100514_21397809.shtml
- Introduction to Nanotechnology
<http://nanogloss.com/nanobots/what-are-the-capabilities-of-nanobots/#ixzz2Blx9L8YJ>
<http://ebookbrowse.com/nanorobotics-2007-pptx-d259230467>
- Nature.com
<http://www.nature.com/nature/journal/v465/n7295/full/nature09012.html>
- Smart Planet.com
<http://www.smartplanet.com/blog/savvy-scientist/tomorrows-nanobots-today/441>
- 科學人
<http://sa.ylib.com/MagCont.aspx?Unit=featurearticles&id=1391>
- Wyss Institute for Biologically Inspired Engineering at Harvard University
<http://wyss.harvard.edu/viewpressrelease/75/>

Q & A

