

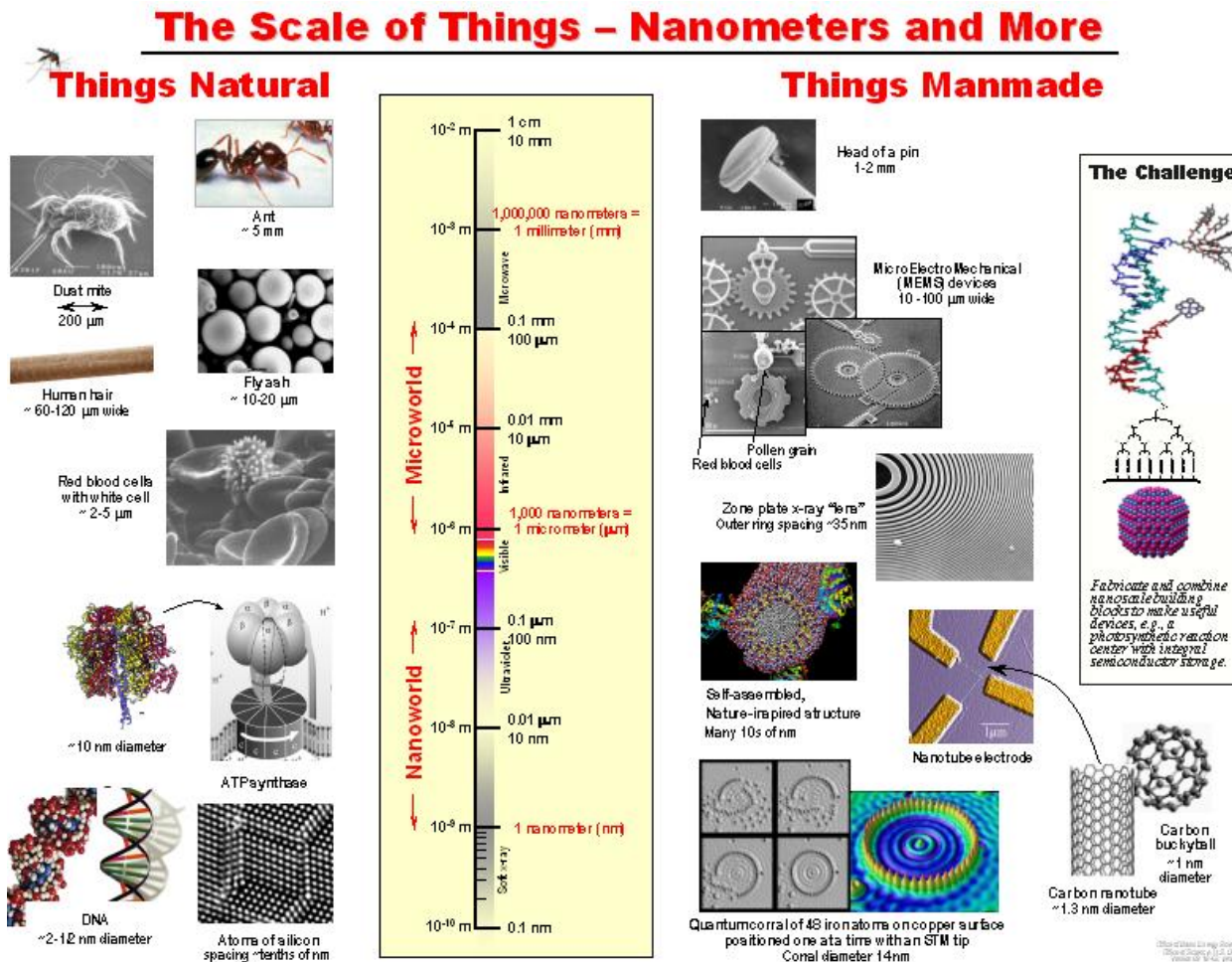
Nanobiotechnology

Place: IOP 1st Meeting Room
Time: 9:30-12:00, Friday

Reference: Review Papers

Grade: 50% midterm, 50% final

What is nano?



History

- Atom
- Earth, Air, Water Fire



SEM: 20-40 nm

Silver 66.2%

Gold 31.2%

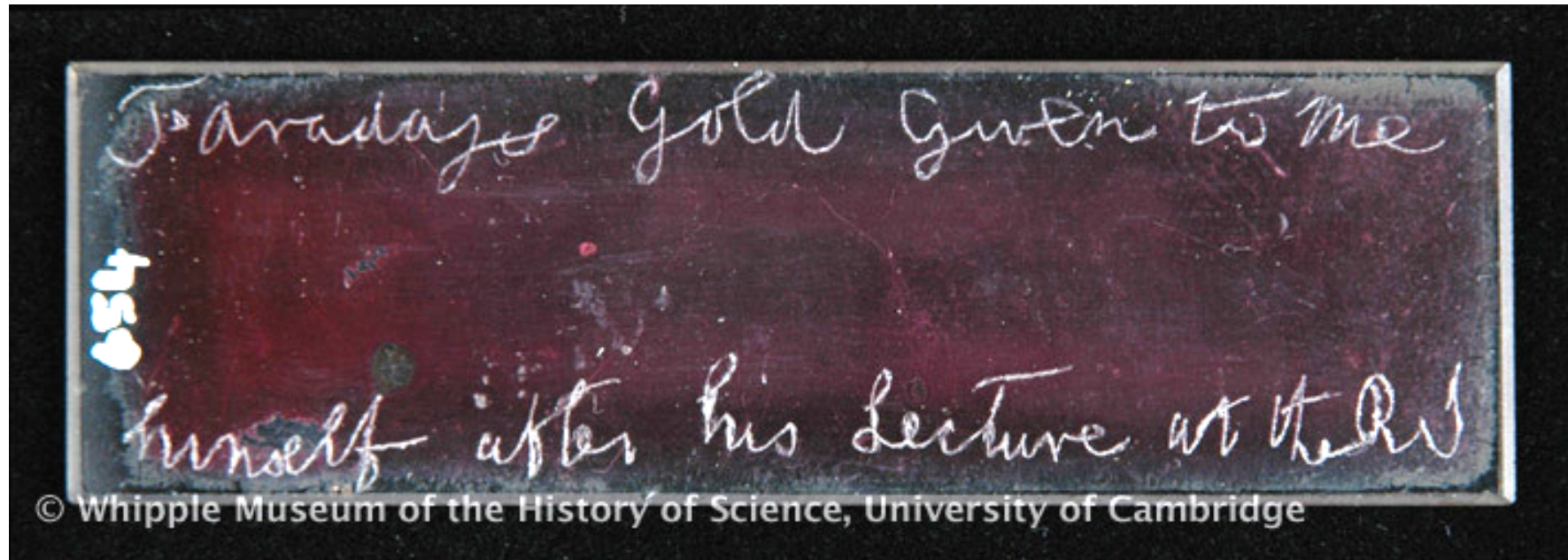
Copper 2.6%

Red – gold at 520 nm

Purple- larger nanoparticles

Green- scattering >40nm

Faraday's Gold Sol



1856
20-40 nm gold



Plenty of Room at the Bottom

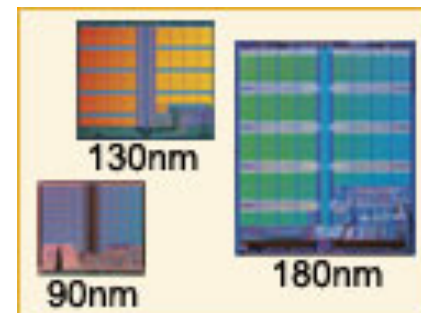
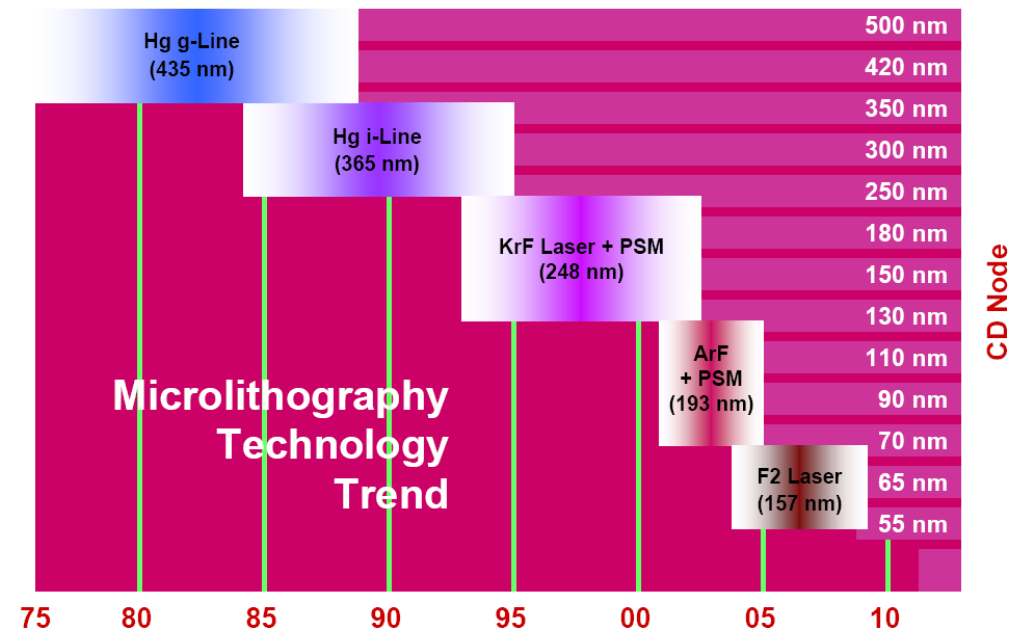
Richard P. Feynman, December 1959

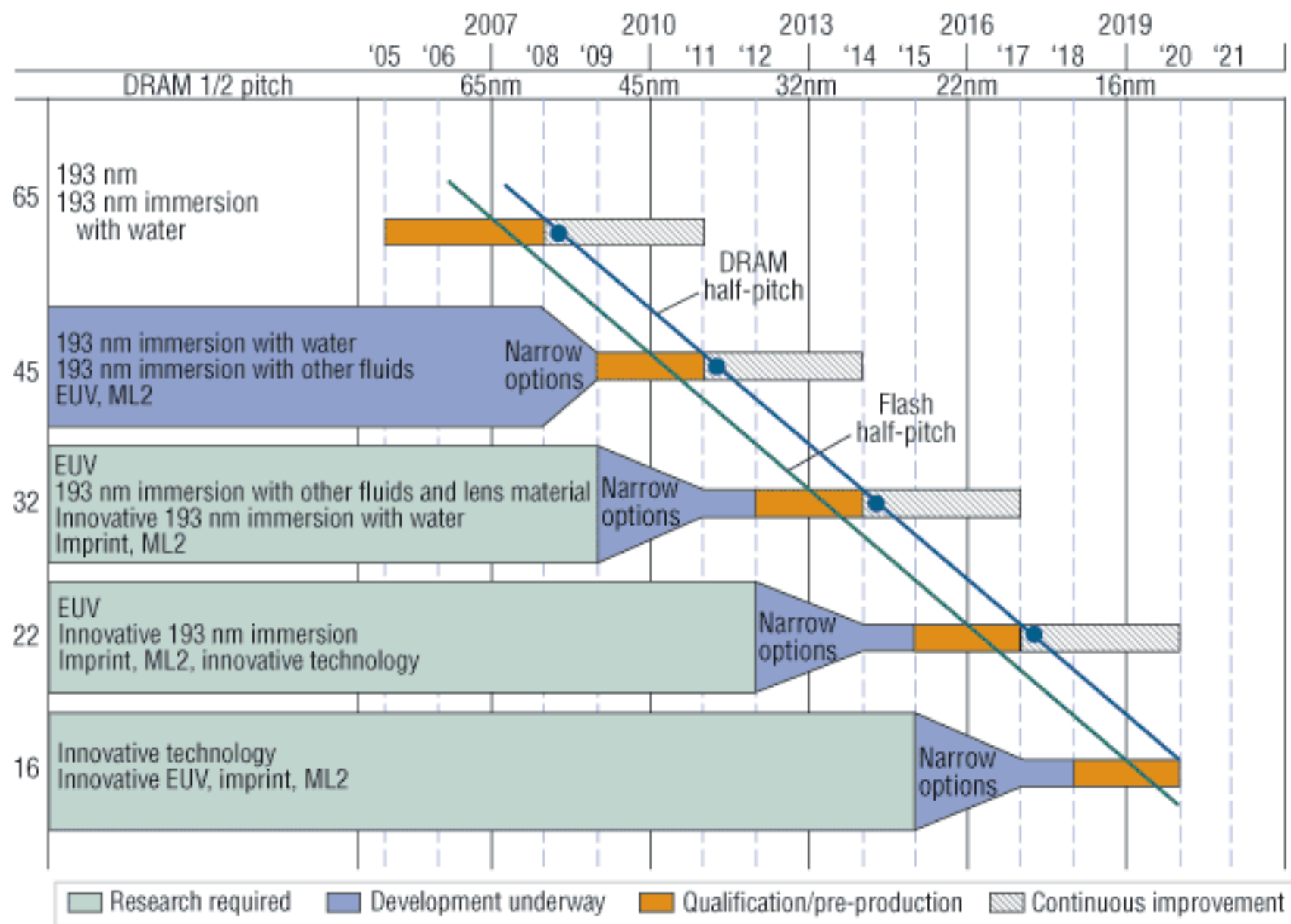
How do we *write* it? We have no standard technique to do this now. But let me argue that it is not as difficult as it first appears to be. We can **reverse the lenses of the electron microscope** in order to demagnify as well as magnify. A source of **ions**, sent through the microscope lenses in reverse, could be focused to a very small spot. We could write with that spot like we write in a TV cathode ray oscilloscope, by going across in lines, and having an adjustment which determines the amount of material which is going to be deposited as we scan in lines. **This method might be very slow** because of space charge limitations. There will be more rapid methods. We could first make, perhaps by some **photo process**, a screen which has holes in it in the form of the letters. Then we would strike an arc behind the holes and draw metallic ions through the holes; then we could again use our system of lenses and make a small image in the form of ions, which would deposit the metal on the pin.

Nanotechnology

- Top-Down Approach
 - Lithographic, Manipulation, Industrial process
- Bottom-Up
 - Self-assembly, natural process

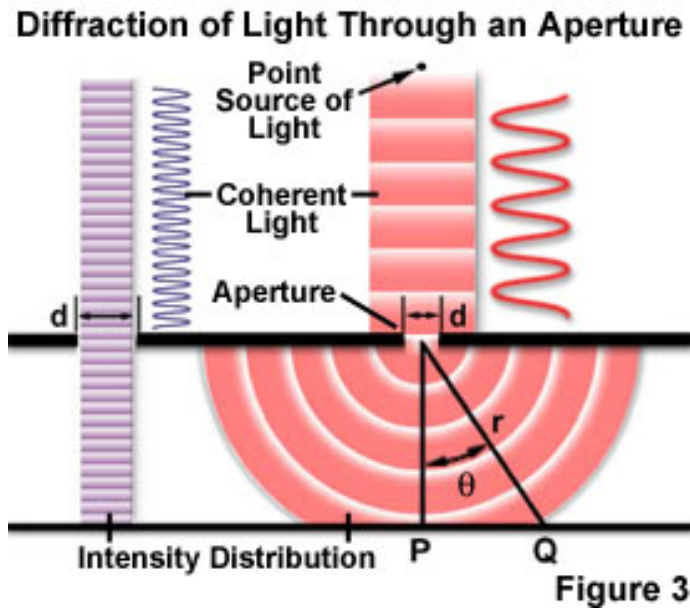
Photolithography



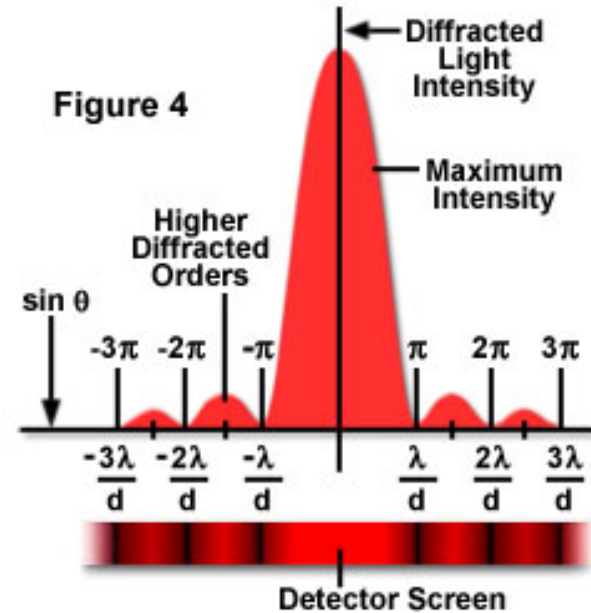


This legend indicates the time during which research, development, and qualification/pre-production should be taking place for the solution.

Limit of Photolithography

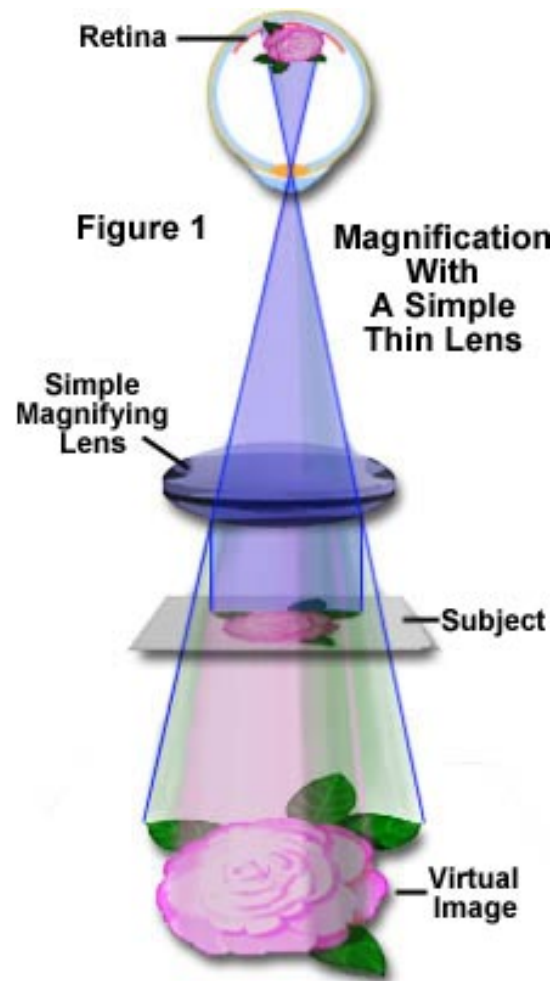


Intensity Distribution of Diffracted Light

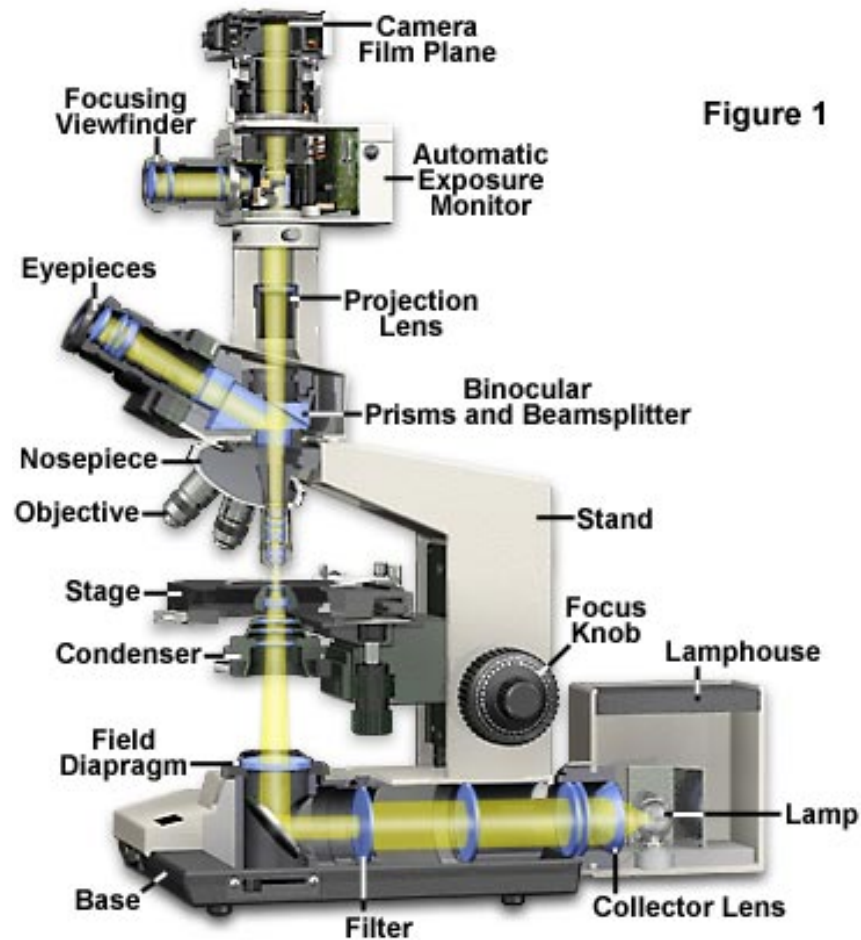


$$r = 1.22 \times \lambda / (2 \times \text{N.A.})$$
$$\text{N.A.} = n \times \sin(\theta)$$

Optical Microscope



Modern Microscope Component Configuration





The Nobel Prize in Chemistry 2014



Photo: Matt Staley/HHMI

Eric Betzig

Prize share: 1/3



© Bernd Schuller, Max-Planck-Institut

Stefan W. Hell

Prize share: 1/3



Photo: K. Lowder via Wikimedia Commons, CC-BY-SA-3.0

William E. Moerner

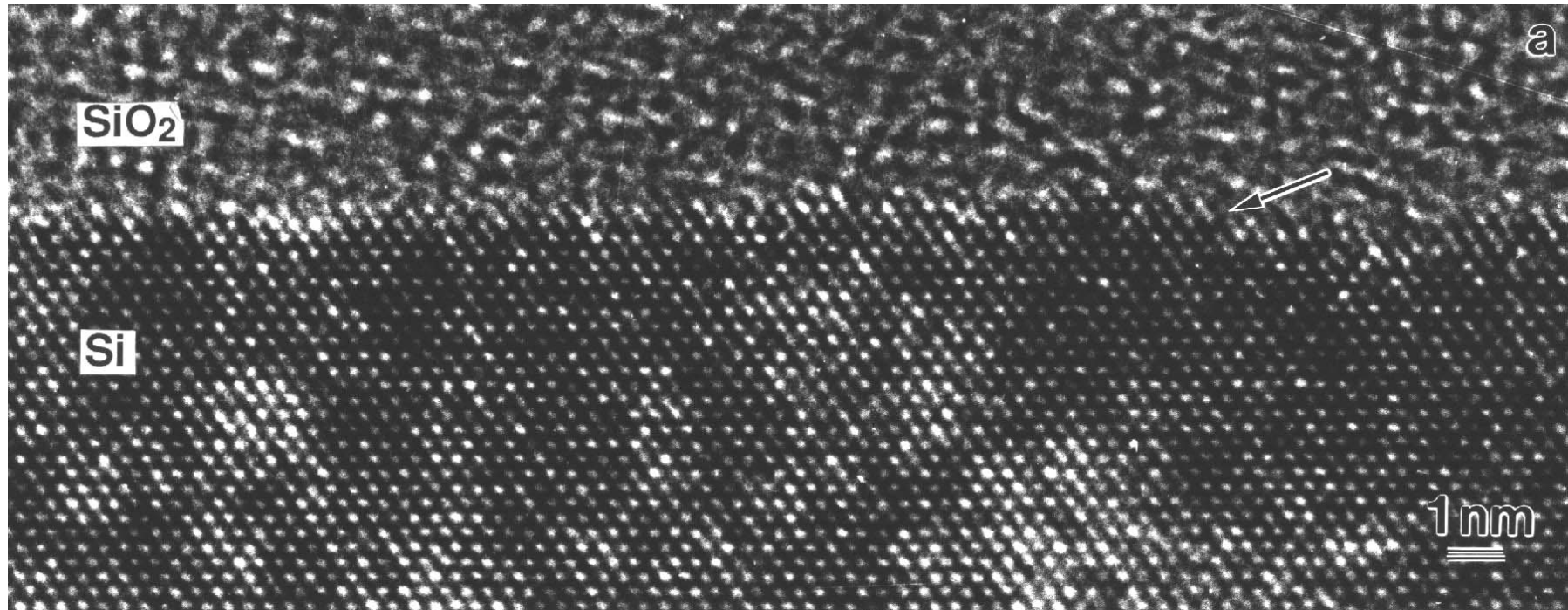
Prize share: 1/3

The Nobel Prize in Chemistry 2014 was awarded jointly to Eric Betzig, Stefan W. Hell and William E. Moerner "*for the development of super-resolved fluorescence microscopy*".

Two separate principles are rewarded. One enables the method *stimulated emission depletion (STED) microscopy*, developed by Stefan Hell in 2000.

Eric Betzig and William Moerner, working separately, laid the foundation for the second method, *single-molecule microscopy*.

TEM Image



100 kV = 0.00388 nm

$$\lambda = h/p = h/mv \quad h / \sqrt{2 \text{ meV}}$$

What is nanobiotechnology

- Nano + Bio
- Nano-fabrication => nanopatterning, NEMs
- Nano-manipulation => optical, electrical, acoustic, thermal, magnetic, mechanical
- Nanomaterials => Q-dots, SERS, Plasmon, Magnetic
- Nano-imaging => SPM, optical tool, EM

What is nanobiotechnology

- Bio + nano
- DNA assembly
- Cell factory
- Molecular motor
- Energy

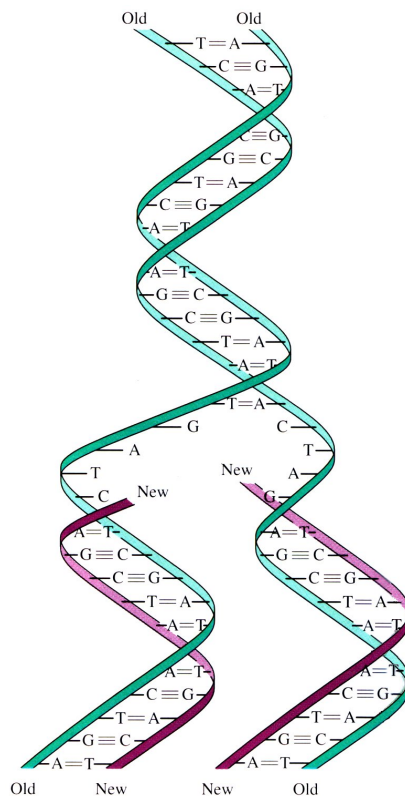
Building Block

- Log, Brick
- High energy physicist –quark
- Physicist-proton, neutron, electron
- →periodic table
- Chemist- molecule
- Biologist- cells

How to assemble them

- Thermodynamic
- Chemical bond
- Hydrogen bond
- Electrostatic
- Van der Waals interaction
- Other interactions

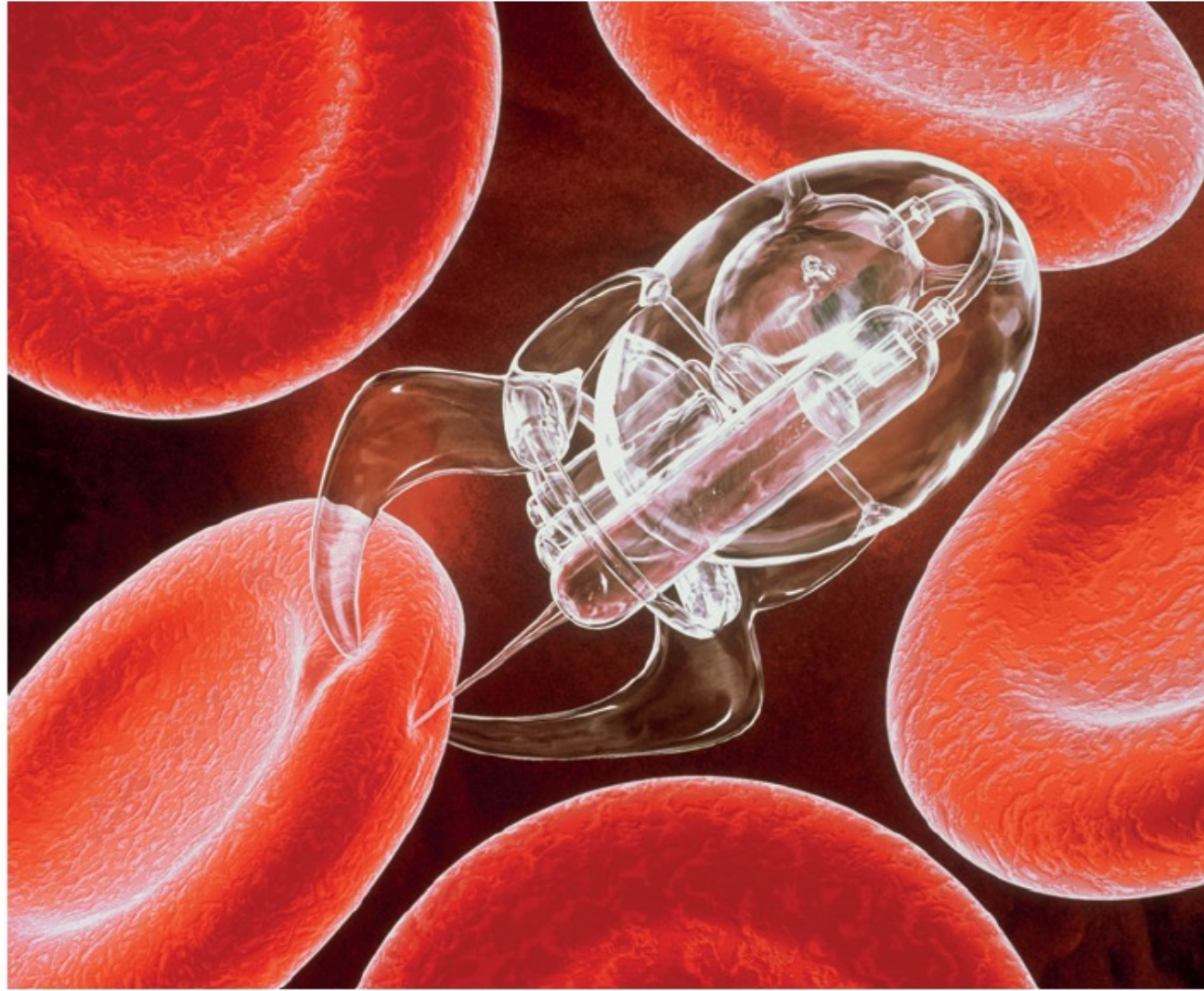
Self-Assembly Process in Nature



5' [cap AUGAGAUACCAAGAACCUACCAAGGUAGAGCUUUAGCCCG AAAAAAAAAAAAAA] 3'

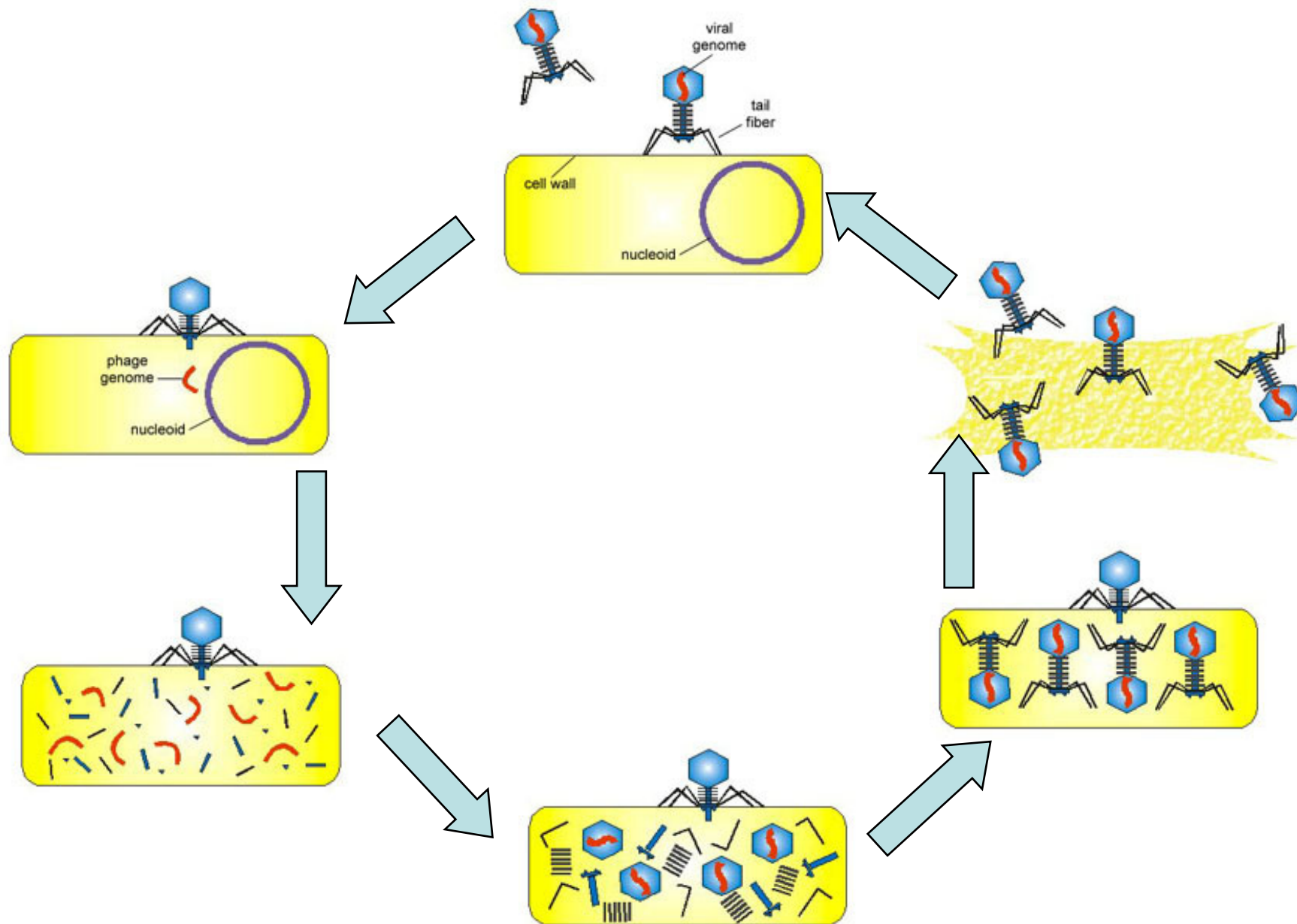
Nanomedicine

Nanobots



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Virus Infection



Topics

Fundamental Knowledge and Current Literatures

- Analytical Chemistry
 - Spectroscopic tools
 - Microarray
 - Cell-surface interaction
 - Ultrasensitive detection
- Physical Chemistry
 - Single molecular behavior (Optical and AFM)
 - Optical properties of Q-dot
 - SERS
 - Surface plasmon
- Material Chemistry:
 - Nanomaterials: Q-dot, nanoparticle, DNA assembly
 - Surface functionalization
 - Drug delivery
 - DNA, Protein, Cell interactions
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