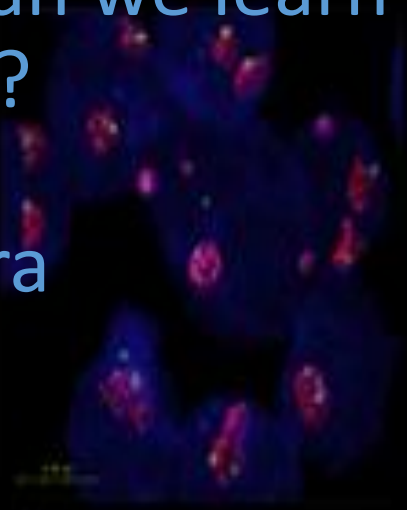
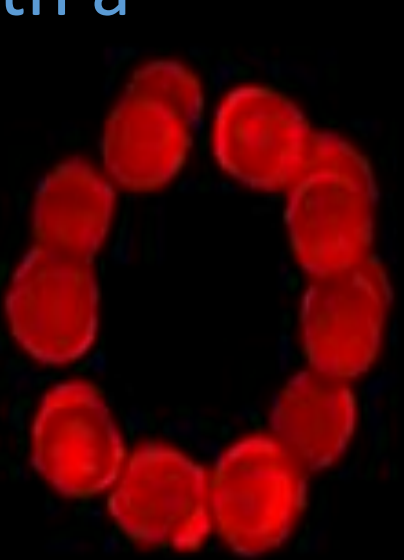
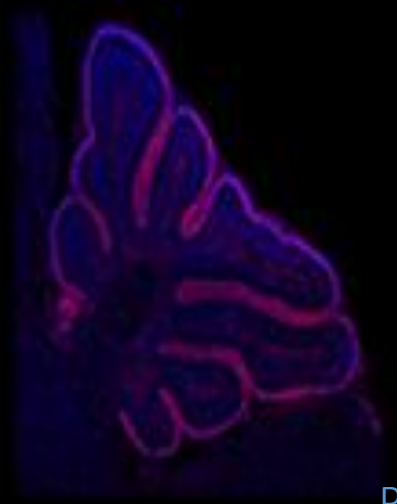
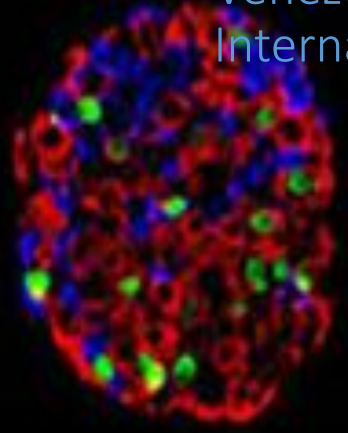
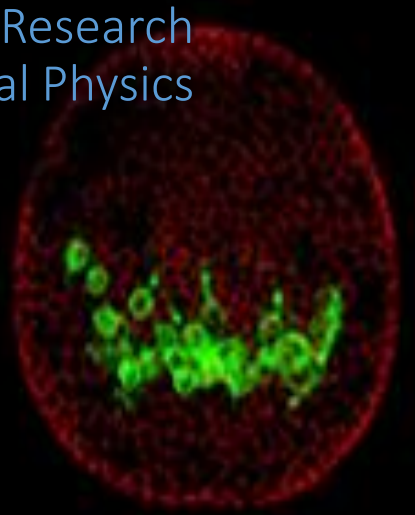
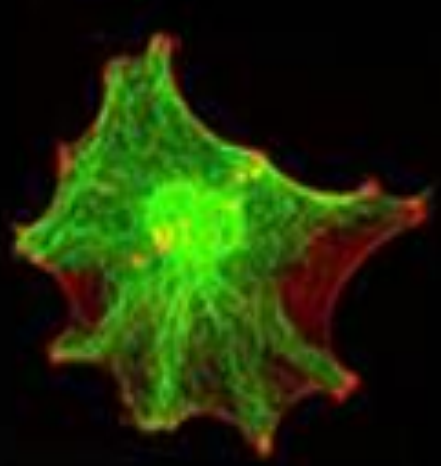
The history of microscopy, what can we learn with a light microscope?

Humberto Cabrera

Venezuelan Institute for Scientific Research
International Centre for Theoretical Physics



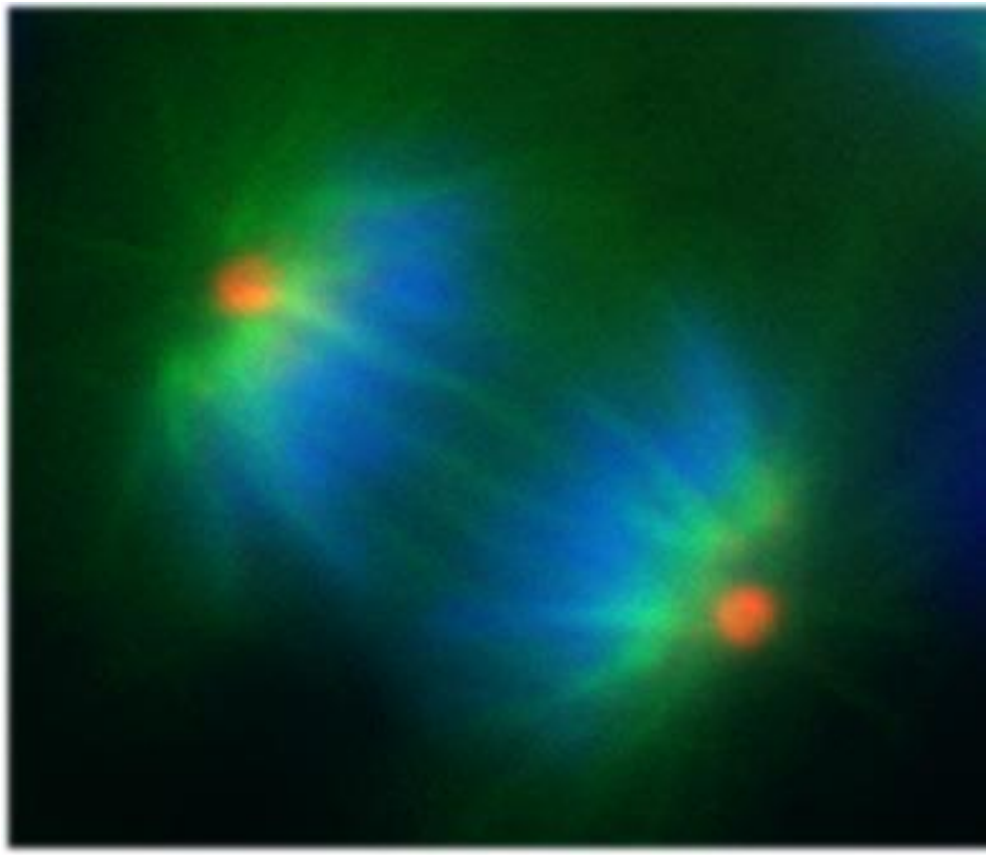



Preparatory School to the Winter College on Optics: Advanced Optical Techniques for Bio-imaging

Microscopy is often what first captivates kids with science

What the Telescope has done for studies of the universe

The microscope has done for biology



S2 cell anaphase

Microscopes allow us to explore beautiful worlds

Stephen J Smith - http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2693015/

Assorted Still and Video Micrographs

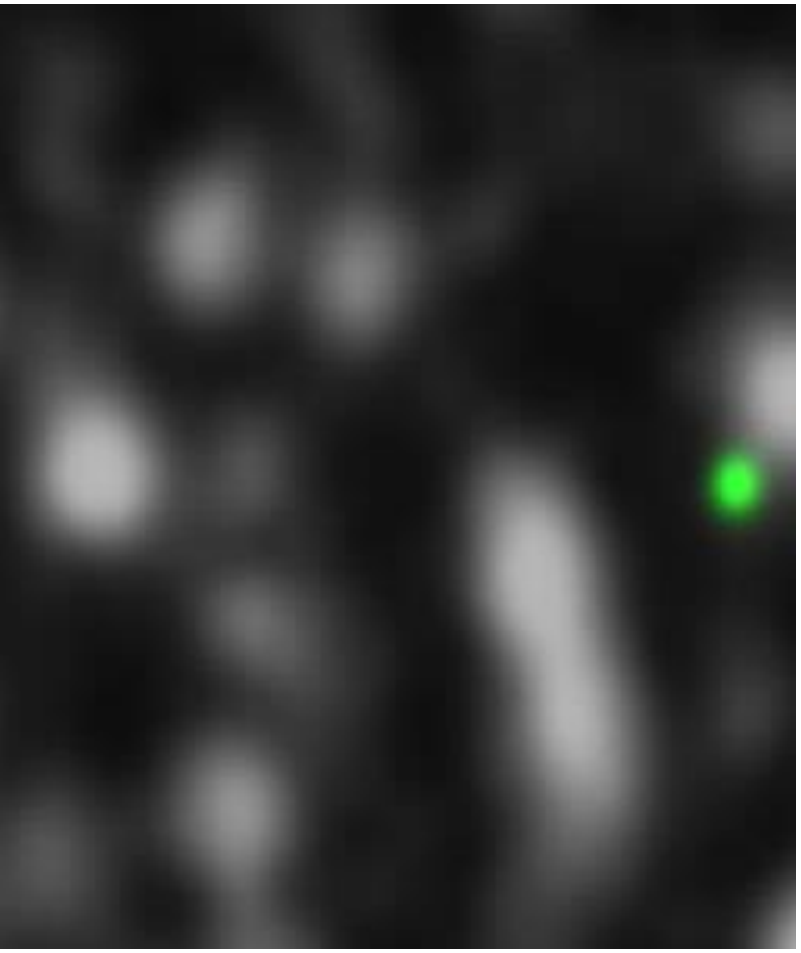
by

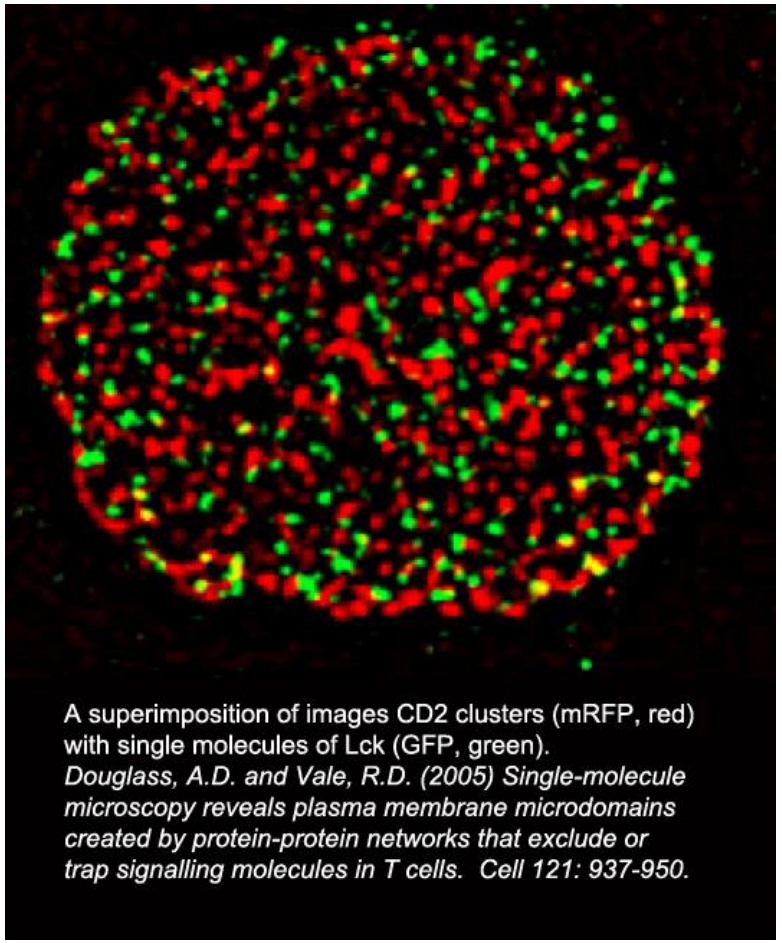
Craig A. Smith

2012

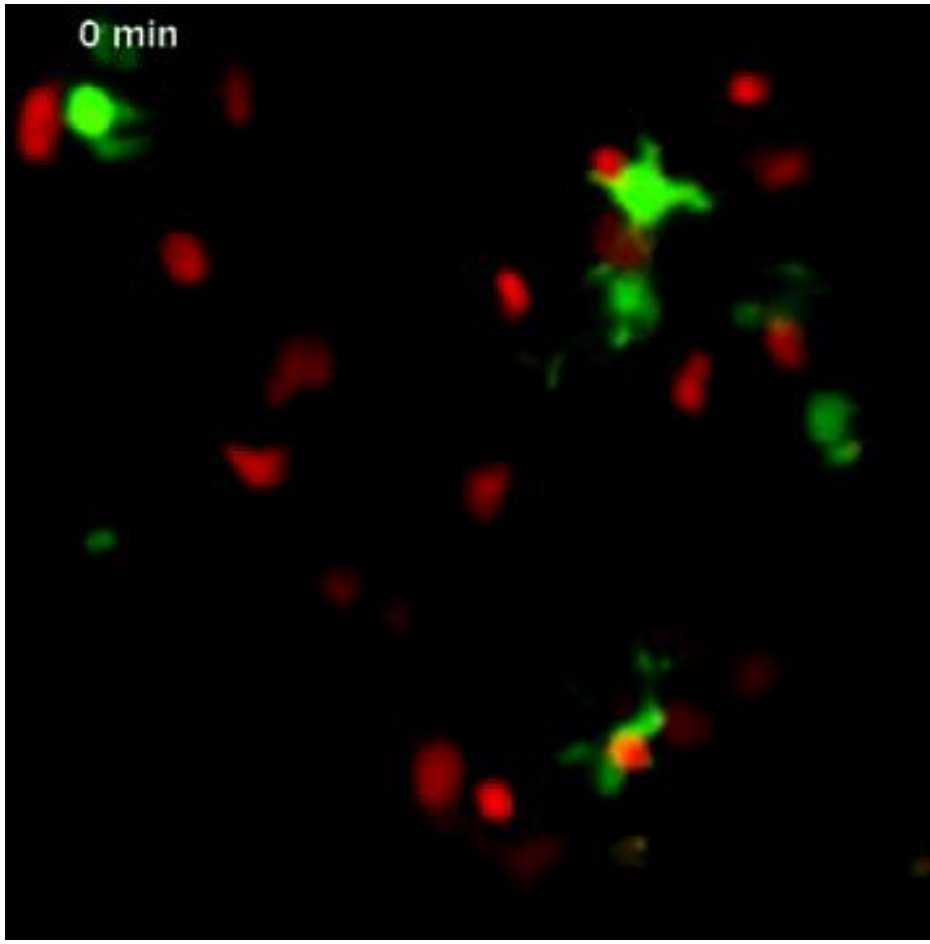
“You can observe a lot just by watching”
Yogy Berra

Microscopes reveal the dynamics of biological systems



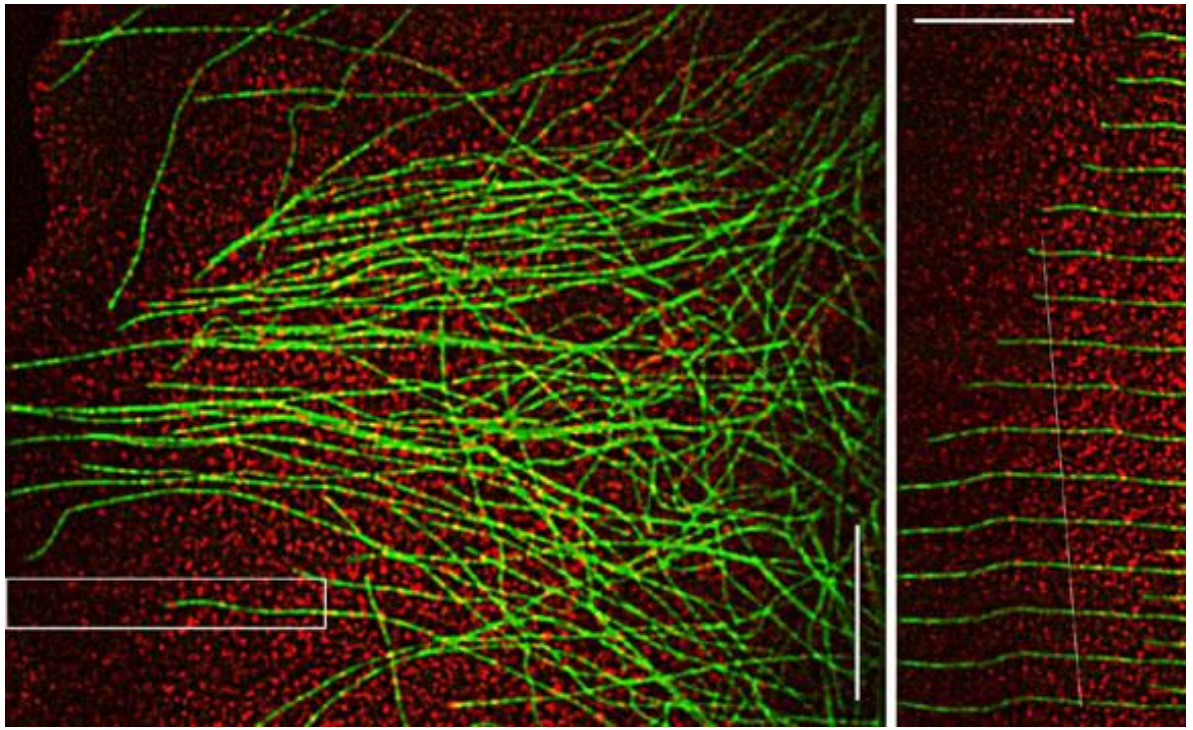


A superimposition of images CD2 clusters (mRFP, red) with single molecules of Lck (GFP, green).
Douglass, A.D. and Vale, R.D. (2005) Single-molecule microscopy reveals plasma membrane microdomains created by protein-protein networks that exclude or trap signalling molecules in T cells. Cell 121: 937-950.



Immune cells in a lymph node
Philipe Bousso

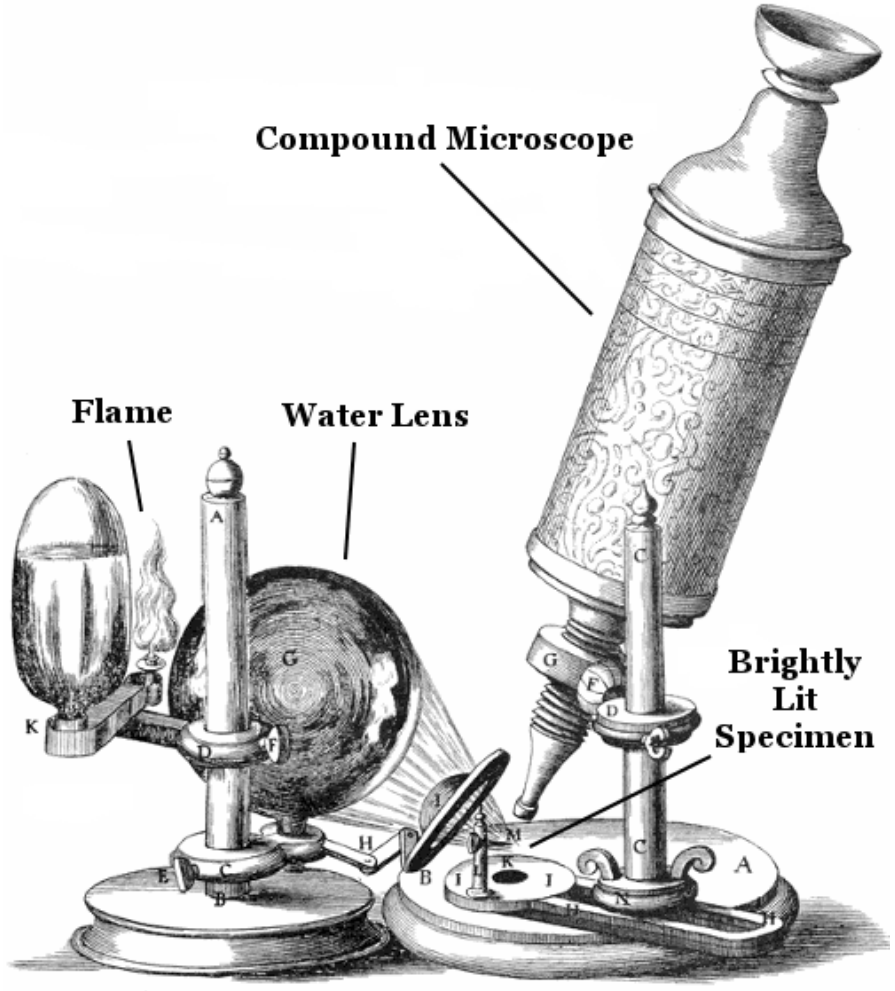
Microscopes reveal the dynamics of biological systems

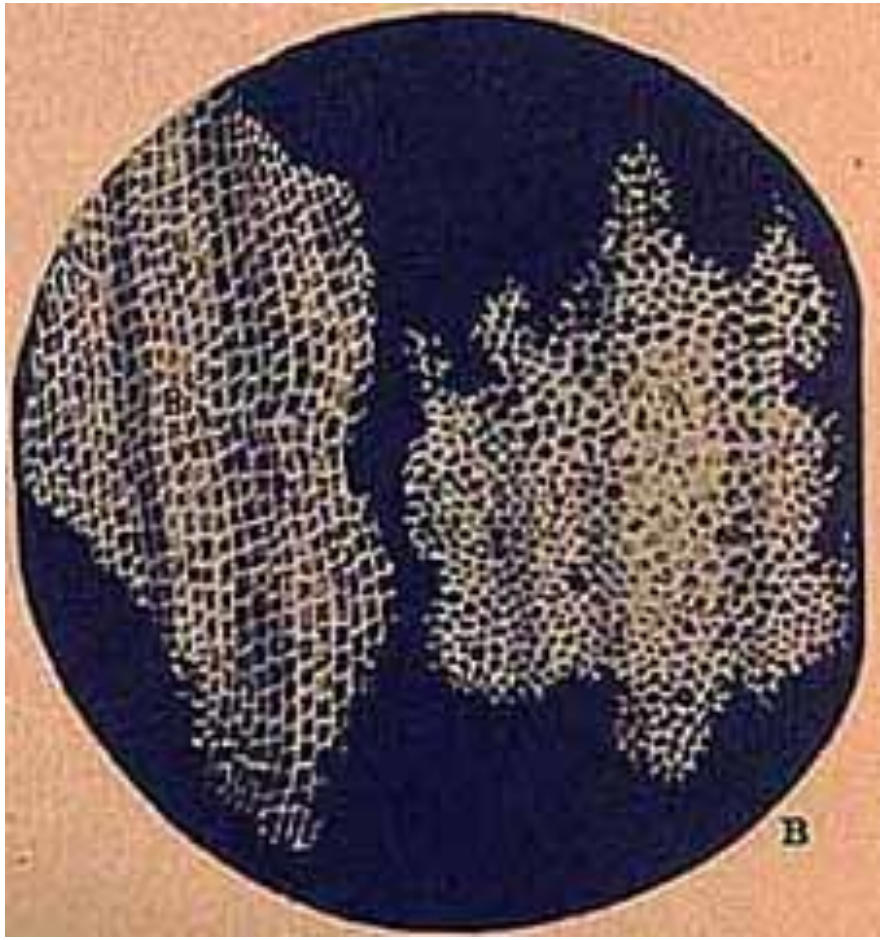


Microtubules and F-actin, newt lung epithelial cell
C. Waterman-Storer

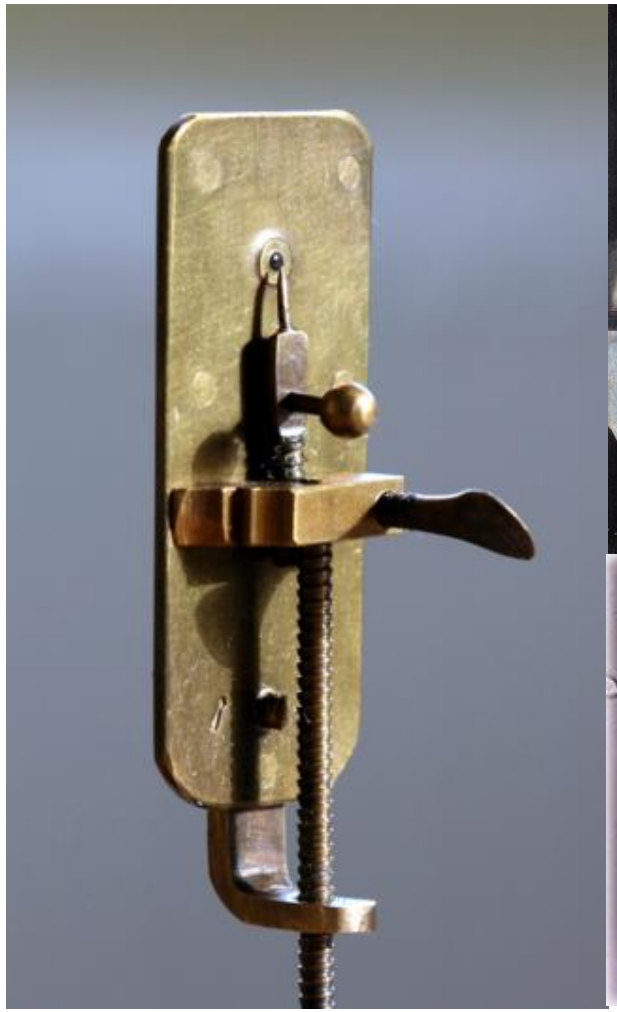
Drosophila embryo mitosis
D. Sharp

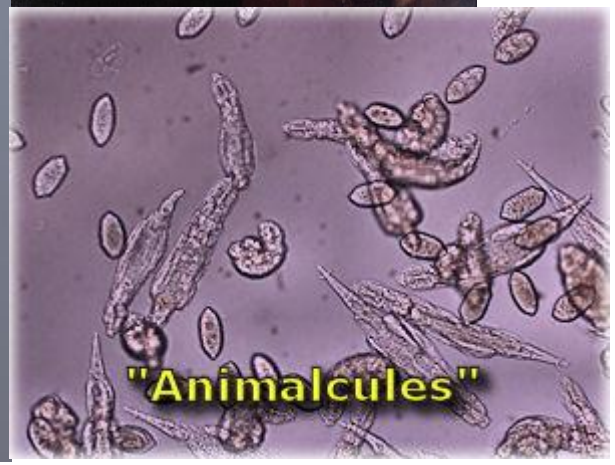
Robert Hooke´s cell from cork 1665

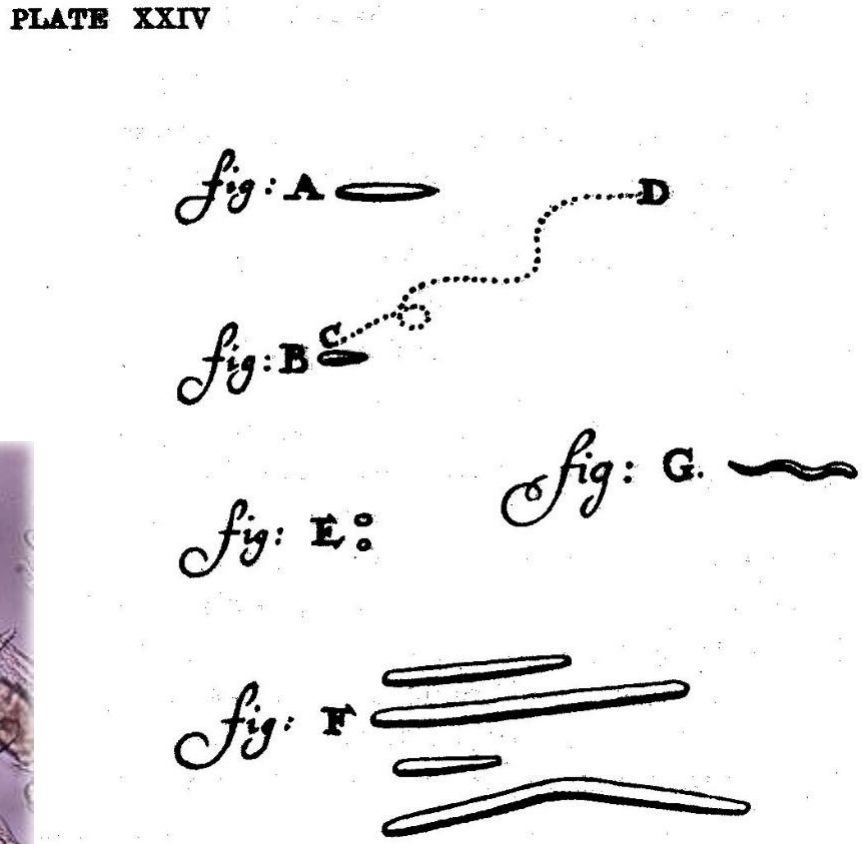




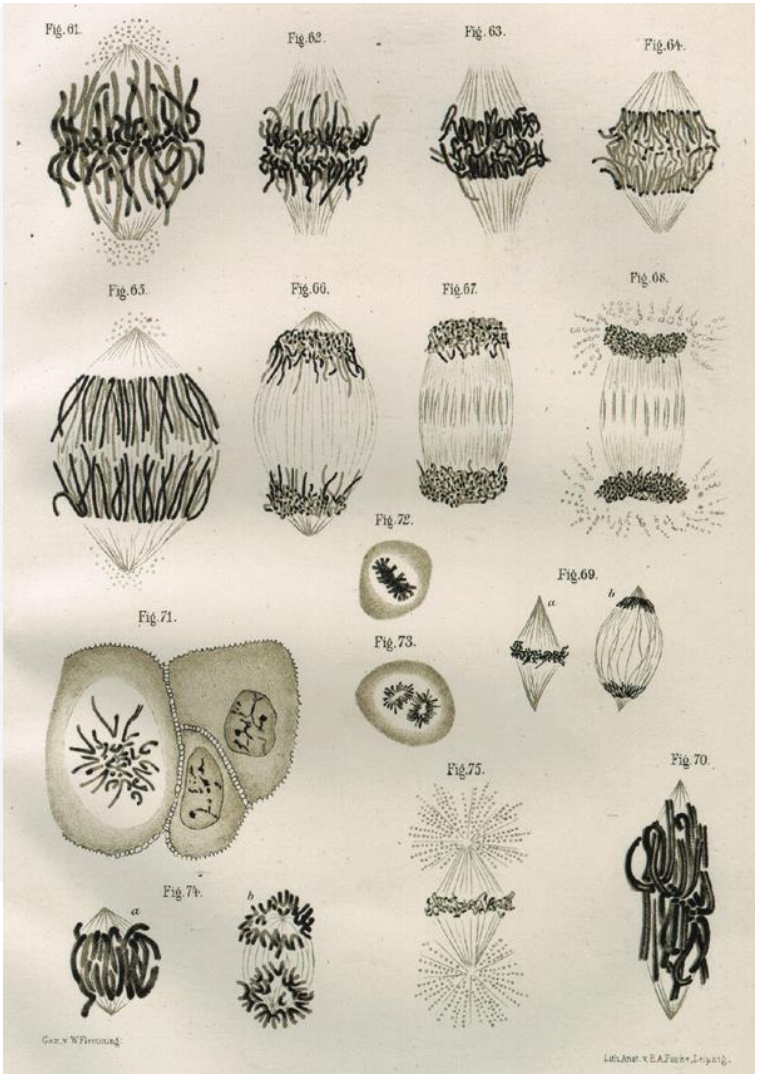
Anton van Leeuwenhoek´s “Animalcules”, 1676



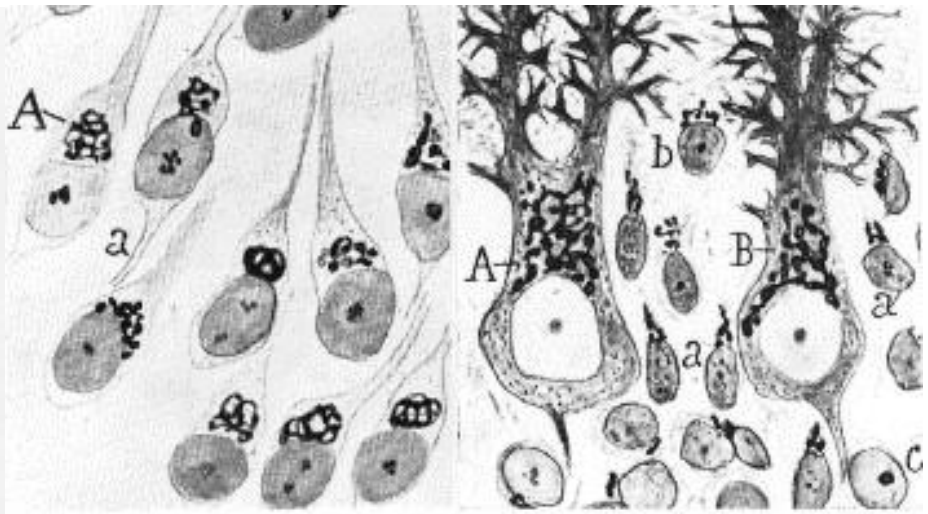


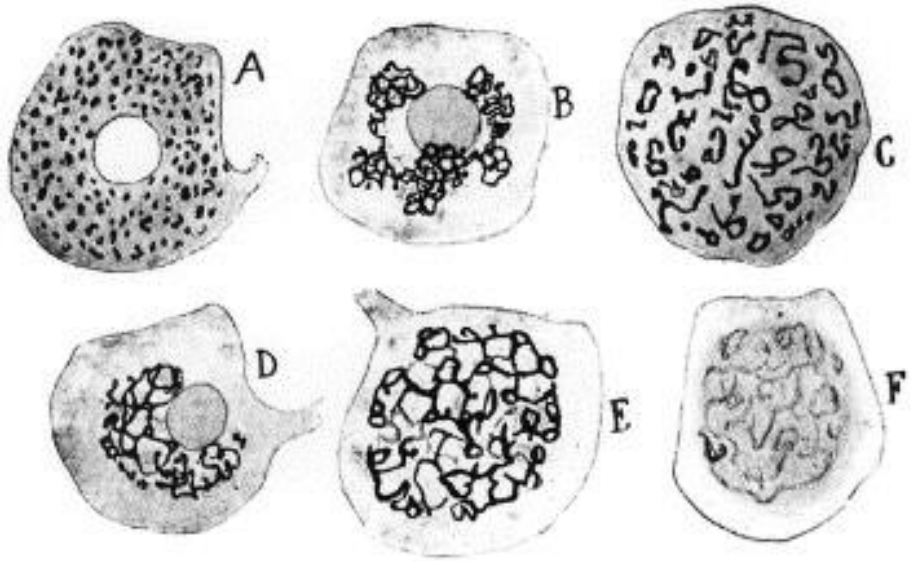


Walther Flemming pioneer of mitosis, 1878

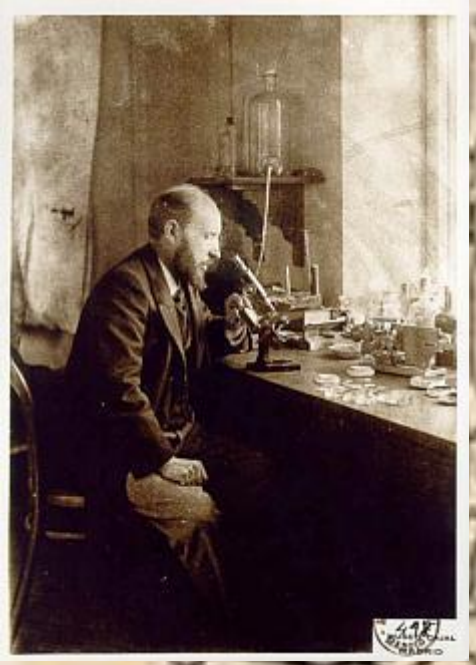


Camillo Golgi´s silver staining of internal membranes (Golgi apparatus), 1898





Ramon y Cajals´cerebellar neurons, 1905



Shinya Inoue turns to live cell imaging

Mitosis in pollen mother cells from easter lilly 1951

Hugh Huxley´s and Andrew Huxley´s studies of muscle contraction

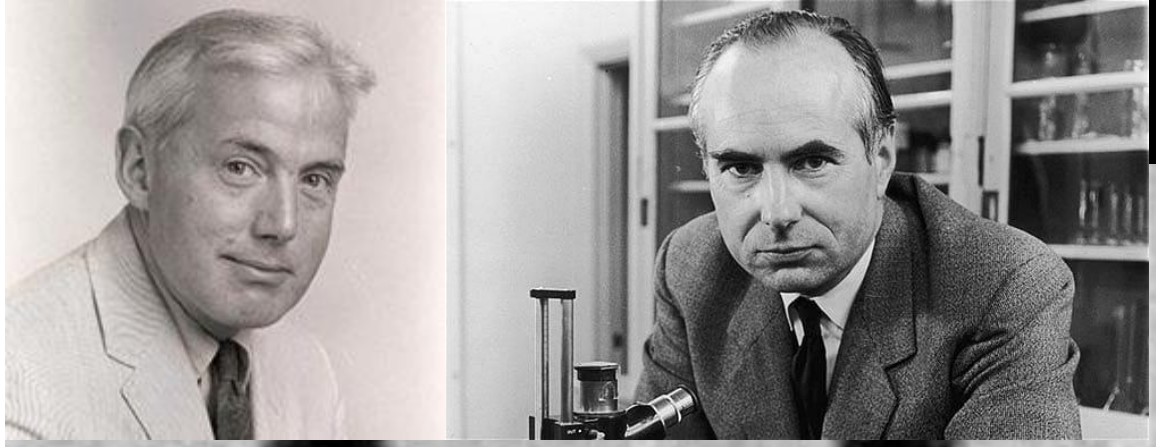
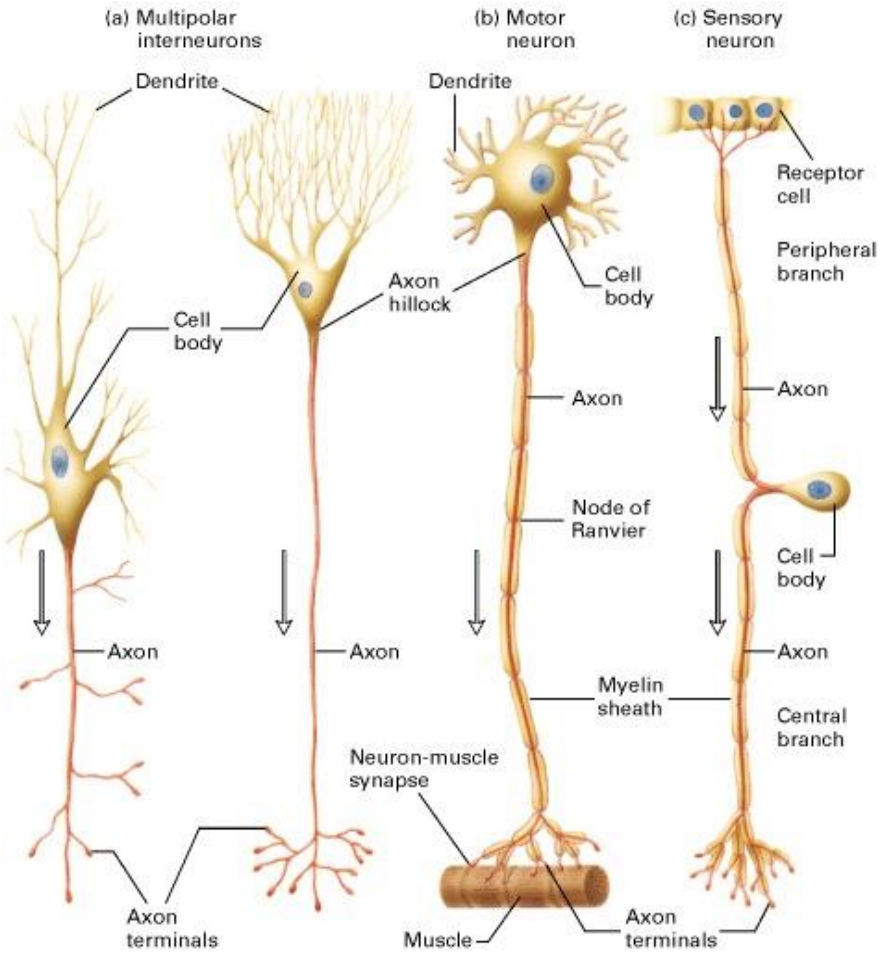
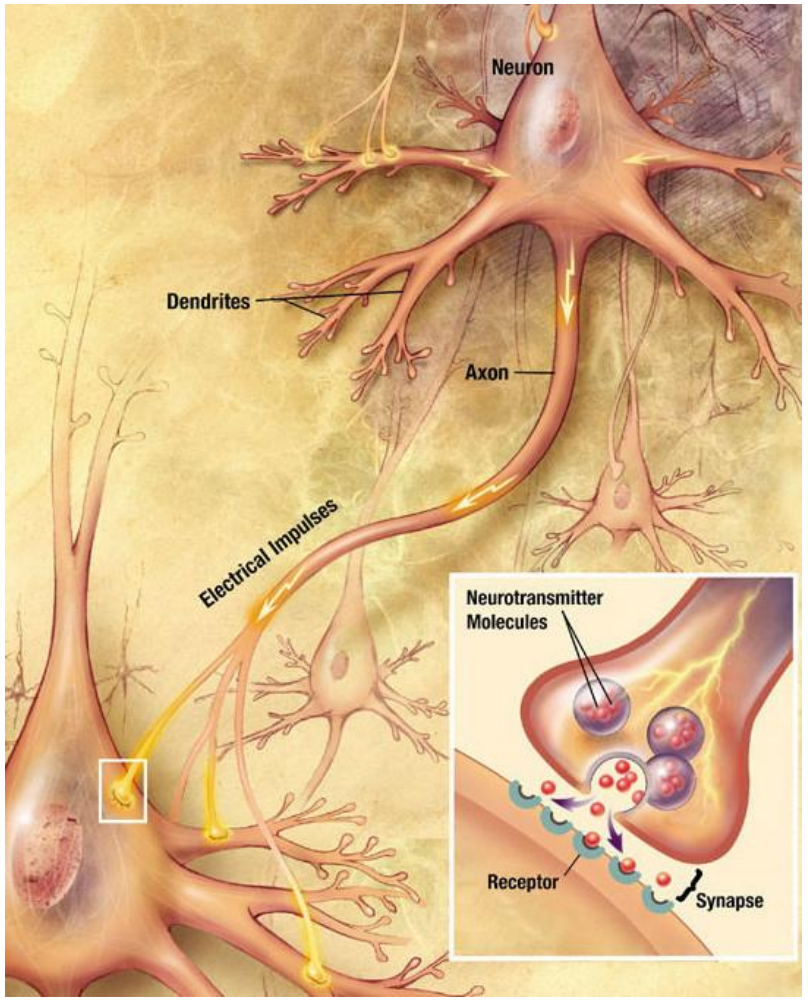


Figure from H. Huxley and J. Hanson, Nature 1954

How are proteins and membranes transported in nerve cells?





In 1960-70s, axonal trasport was studied primarily by following the movement of radioactively labelled proteins

A revolution in microscopy at the Marine Biological Laboratory: the birth of video microscopy

Robert Day Allen
(1927-1986)

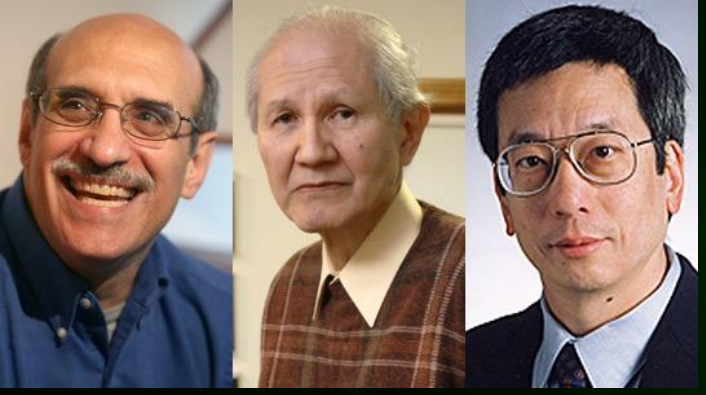
Shinya Inoué
(1921-Present)

Video-DIC microscopy of squid giant axon, Allen, Brady Lasek, 1982

Watching biochemistry in action

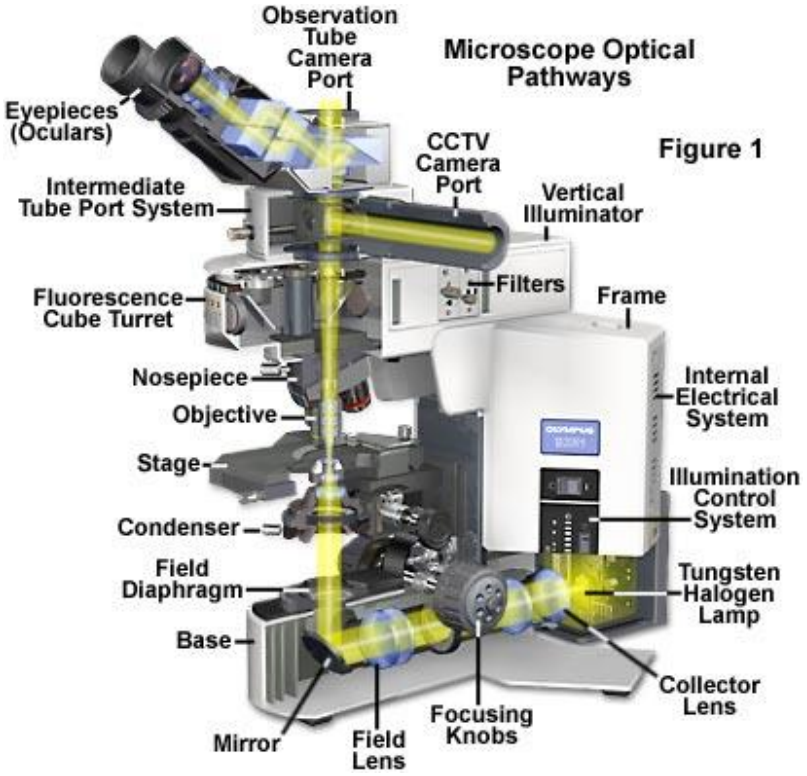
Purified kinesin moving artificial beads along microtubules, 1984 (Ron Vale) https://valelab.ucsf.edu/

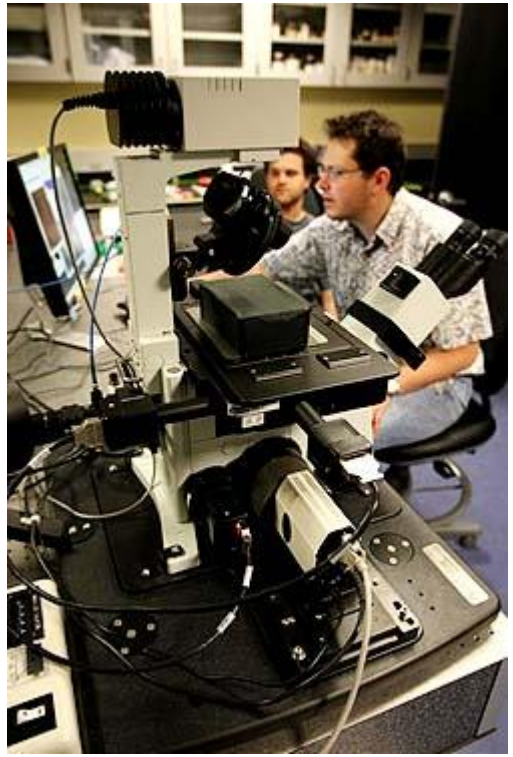
Fluorescent Proteins Start a New Revival in Microscopy

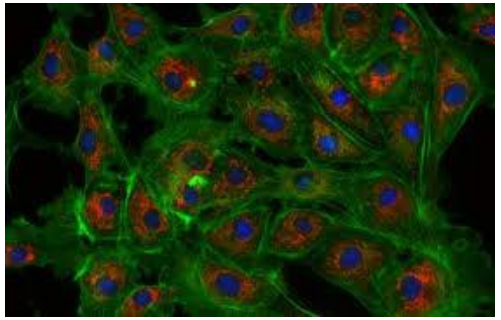


Shalfie, Shimomura and Tsien
Nobel prize in 2008

Microscopy is constantly advancing



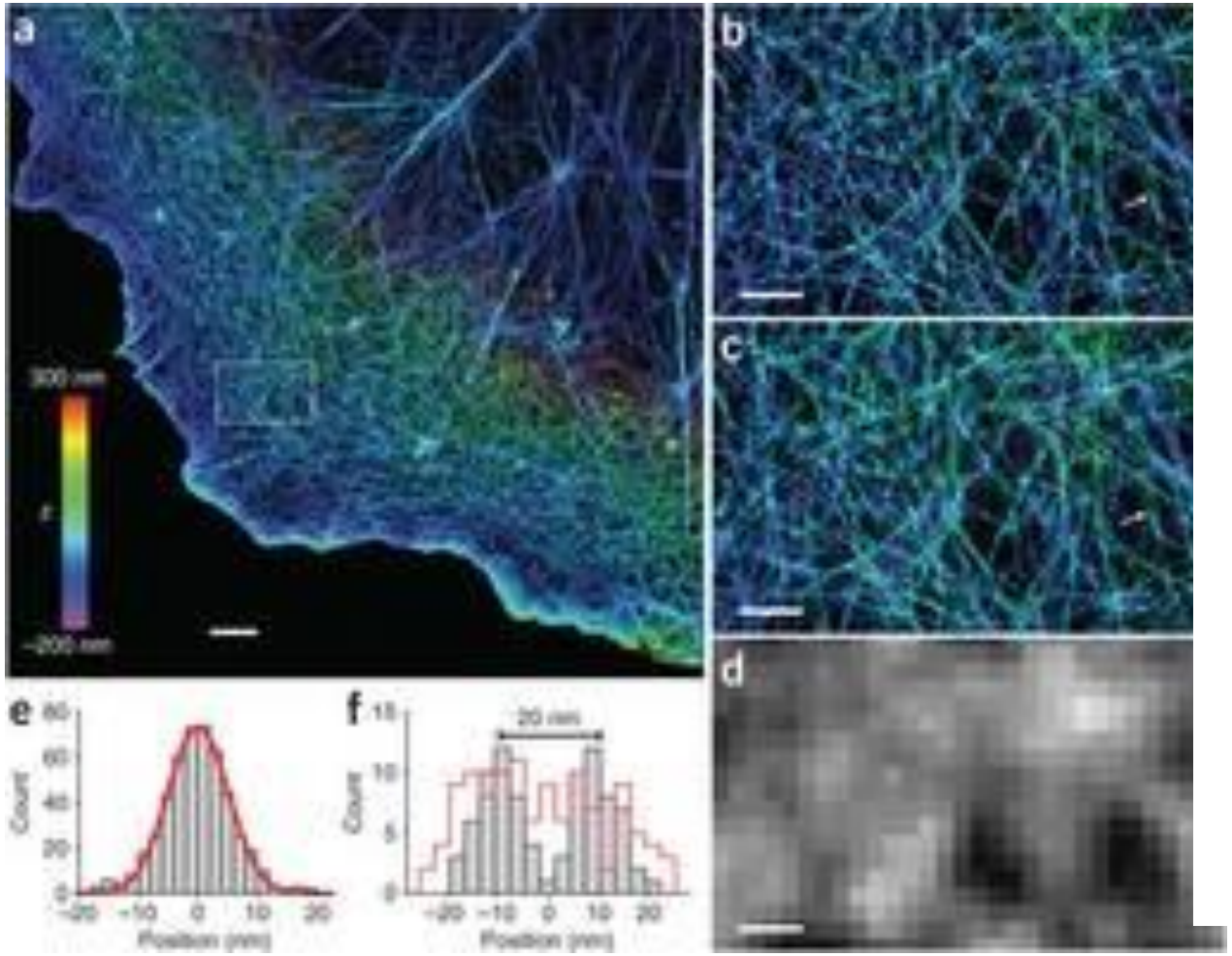


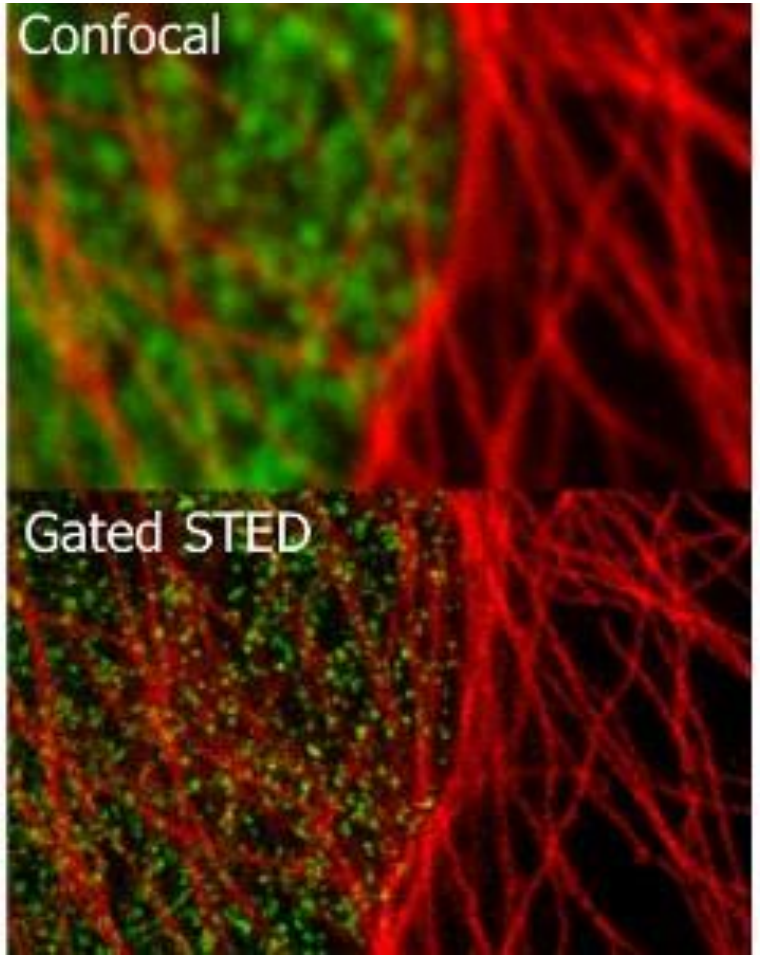


Resolution Limits of Light

Ernst Abbe
(1840-1905)

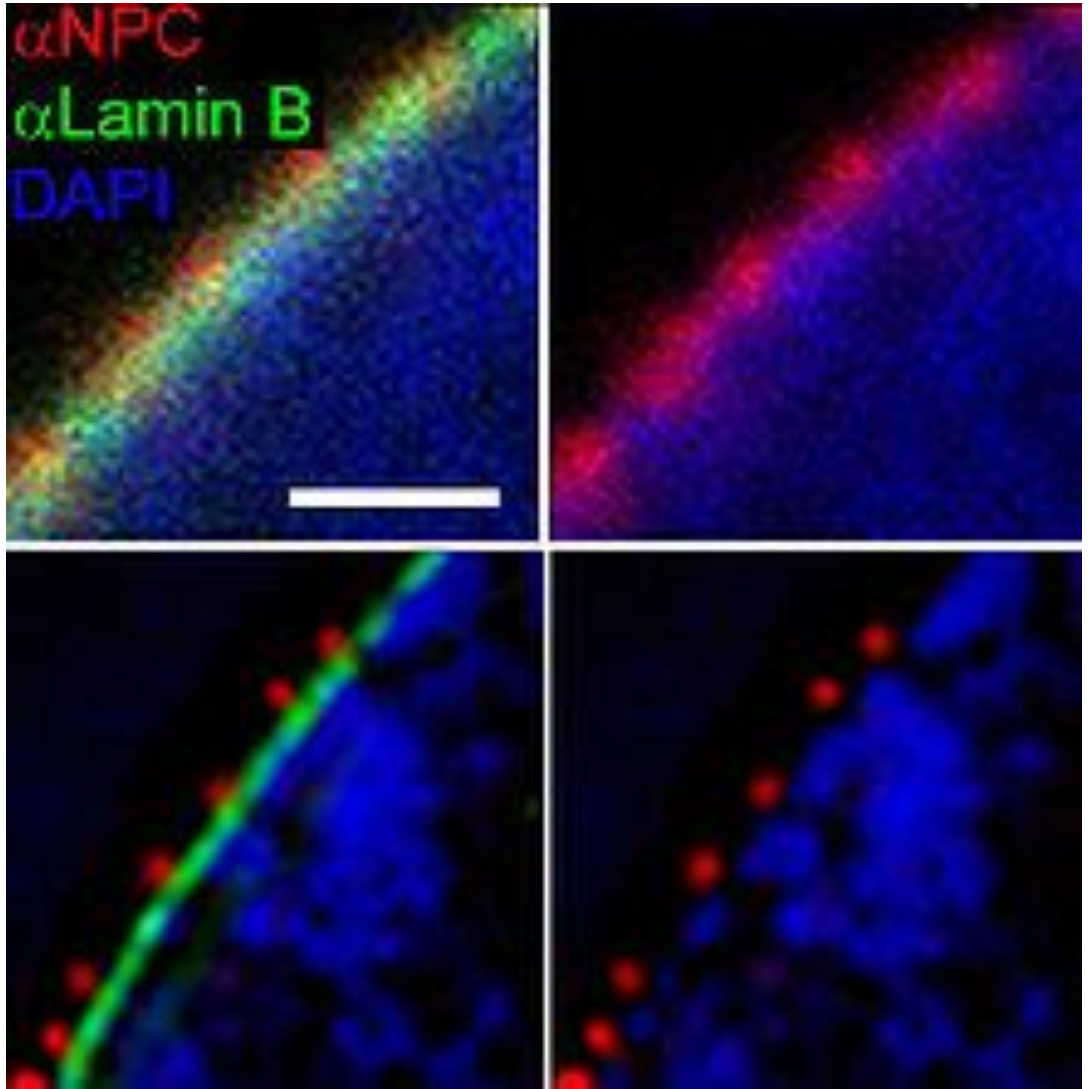
Breaking Resolution Barriers
Super-resolution Microscopy





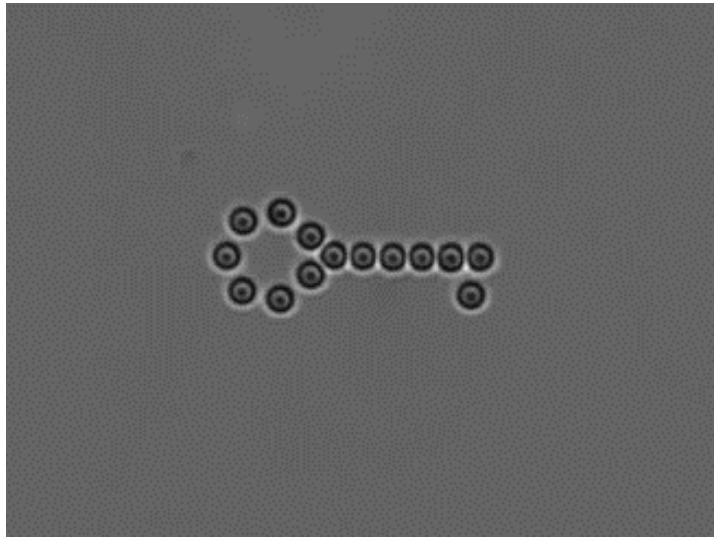
Xu K, Babcock HP, Zhuang X, Nature Methods 2012

Breaking Resolution Barriers
Super-resolution Microscopy

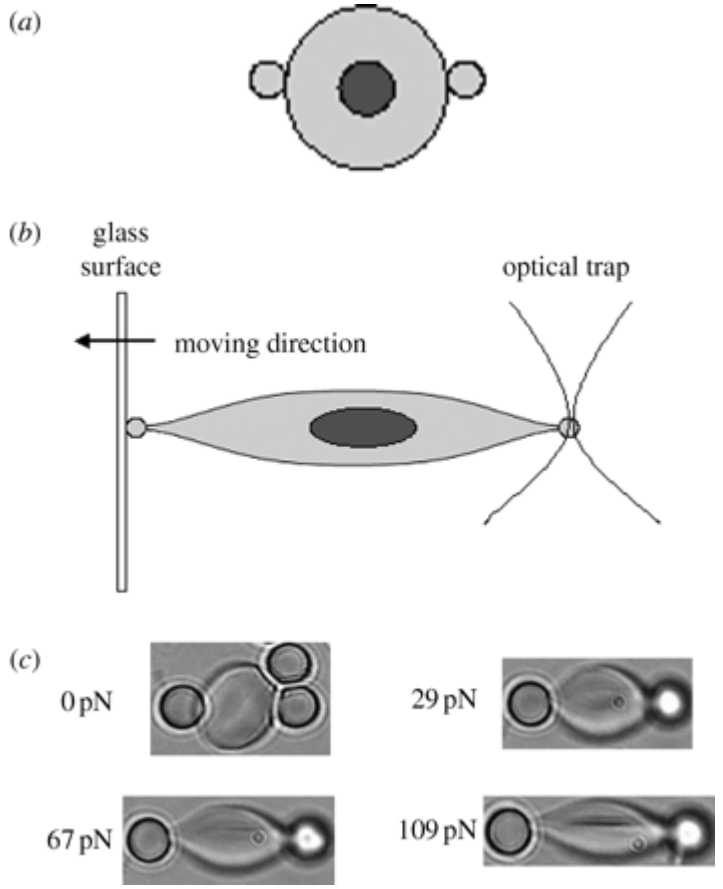


Comparison of the resolution obtained by confocal laser scanning microscopy (top) and 3D structured illumination microscopy (3D-SIM-Microscopy, bottom). Shown are details of a nuclear envelope. Nuclear pores (anti-NPC) red, nuclear envelope (anti-Lamin) green, chromatin (DAPI-staining) blue. Scale bar: 1µm

Manipulations of objects, molecules and cells with light



Dance of beads

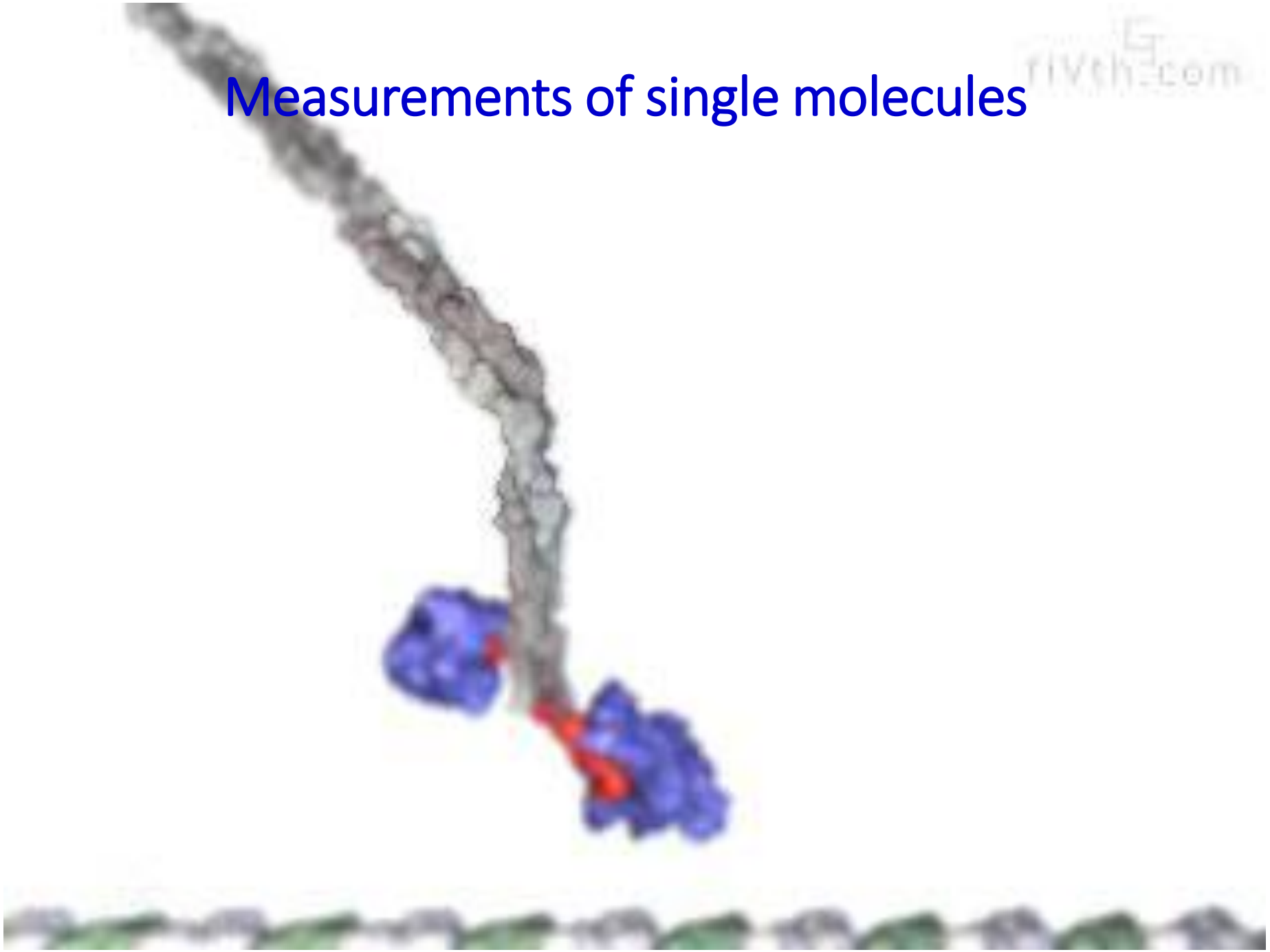


Stretching RBCs by optical tweezers. (*a*) Two diametrically opposed silica beads of 4.1 µm are attached onto an RBC surface. (*b*) One bead is trapped by optical tweezers while the other is fixed onto a glass surface. Deformation is achieved by moving the glass surface to the opposite direction. (*c*) Large deformations of RBCs in phosphate buffer saline solution at room temperature are captured by optical micrographs under different trapping forces

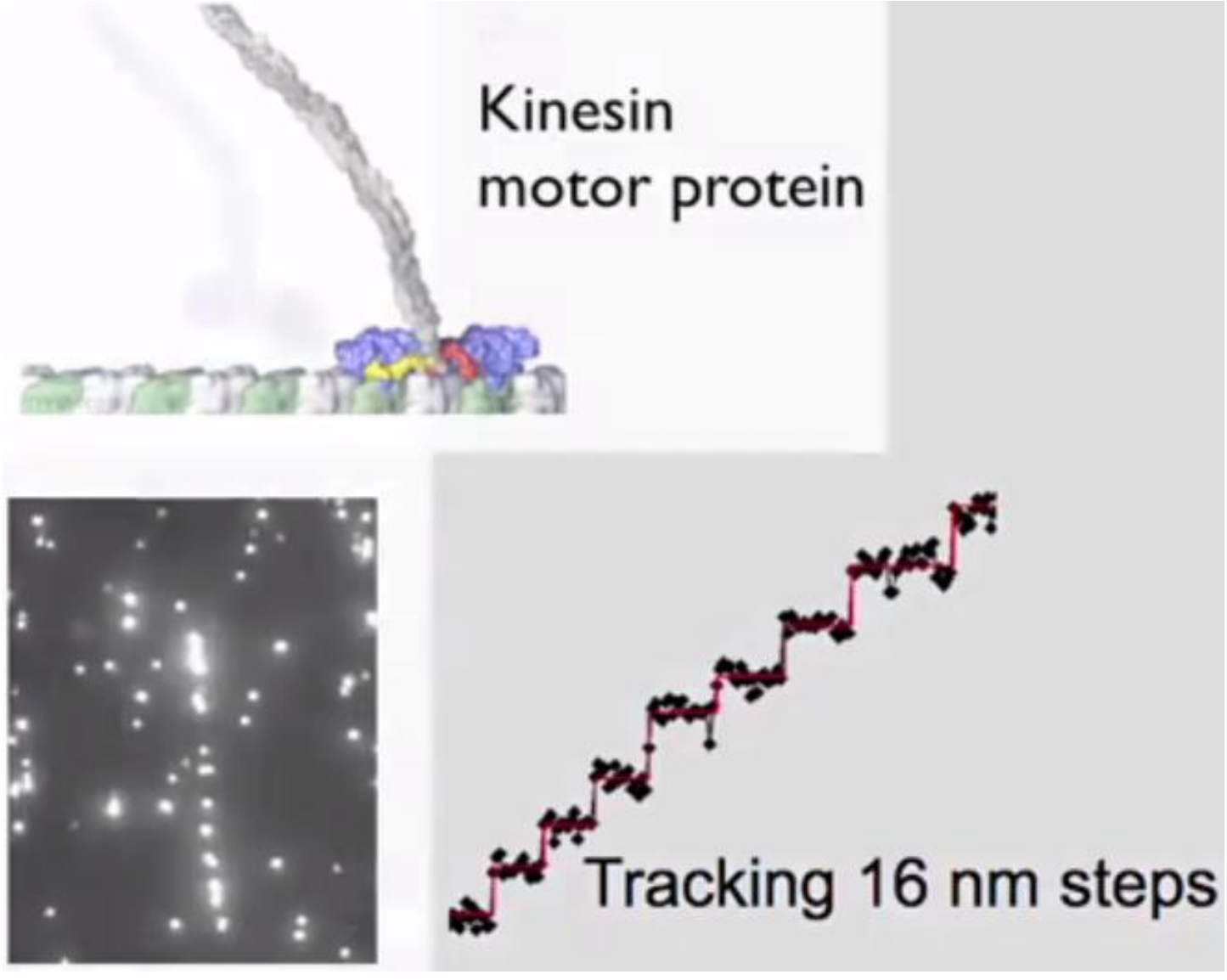
H. Zhang and K Liu, J. R. Soc. Interface (2008) 5, 671–690

Microscopy is making breakthroughs at all scale of biology

Measurements of single molecules



Measurements of single molecules



We acknowledge Profesor Ron Vale for the material used during the preparation of the lecture

https://valelab.ucsf.edu/

https://www.ibiology.org/ibioeducation/taking-courses/ibiology-microscopy-course.html

Thanks