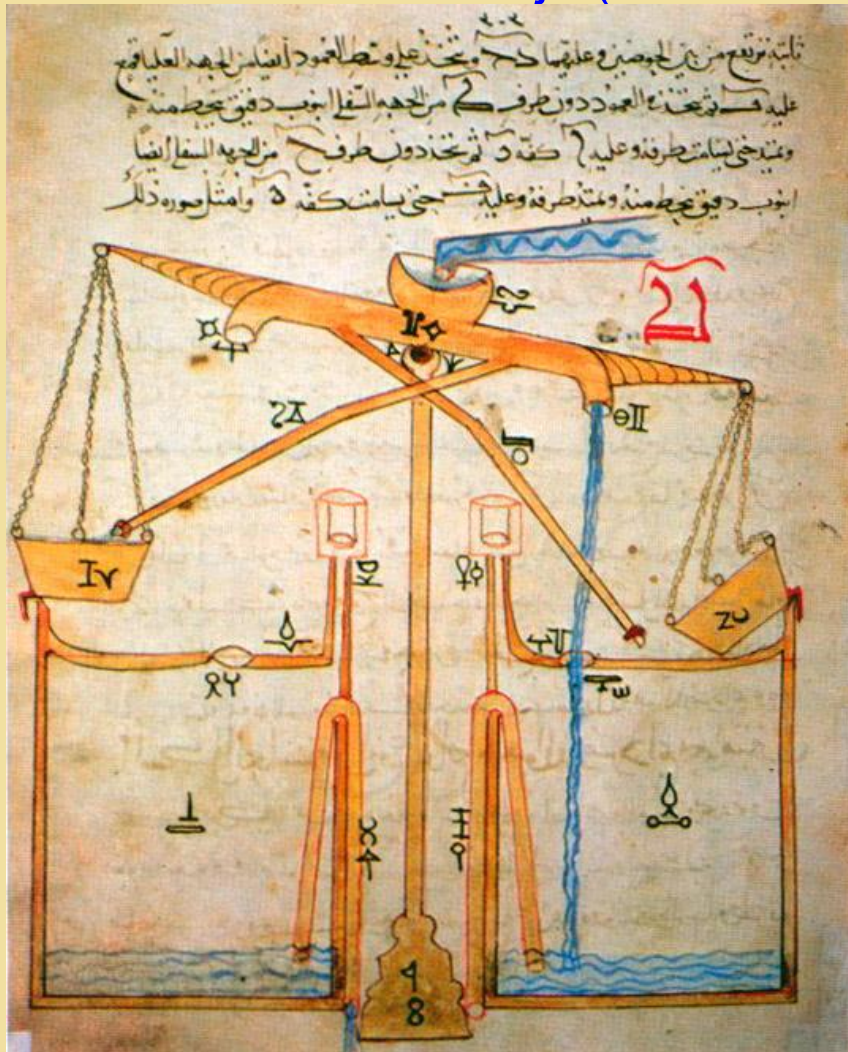


***Molekulární motory:
neuvěřitelně malé
a fantasticky
účinné***

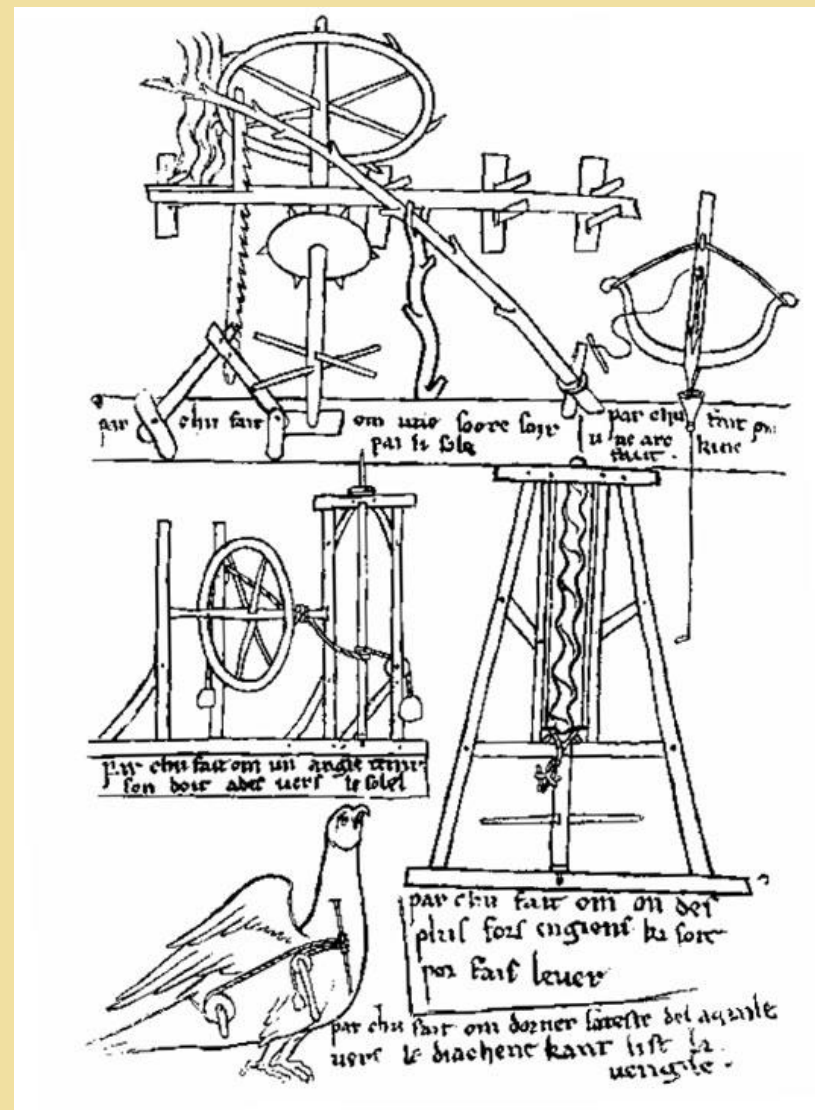
František Slanina

slanina@fzu.cz
www.fzu.cz/~slanina

Středověké stroje (kolem r. 1200)

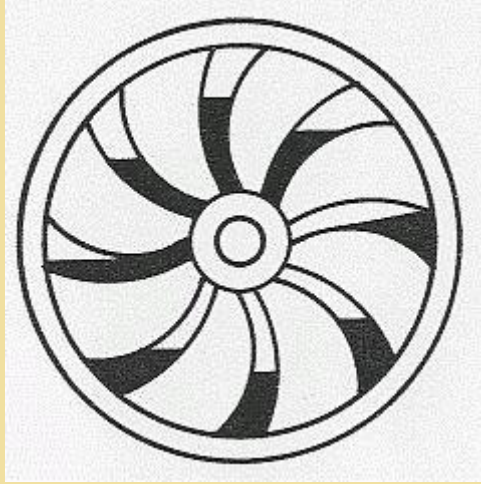


Al-Jazari

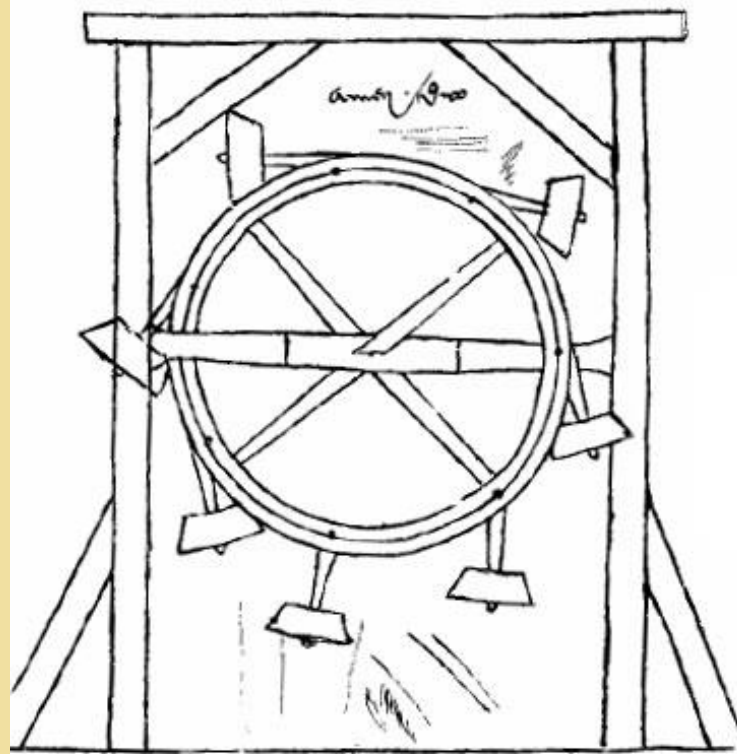


Villard de Honnecourt

Perpetuum mobile?

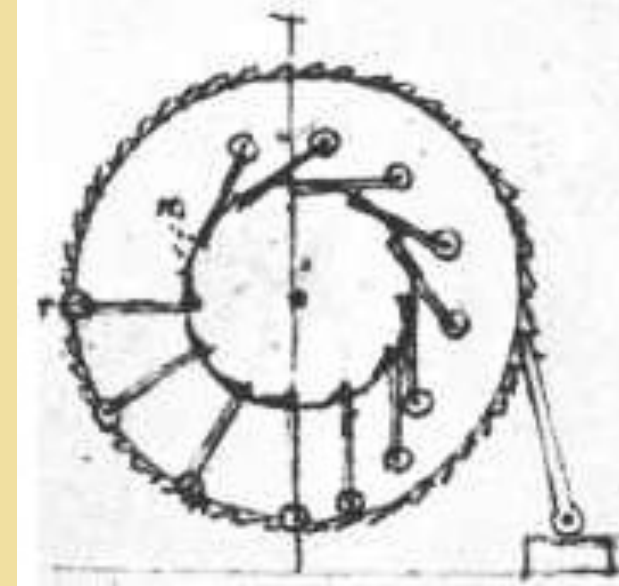


Bhaskara 1159



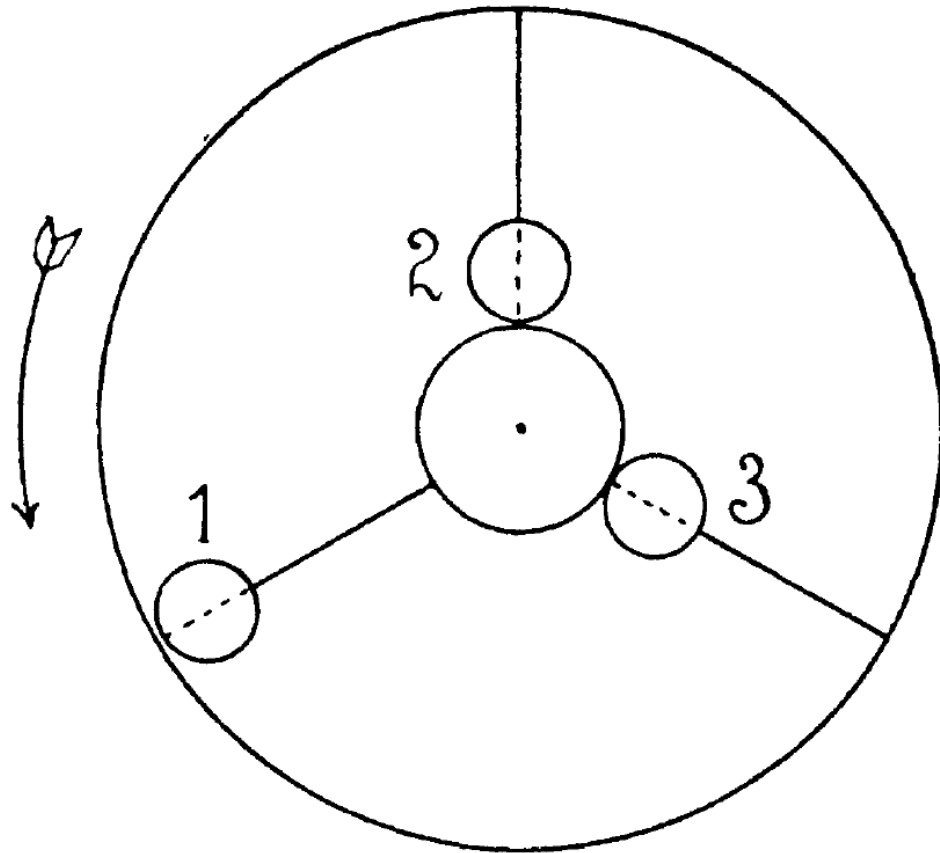
*Maint on se fait maître despuce de faire un ver une roue
par la seule volenté de en puce faire par m'aillet nouppes
par un argent.*

Villard de Honnecourt 1220

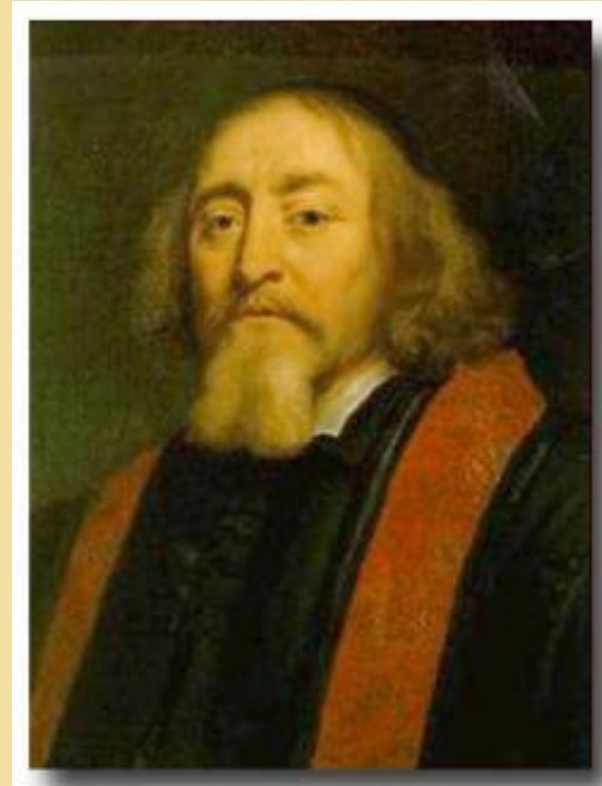


Leonardo 1508

I ty, Jene Ámosi?



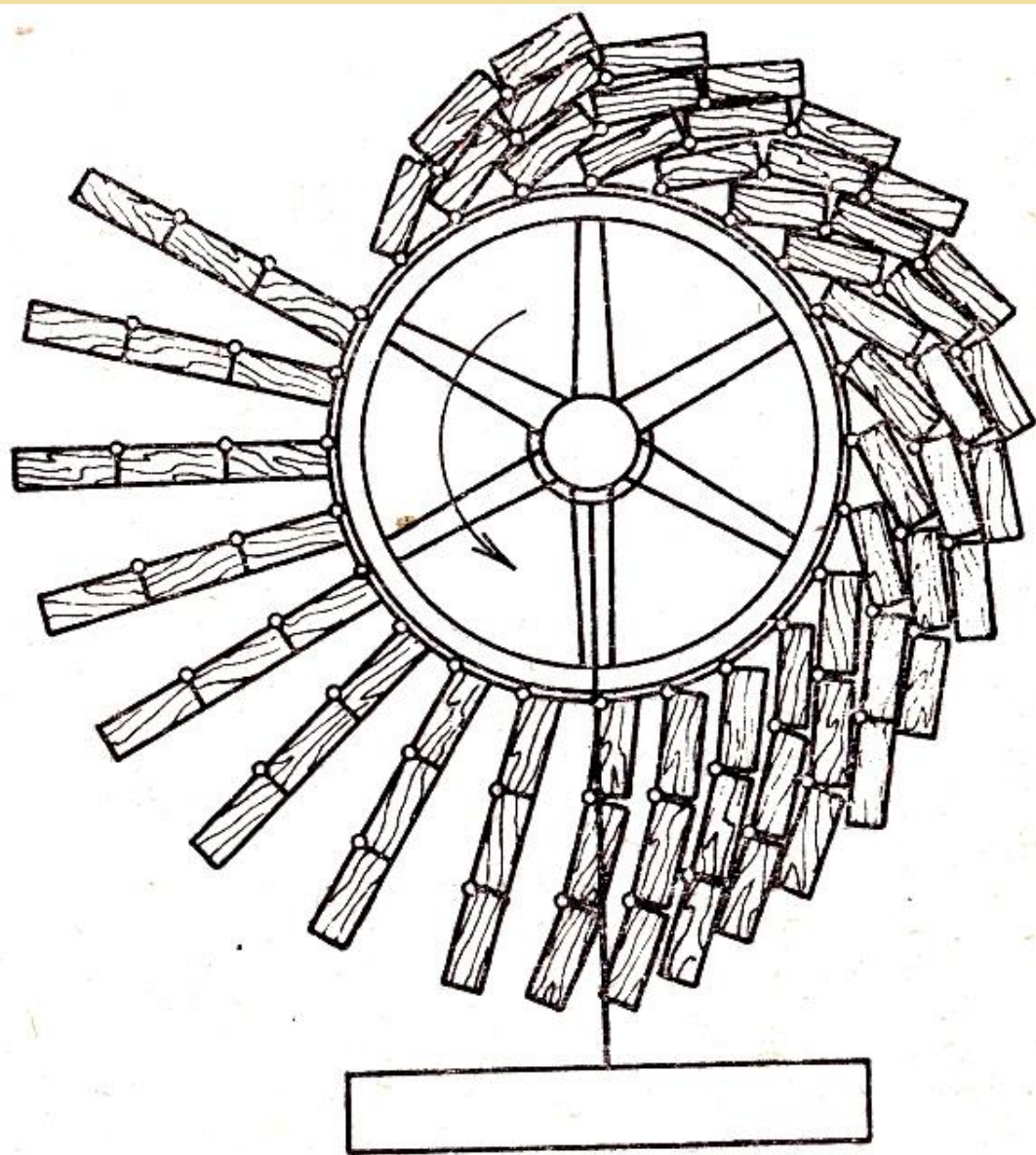
Obr. 1.



J.A.Komenský

Perpetuum mobile?
Perpetuum temptatione!

(Stále
pokušení...)





Hmota je plná pohybu

Můžeme vidět pohyb uvnitř hmoty?



Robert Brown 1827

A
BRIEF ACCOUNT
OF
MICROSCOPICAL OBSERVATIONS
Made in the Months of June, July, and August, 1827,
ON THE PARTICLES CONTAINED IN THE
POLLEN OF PLANTS ;
AND
ON THE GENERAL EXISTENCE OF ACTIVE
MOLECULES
IN ORGANIC AND INORGANIC BODIES.
BY
ROBERT BROWN,
F.R.S., HON. M.R.S.E. AND R.I. ACAD., V.P.L.S.,
MEMBER OF THE ROYAL ACADEMY OF SCIENCES OF SWEDEN, OF THE ROYAL
SOCIETY OF DENMARK, AND OF THE IMPERIAL ACADEMY NATURE
CURIOSORUM ; CORRESPONDING MEMBER OF THE ROYAL
INSTITUTES OF FRANCE AND OF THE NETHERLANDS,
OF THE IMPERIAL ACADEMY OF SCIENCES AT
ST. PETERSBURG, AND OF THE ROYAL
ACADEMIES OF PRUSSIA AND
BAVARIA, ETC.

Můžeme vidět pohyb uvnitř hmoty?



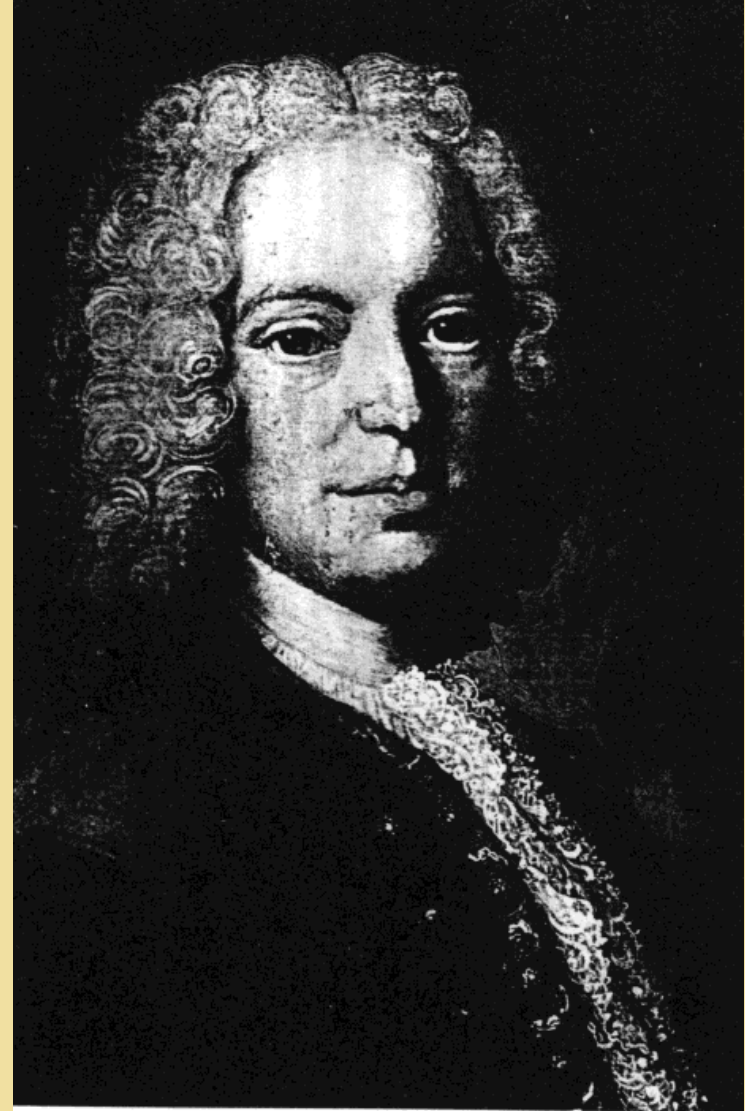
Clarkia pulchella



Hmota je plná pohybu

Daniel Bernoulli
1738

$$P \propto v^2$$

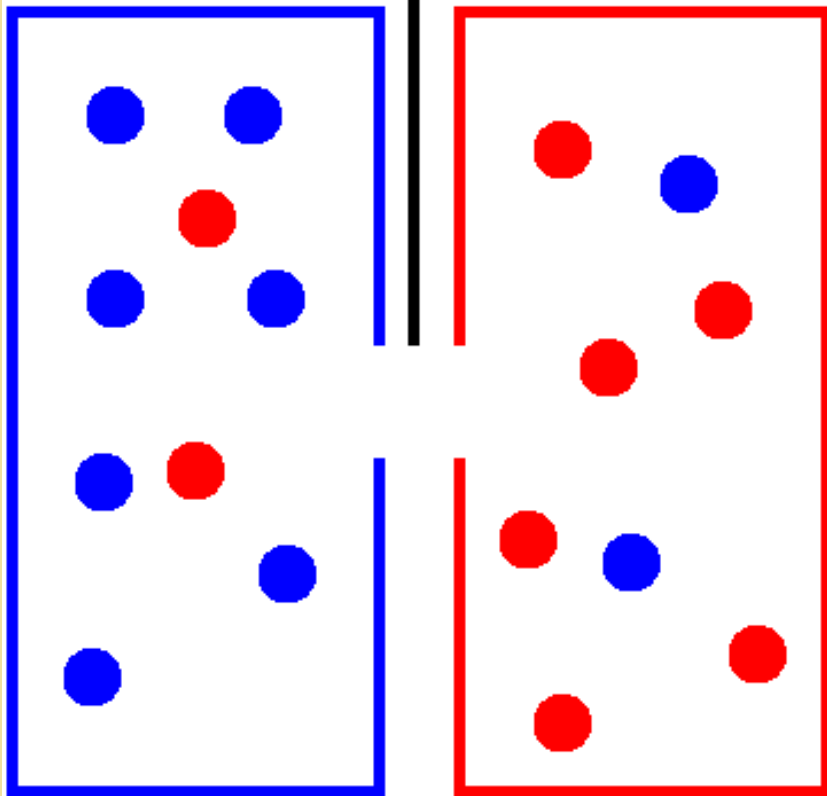


Daniel Bernoulli

Maxwellův démon

Chladné
chladí

Horké
ohřívá

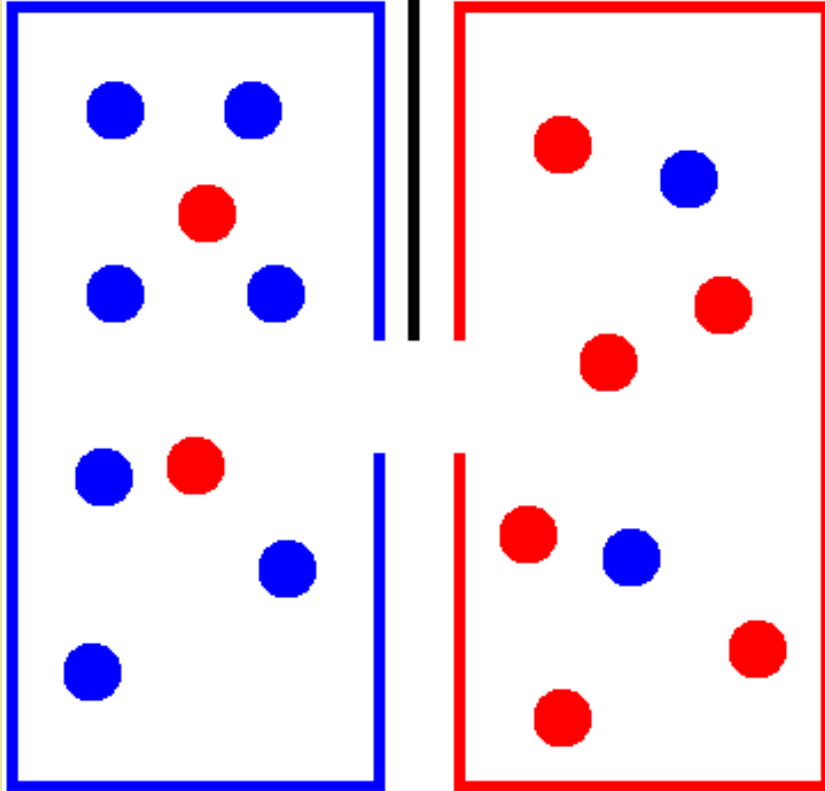


Maxwellův démon

Chladné
chladí



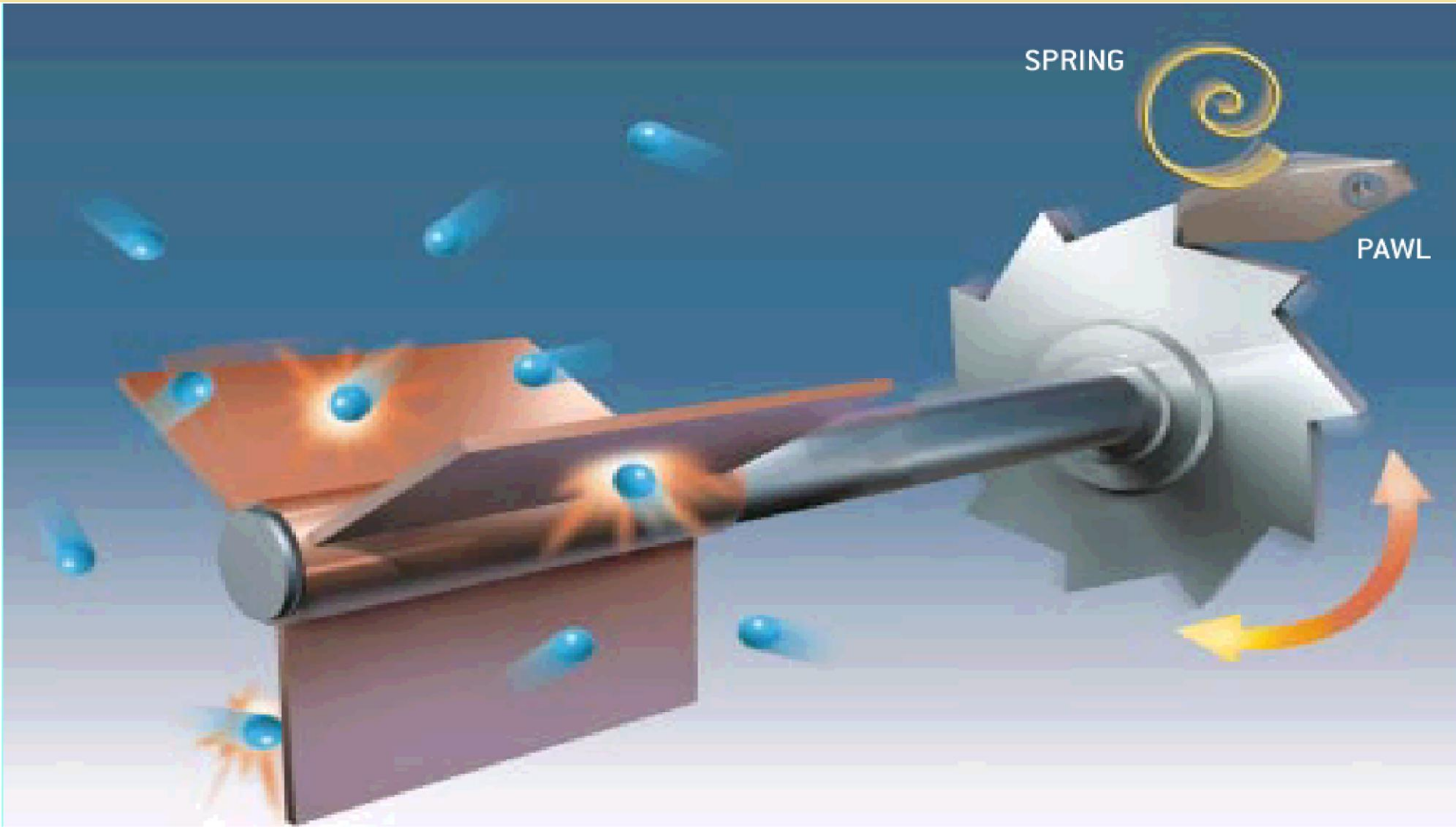
Horké
ohřívá



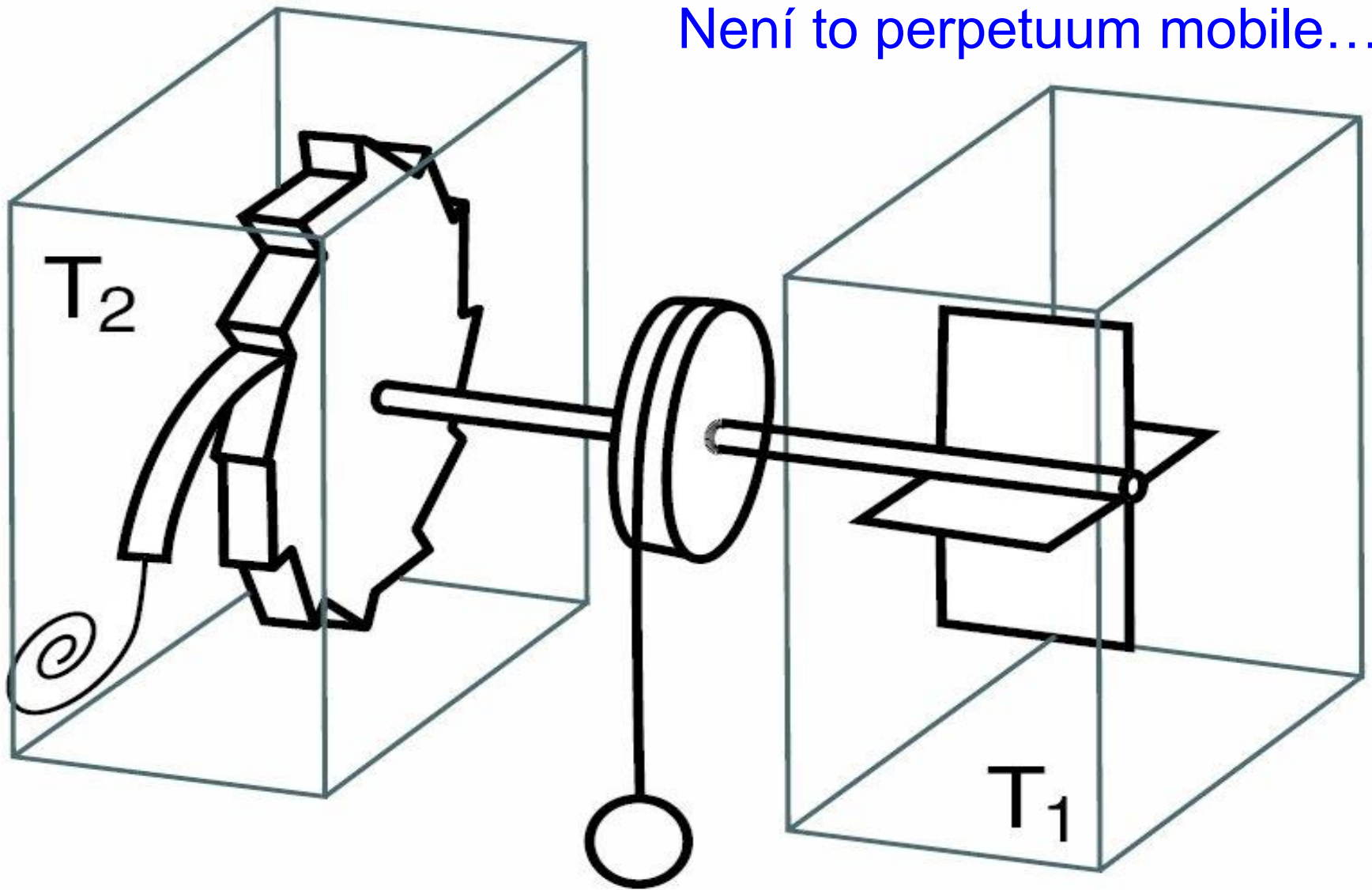
Už stačí jen
připojit parní stroj



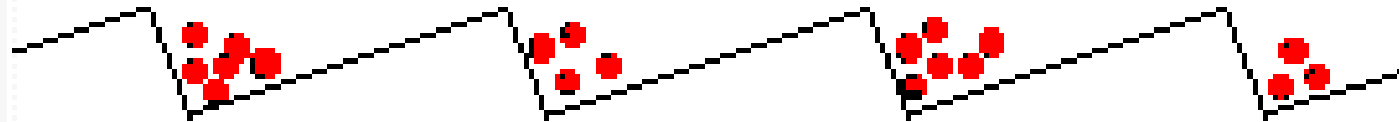
Smoluchowského rohatka



Není to perpetuum mobile...



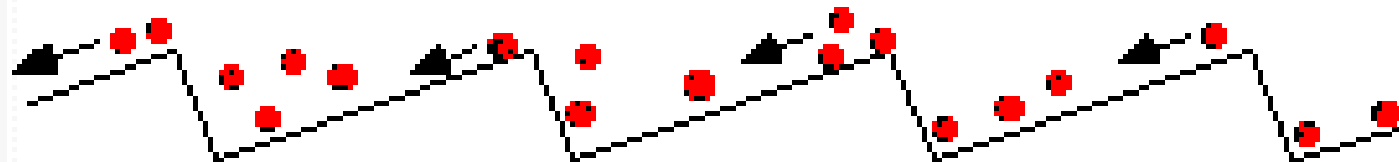
Přepínací rohatka



$t = 0$

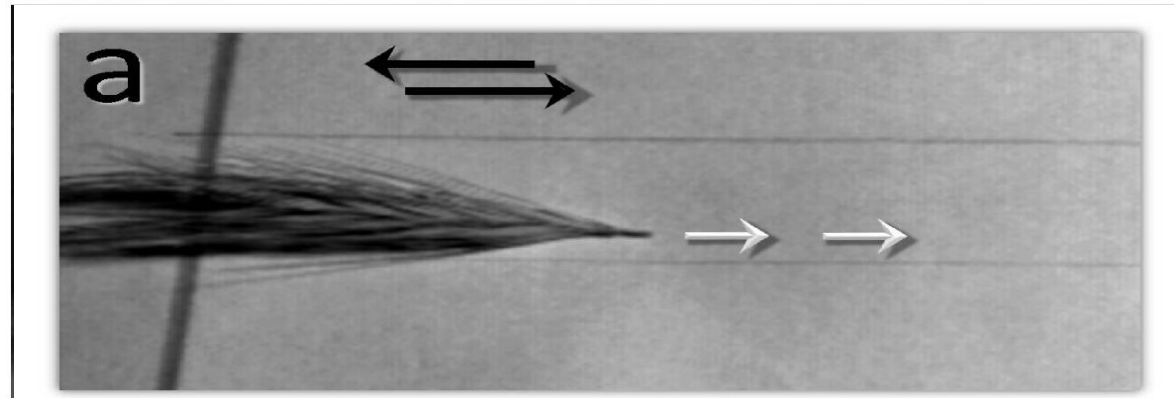
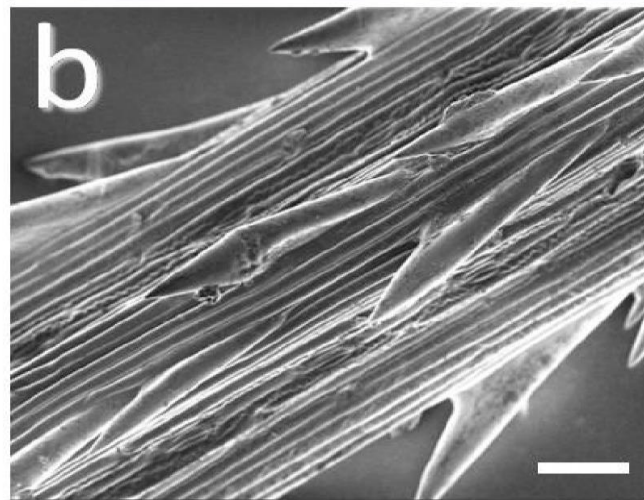
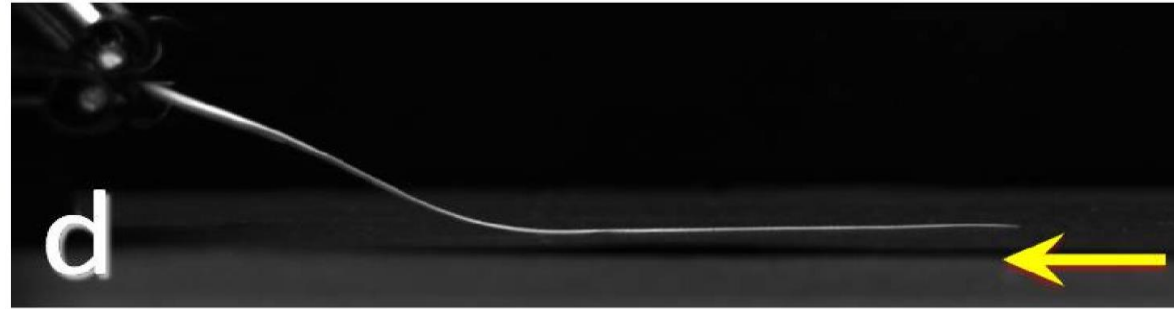
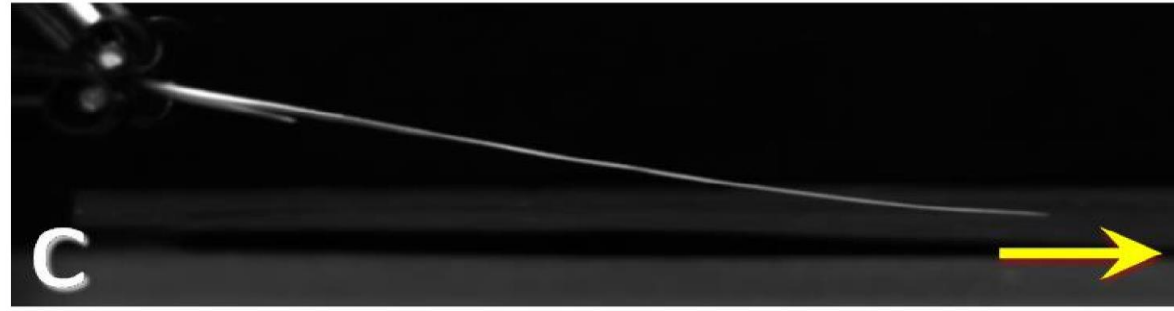


$t = 0.5$



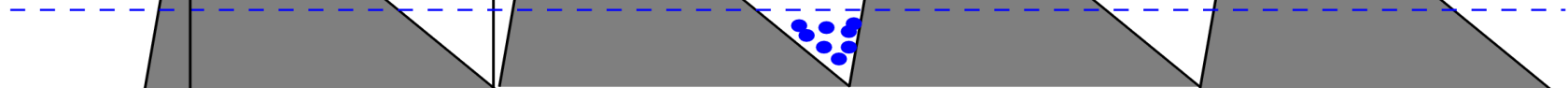
$t = 1$

Botanická rohatka

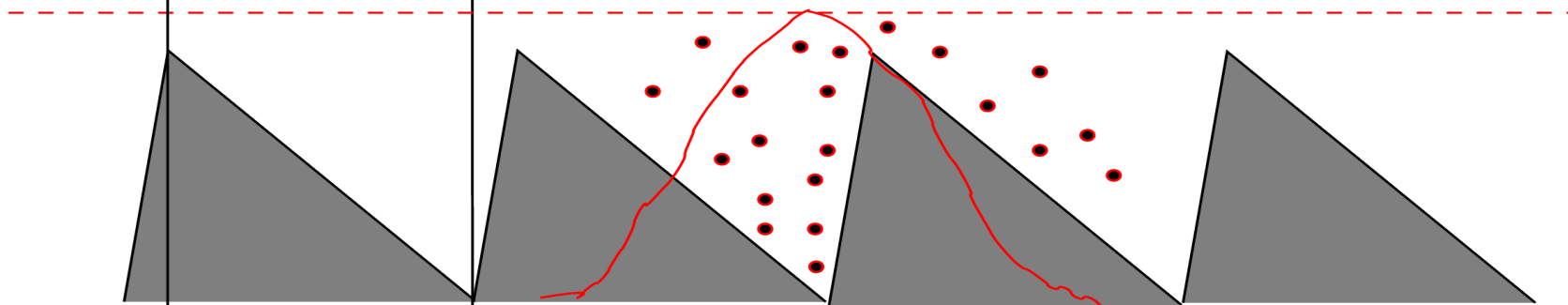


Tepelná rohatka

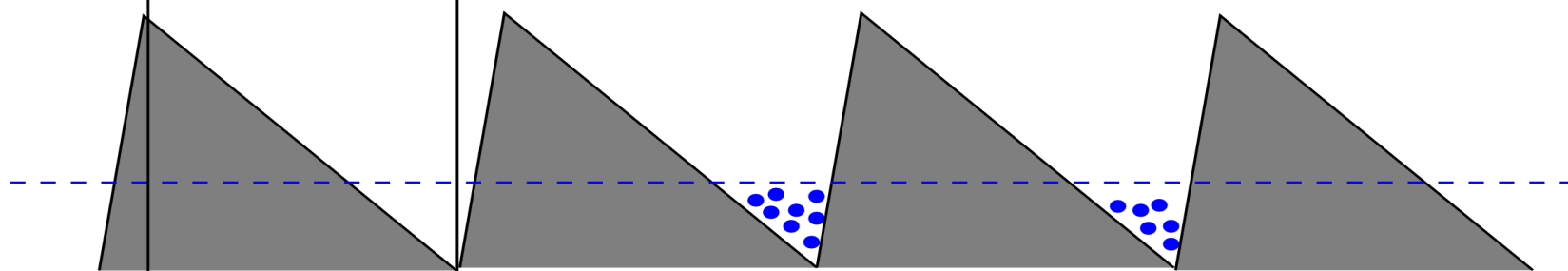
Cold



Hot



Cold



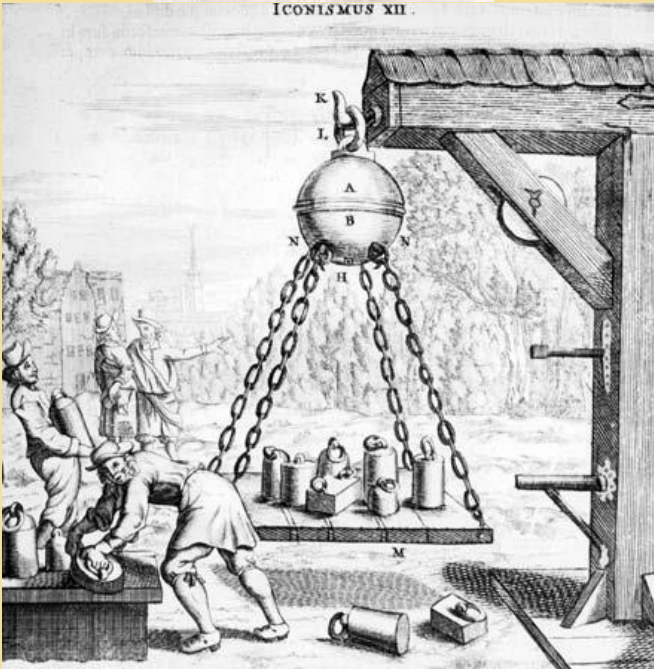
$(1-a)L$

Tepelná rohatka



Ecce perpetuum mobile!

Otto von Guericke

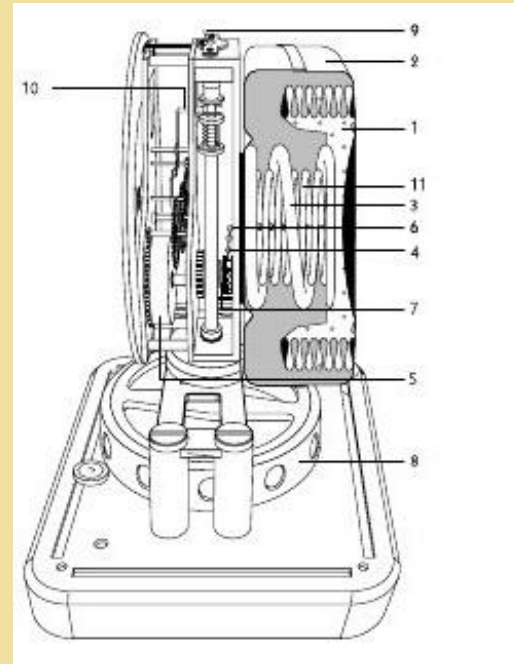
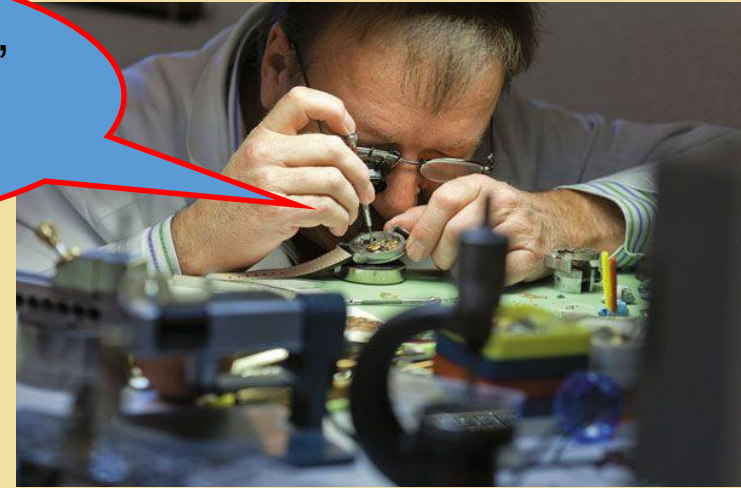


Ale časem se teploty vyrovnají!

J.A.Komenský

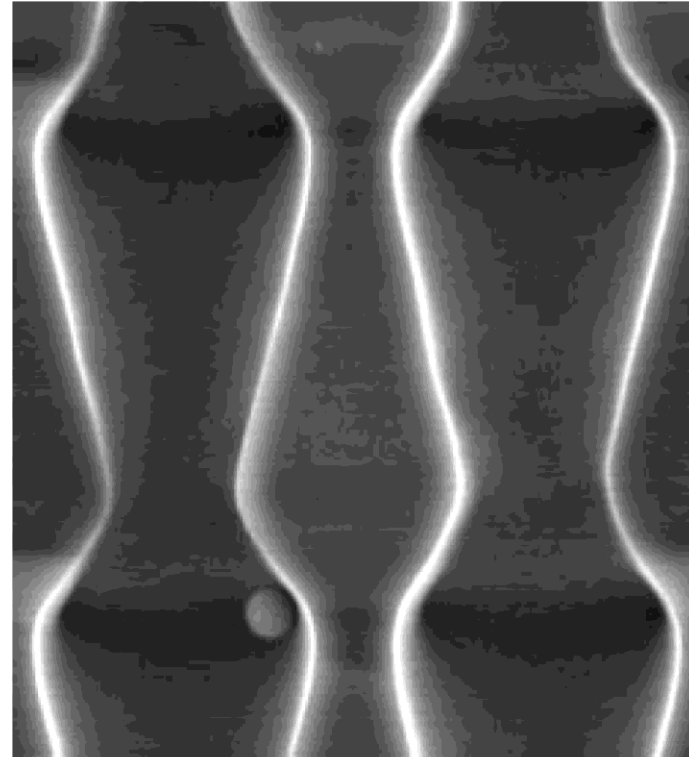
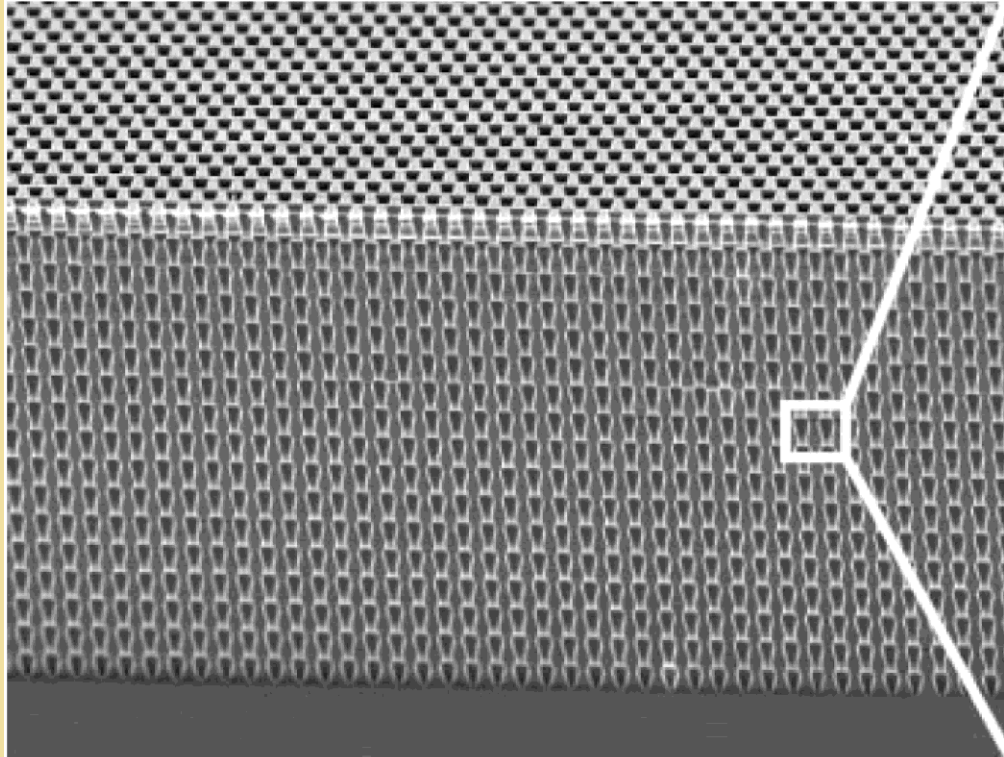
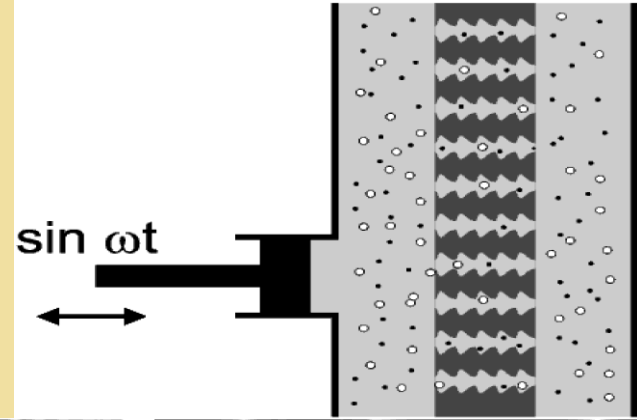


Klidně se hádejte,
já to mezitím
vyrobím

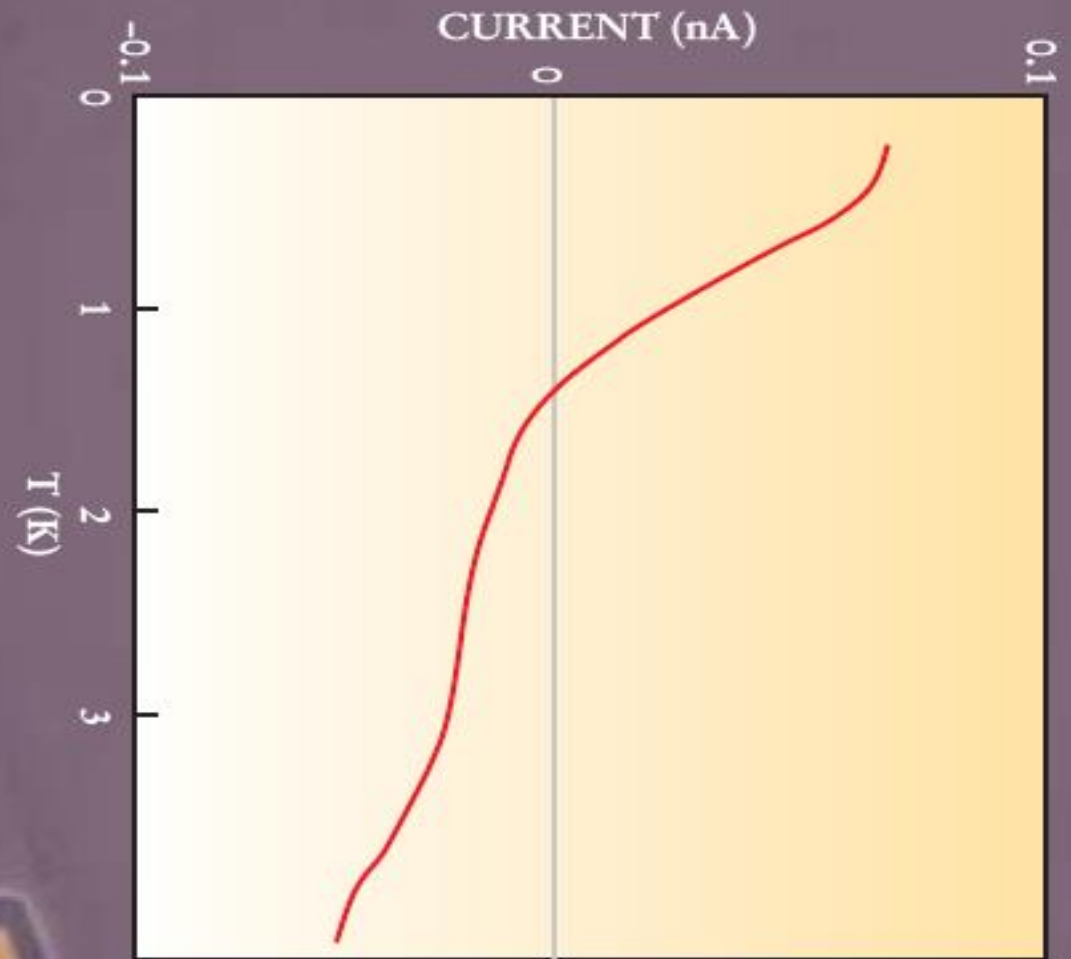


A nyní do mikrosvěta:

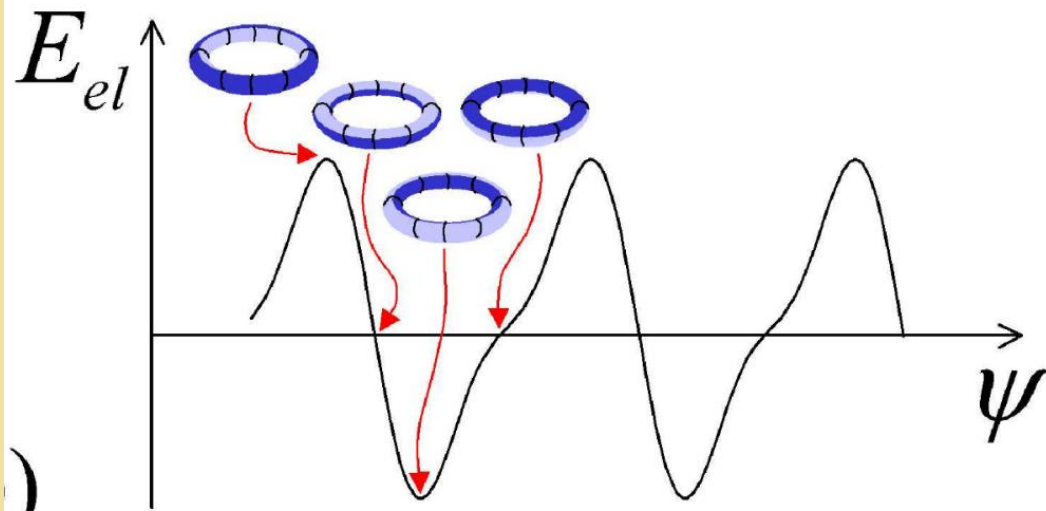
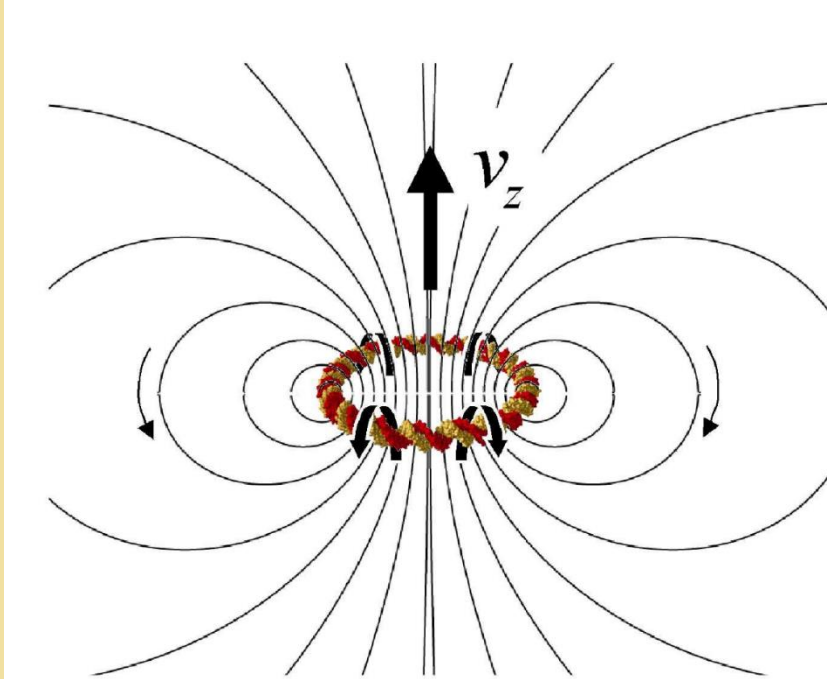
Pumpičková rohatka



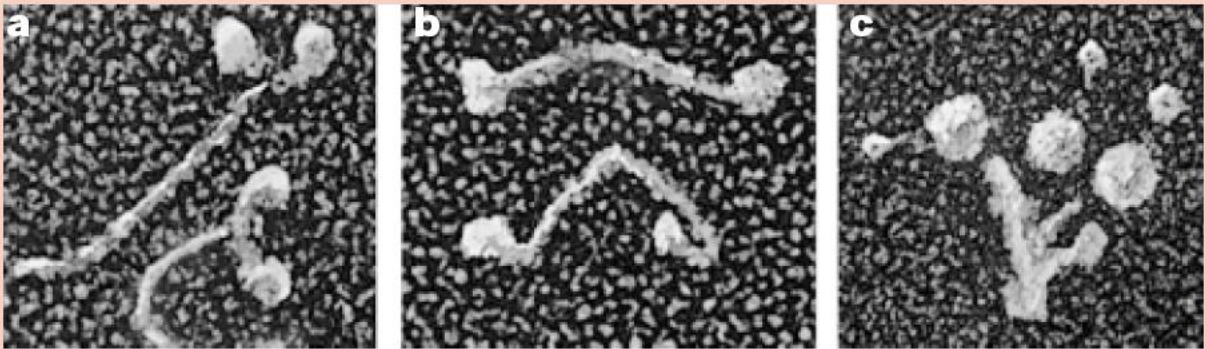
Kvantová rohatka



Plovoucí DNA



A ted' biologie



myosin



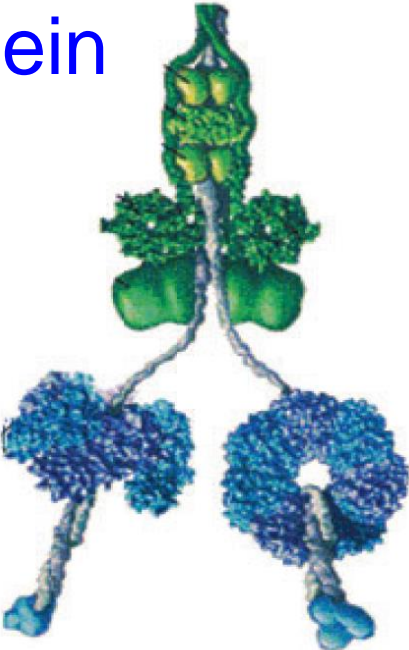
Ahoj,
kamarádi
já jsem
Šmudlín



kinesin



dynein



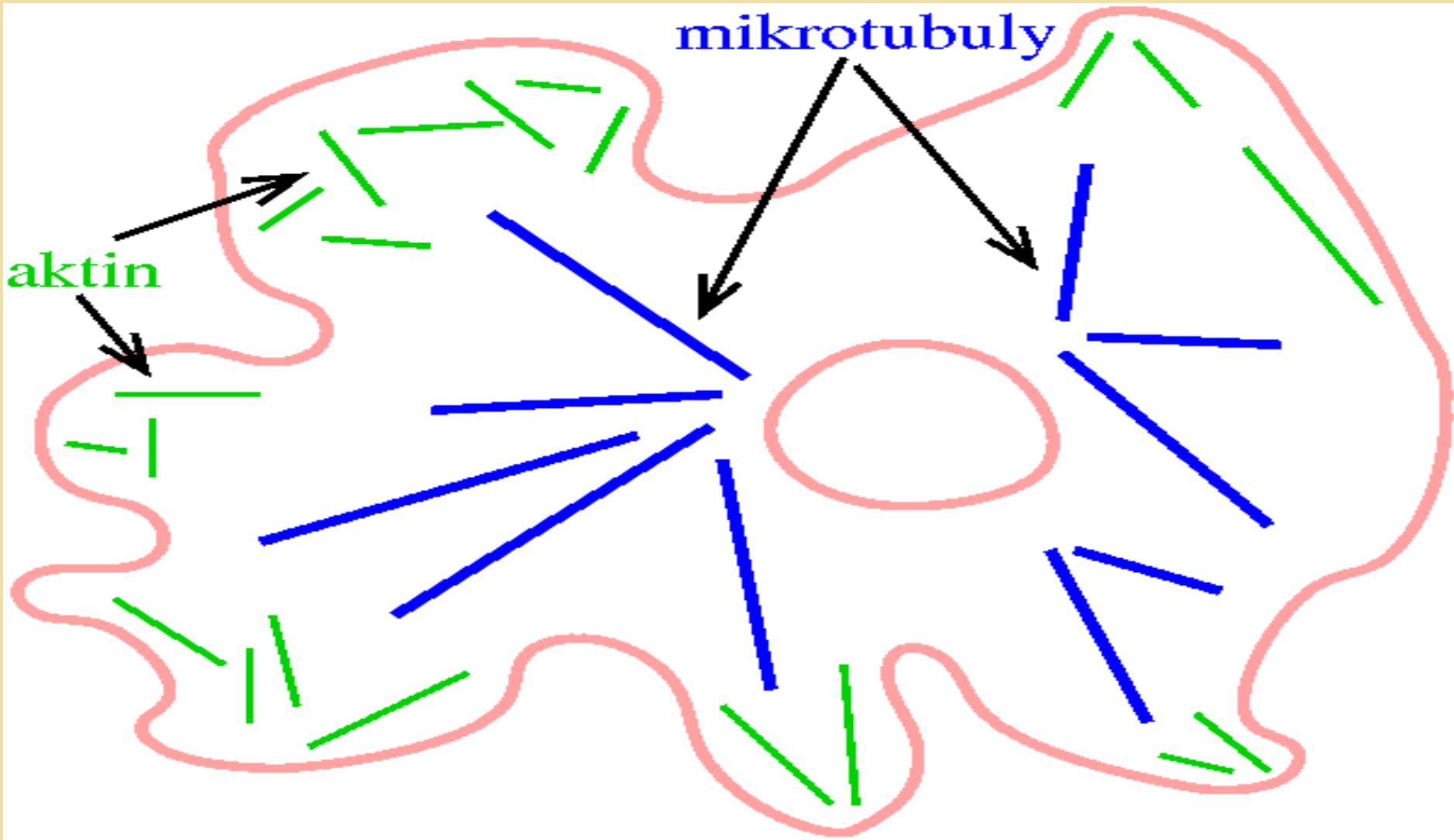
25 nm



cytoskelet

mikrotubuly

aktin

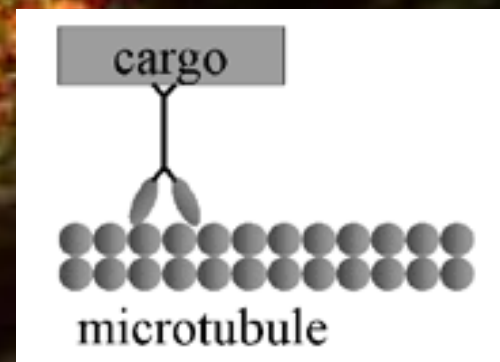


Provoz po cytoskeletu

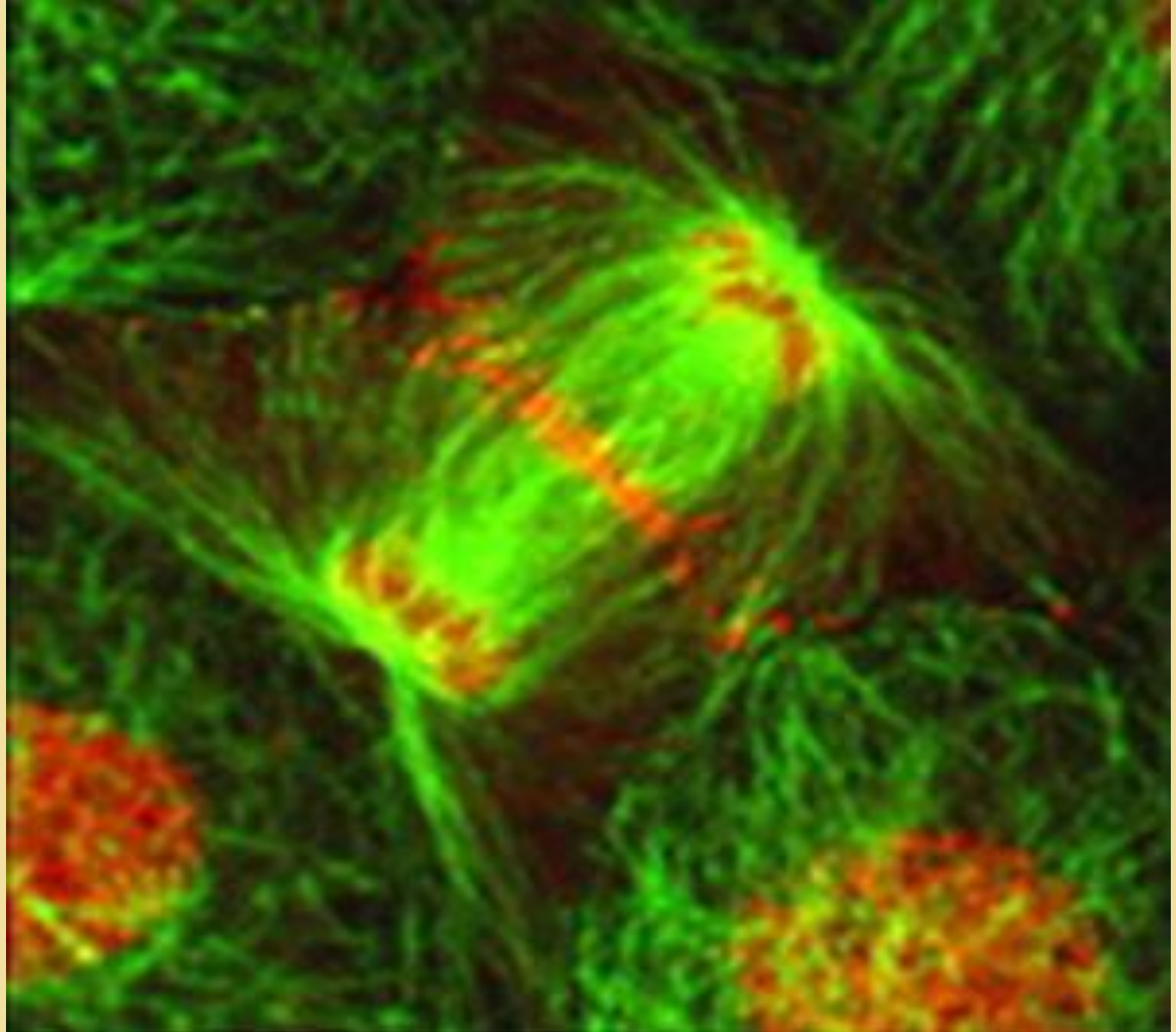


fot. Grzegorz Stępień

Provoz po cytoskeletu

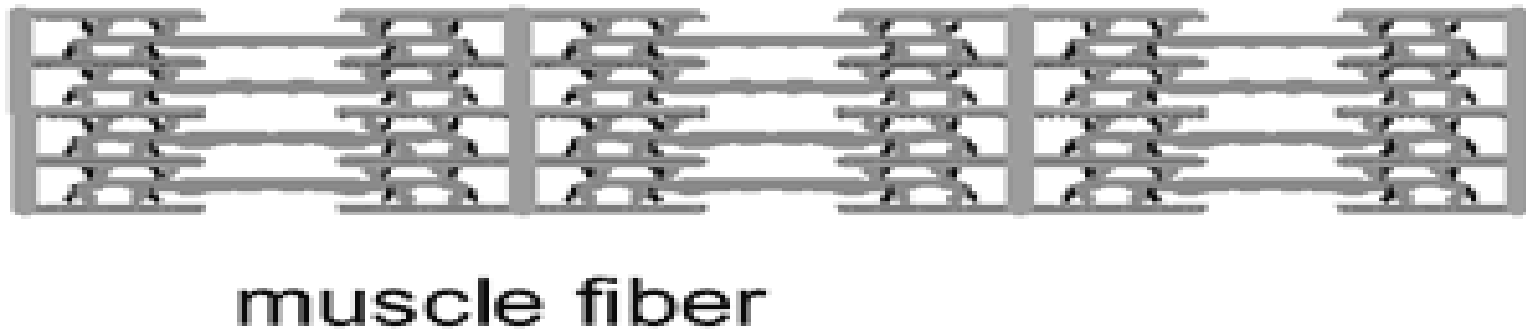
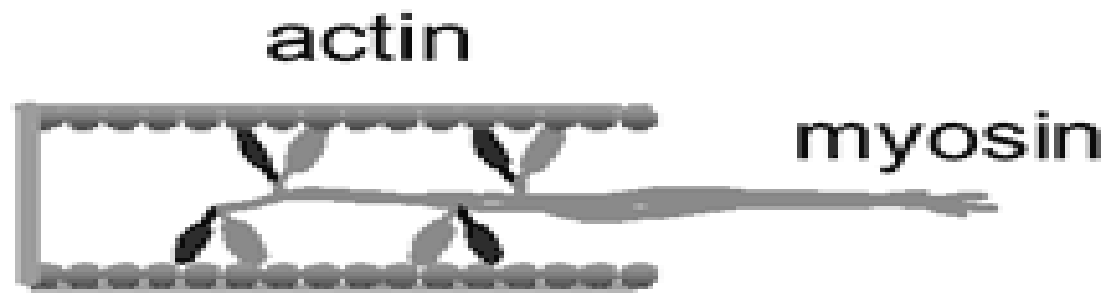


Dělení buňky



Svaly



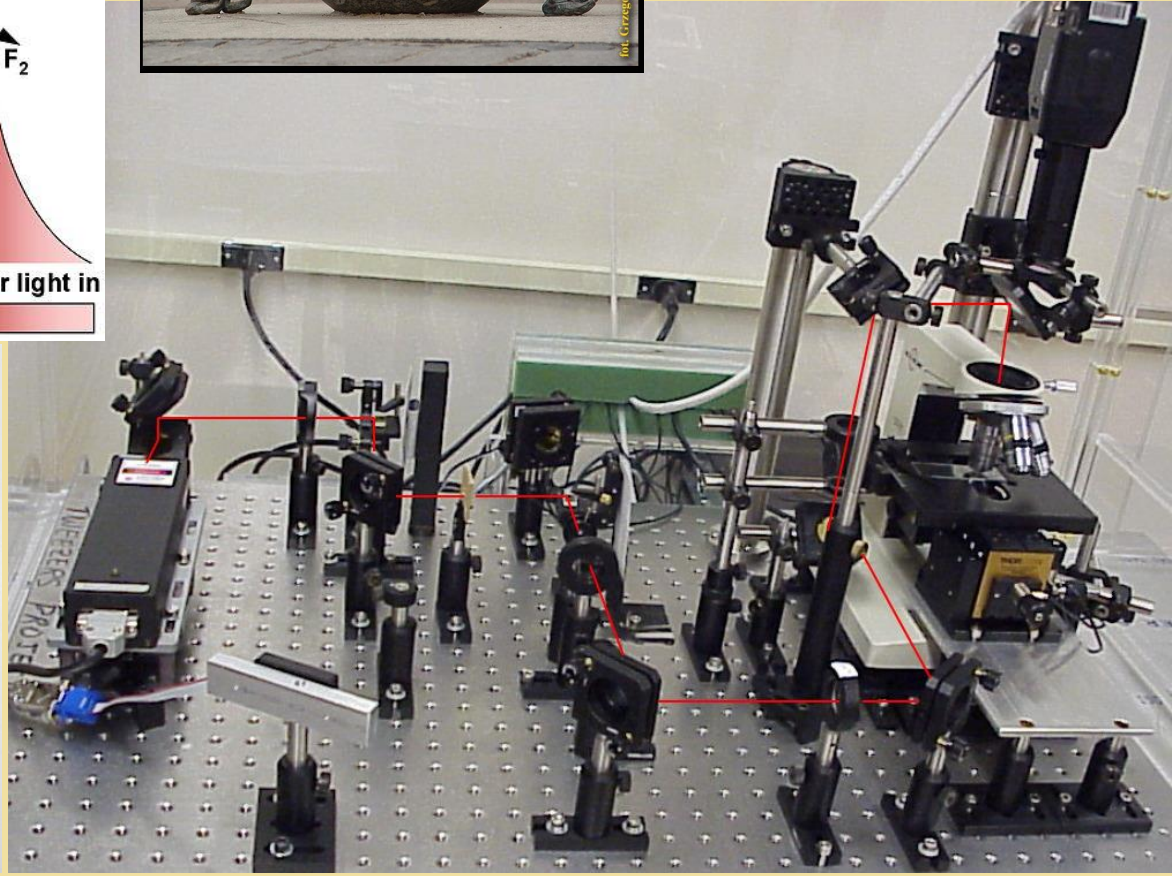
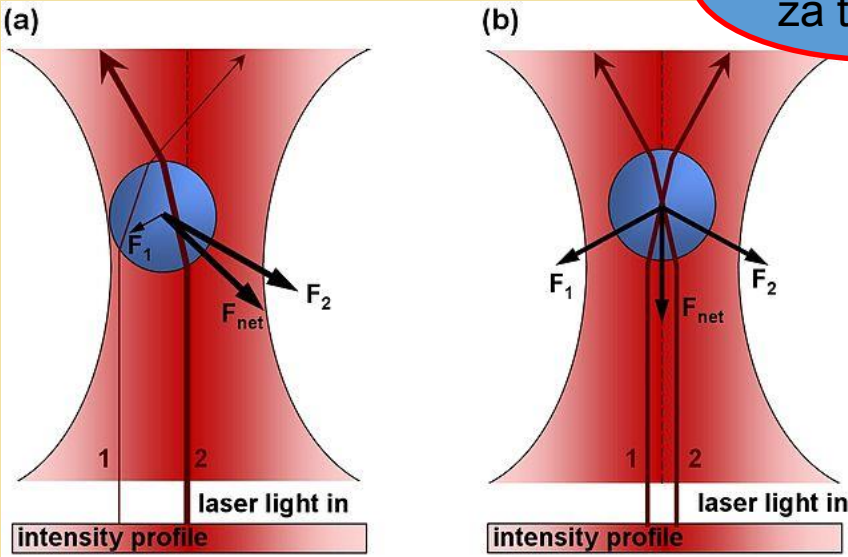


Jak na to?



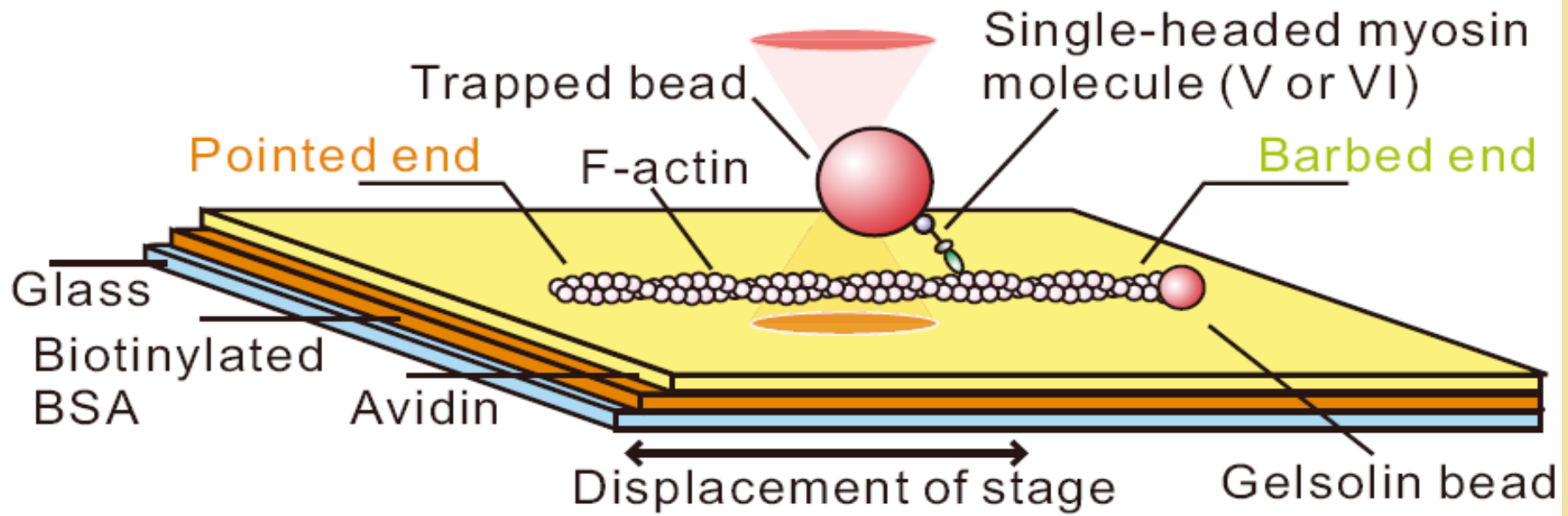
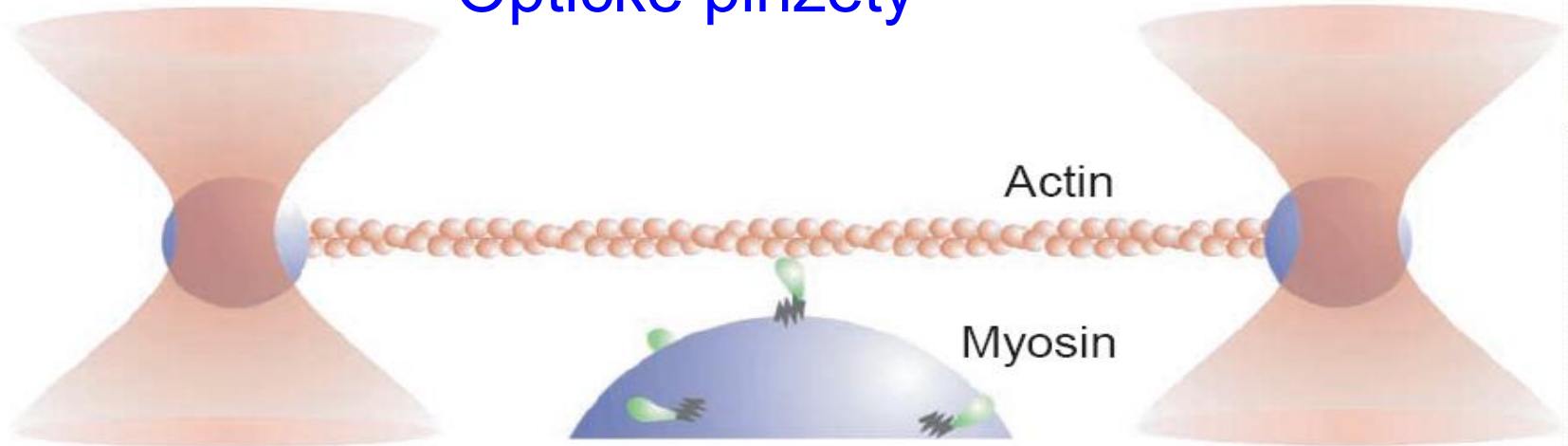
Optická pinzeta

Někdo nám
za to tahá!

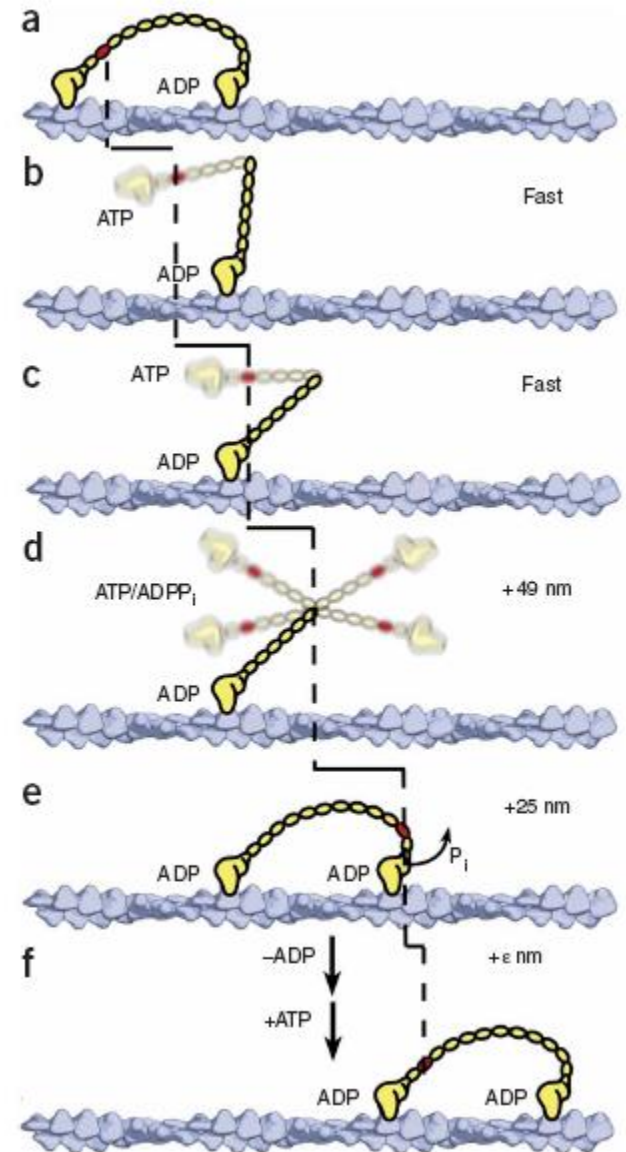
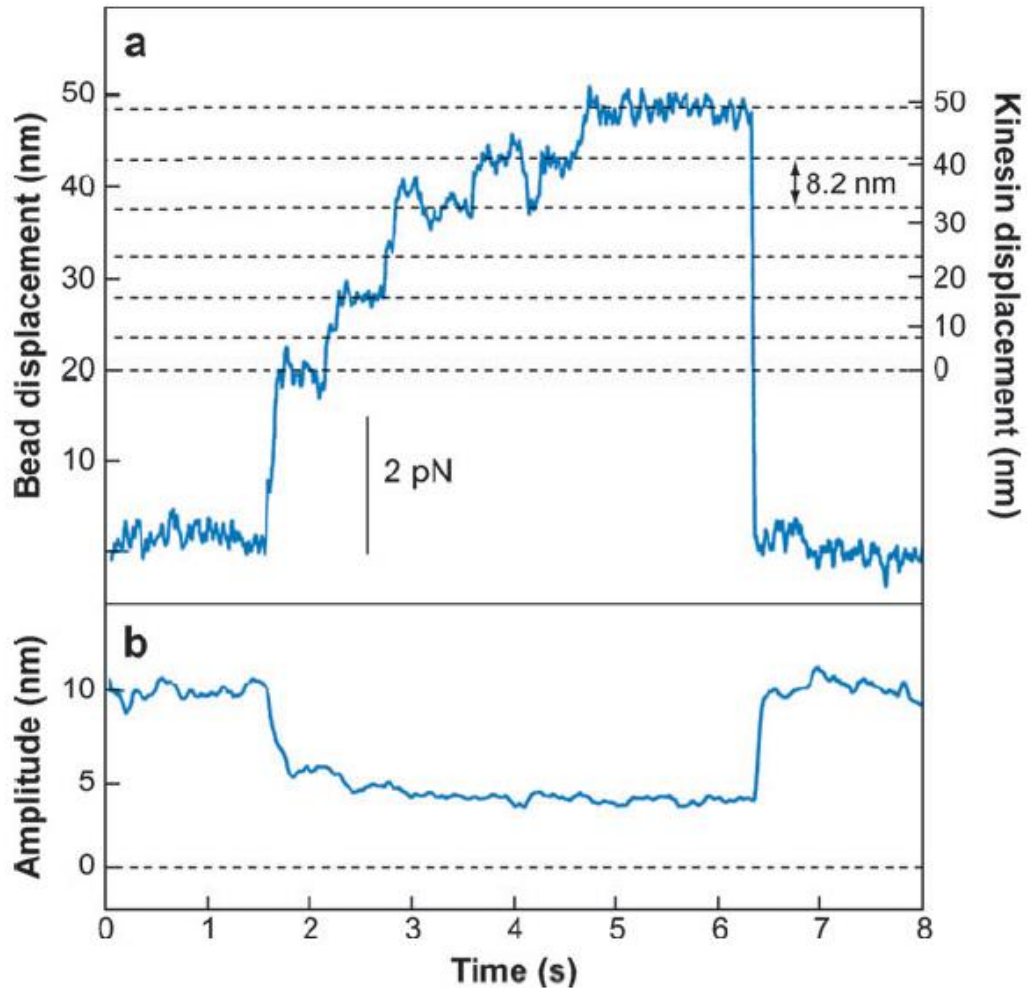


Optical tweezers

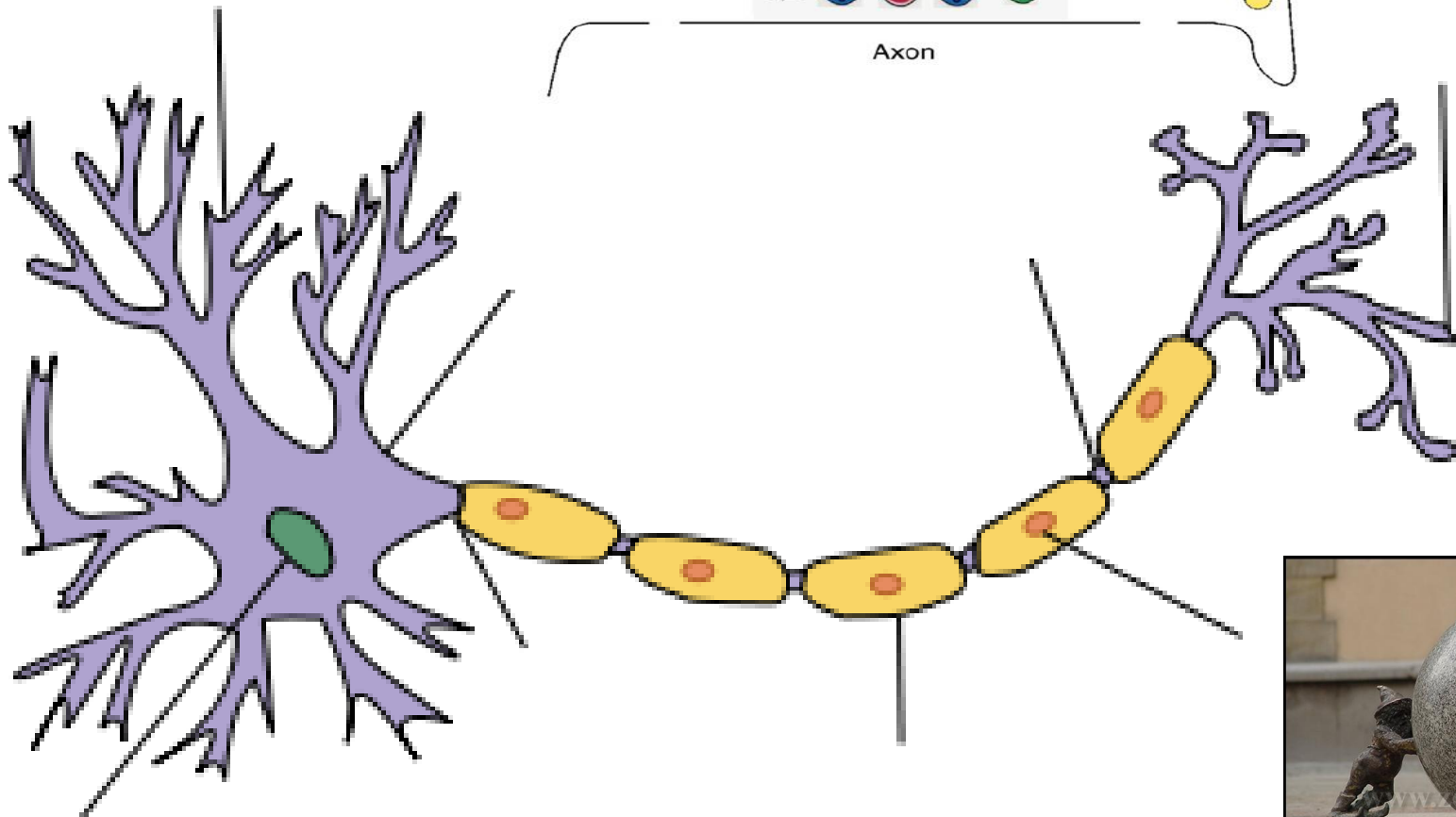
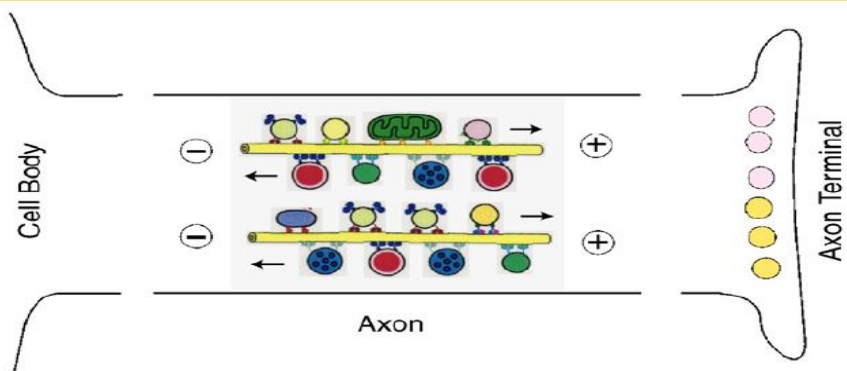
Optické pinzety



Mechanism „chůze“

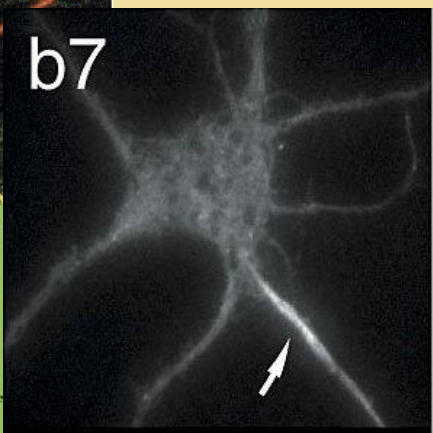
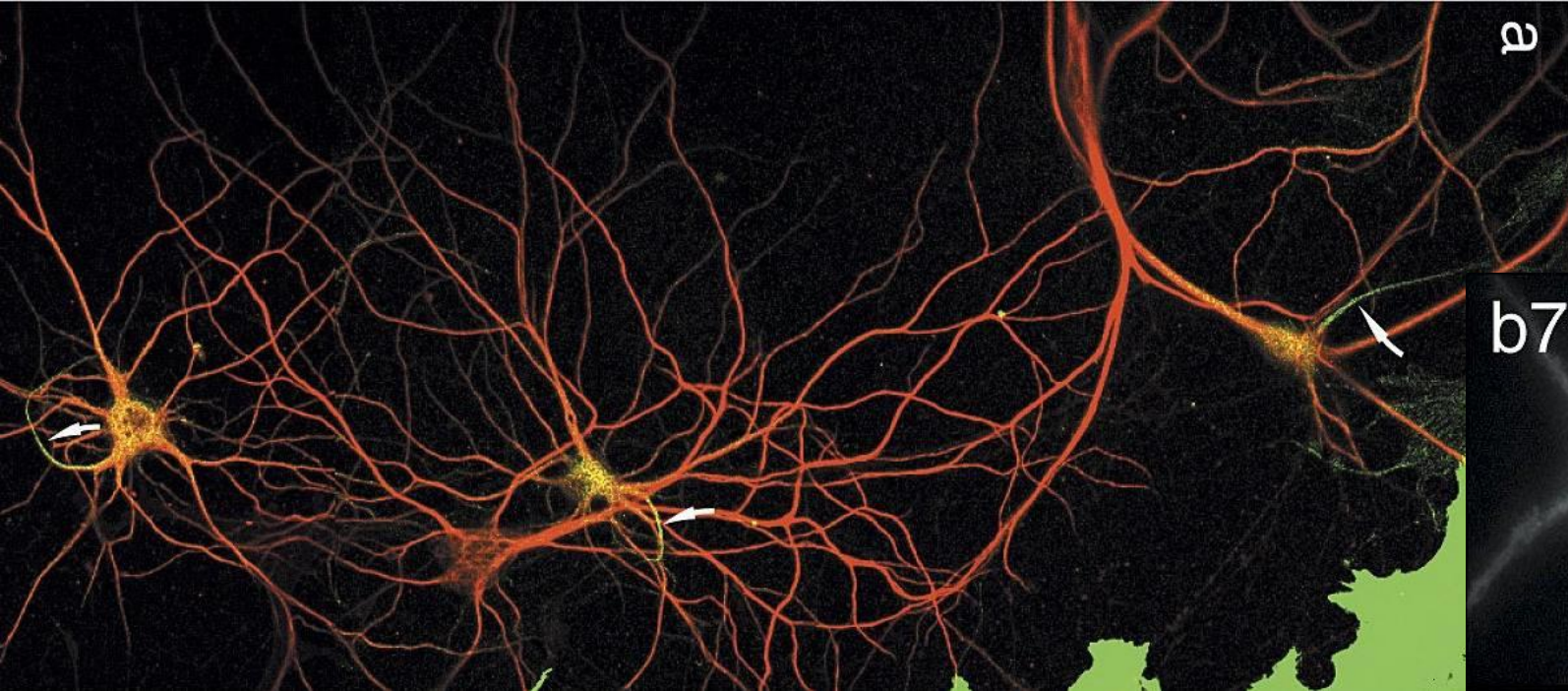


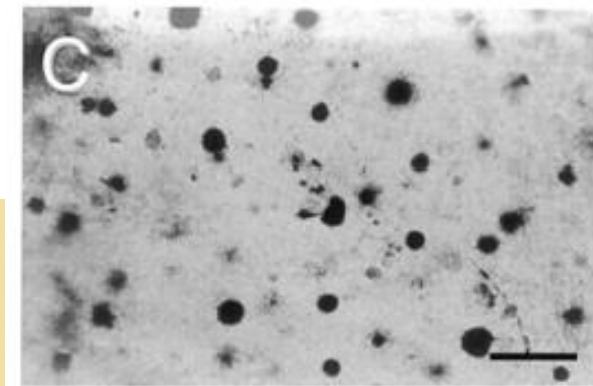
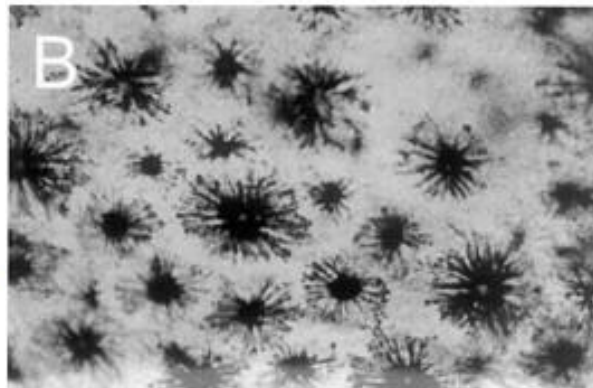
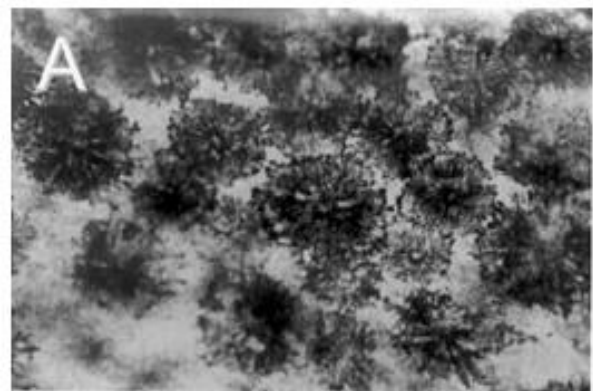
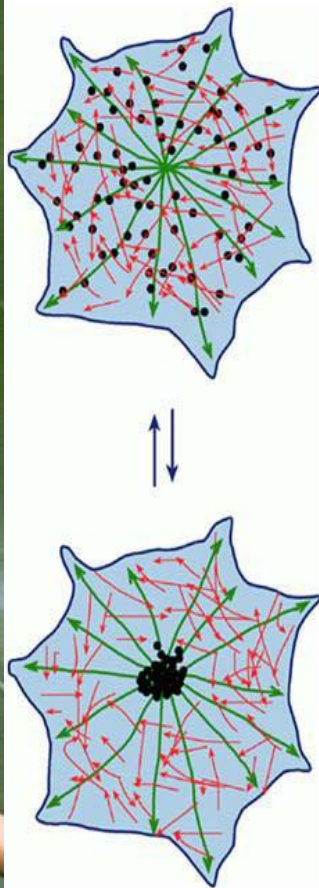
Neurony

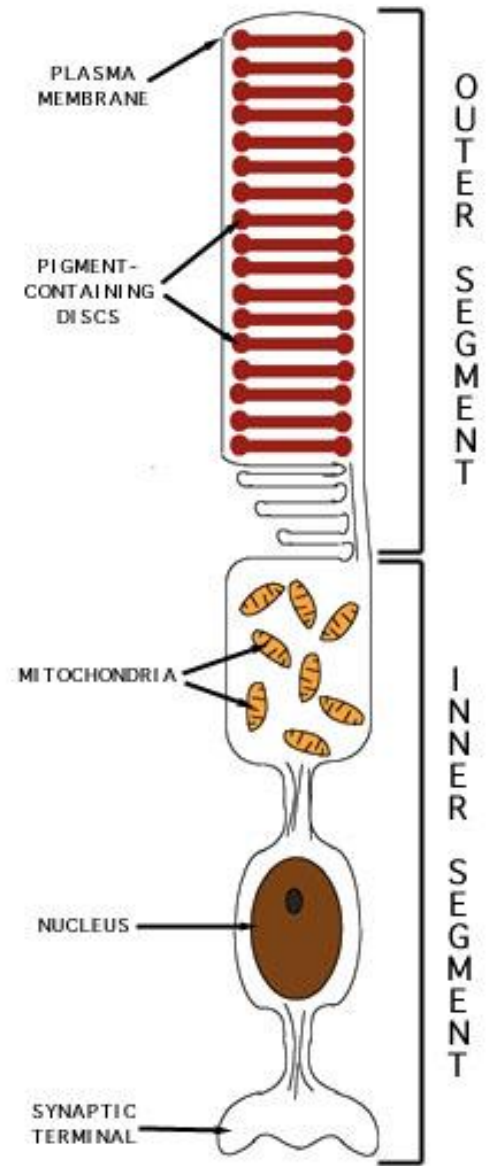
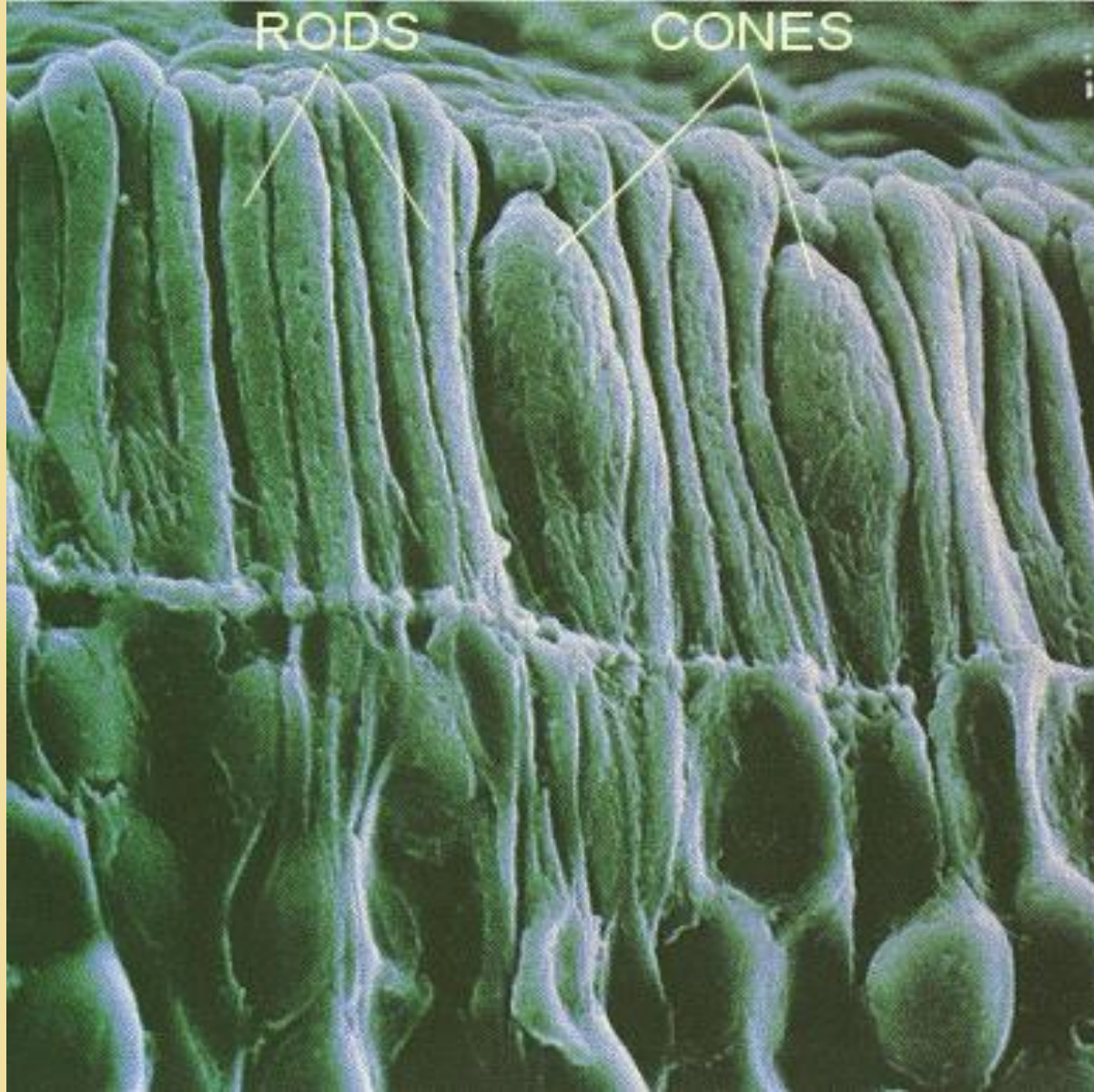


To jsou ale nervy!



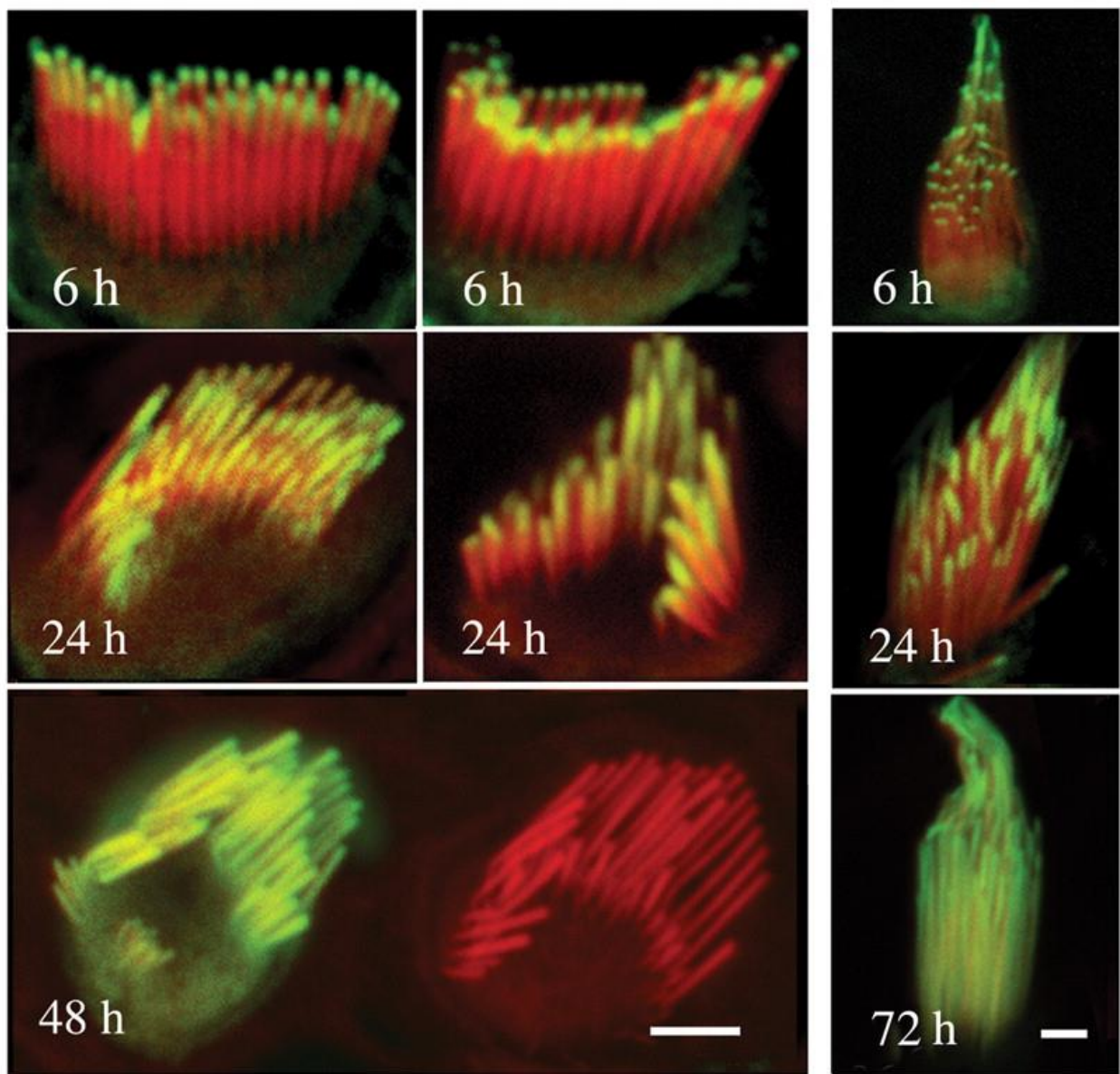
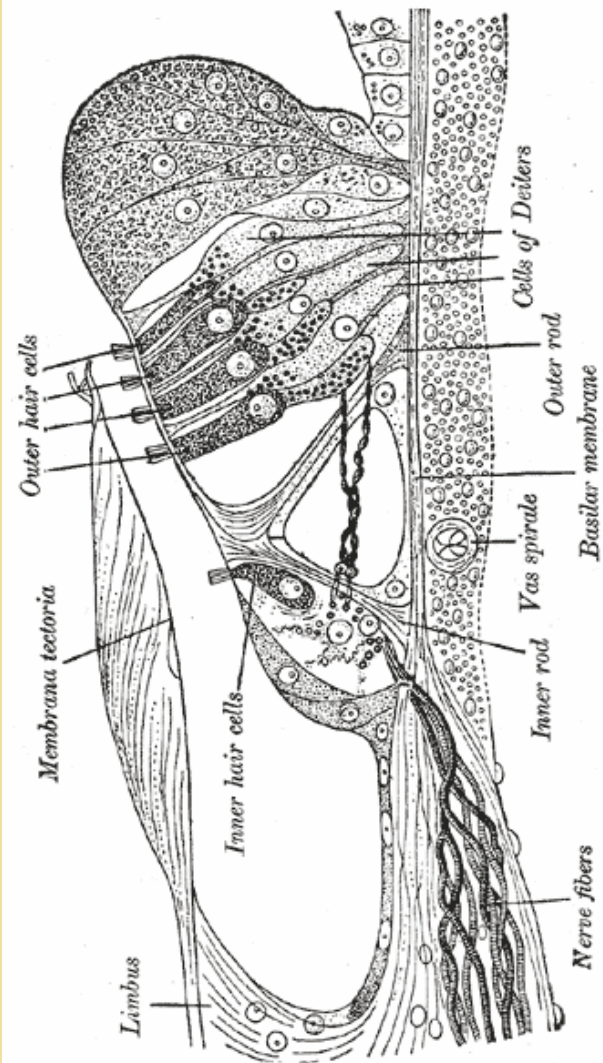


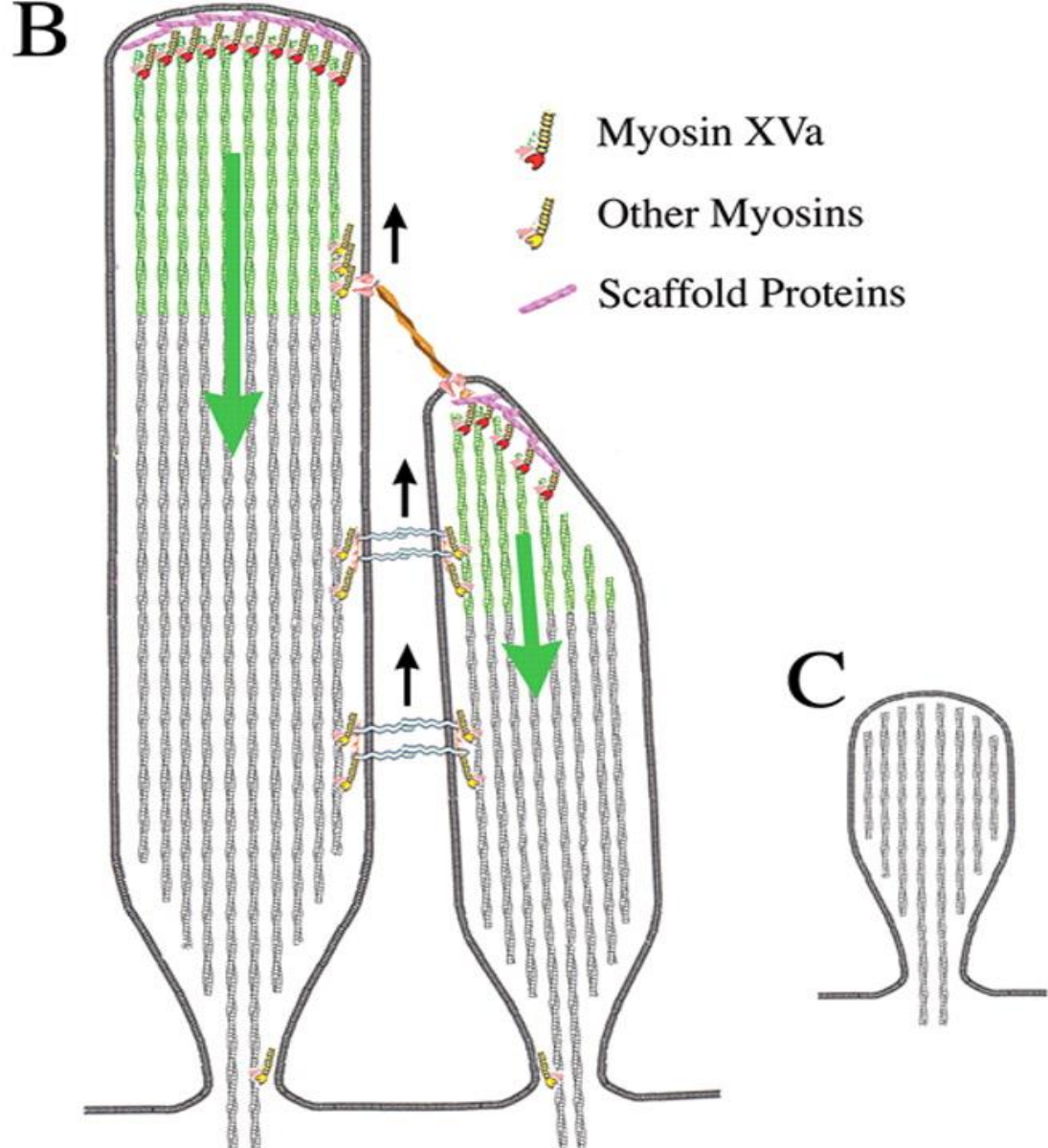
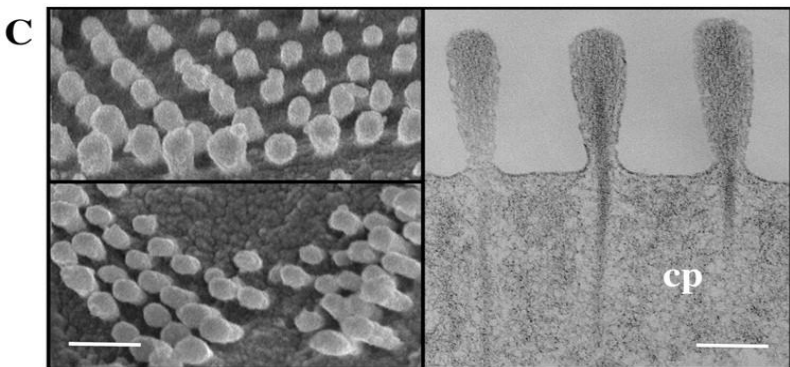
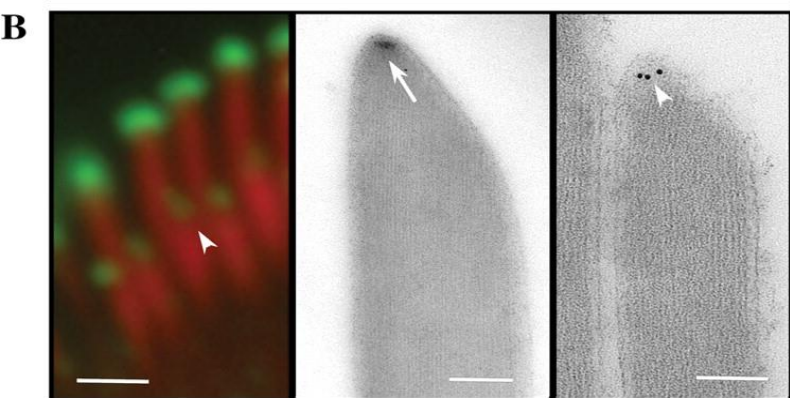
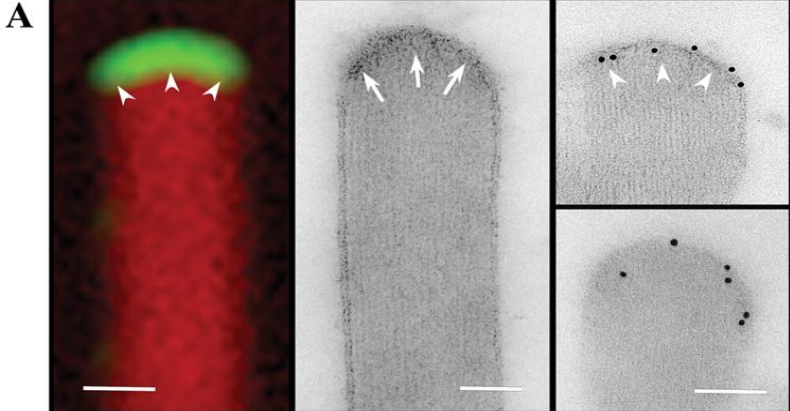




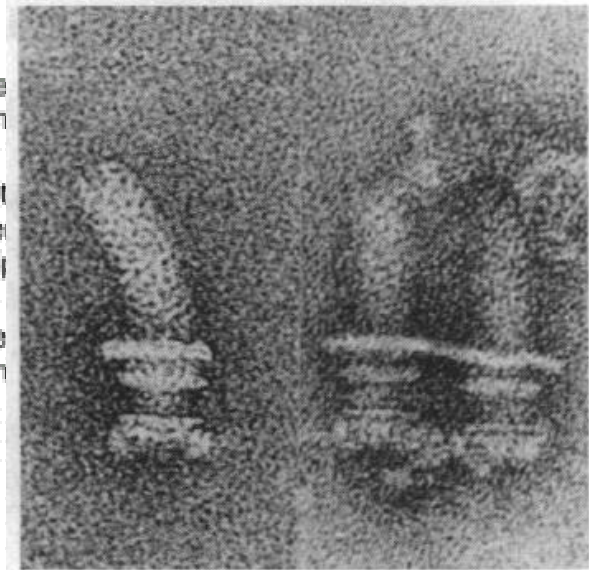
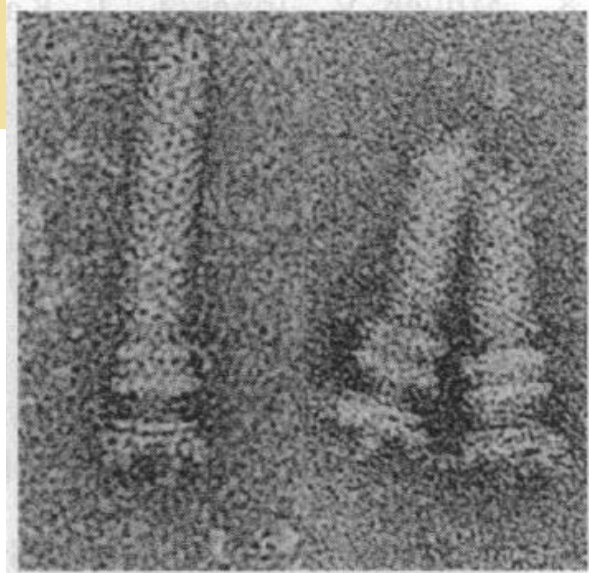
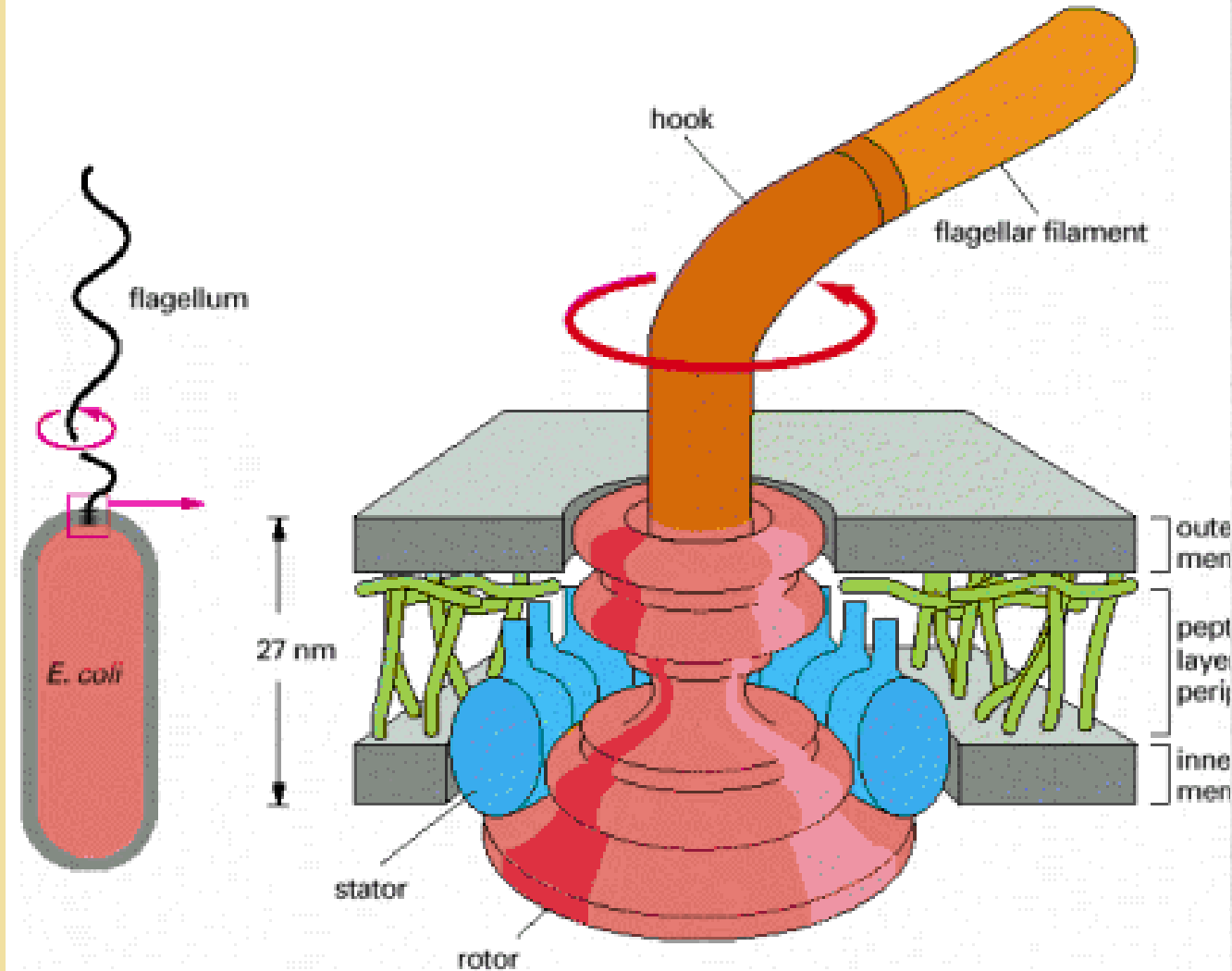
Ucho

A





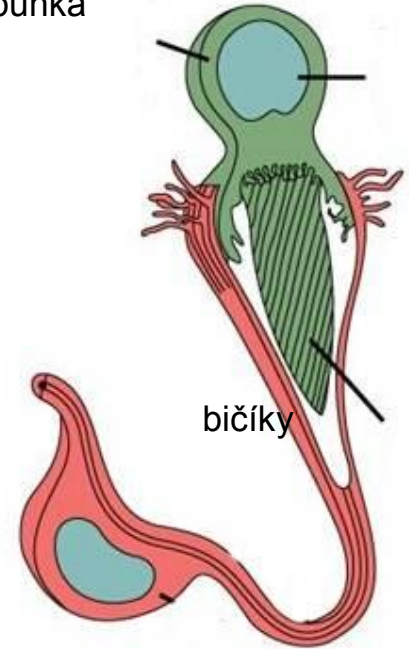
Bakteriální bičík (lodní šroub)



Primitivní ledviny u ploštěnek (čerpadlo)



Plaménková
buňka

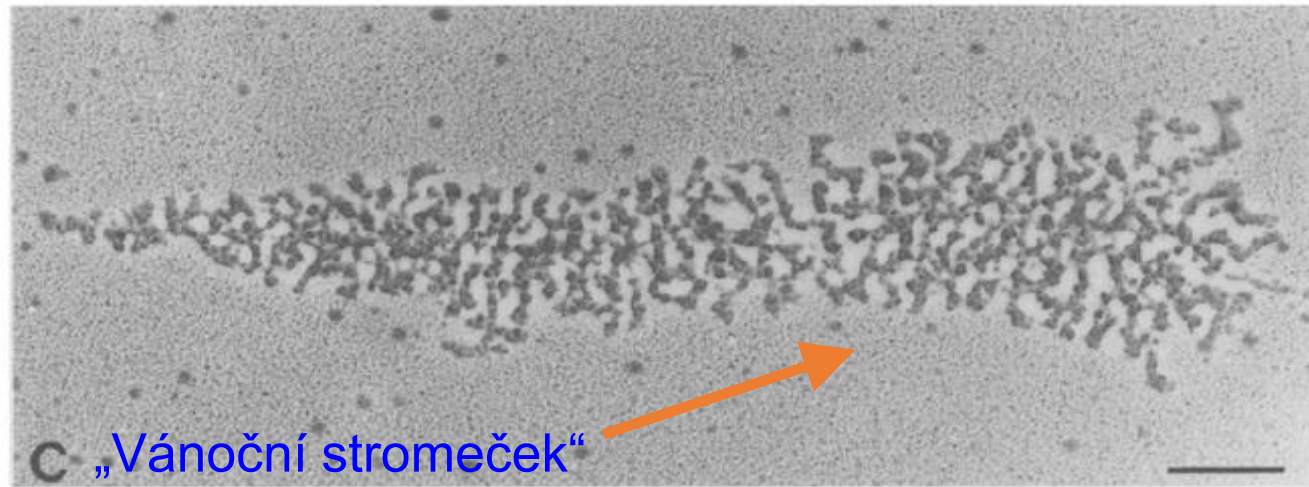
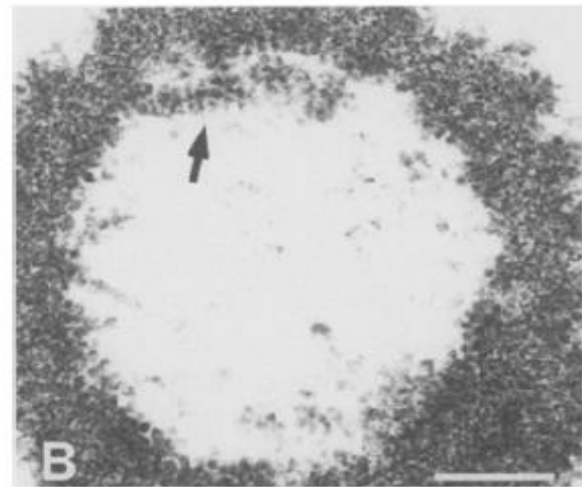
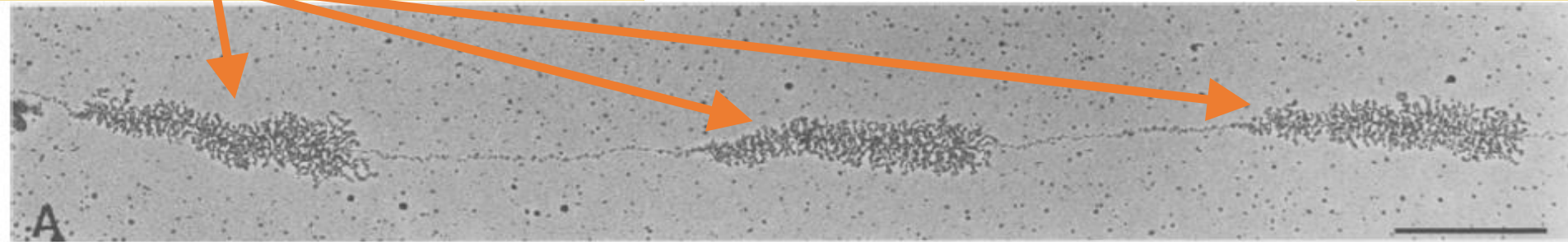
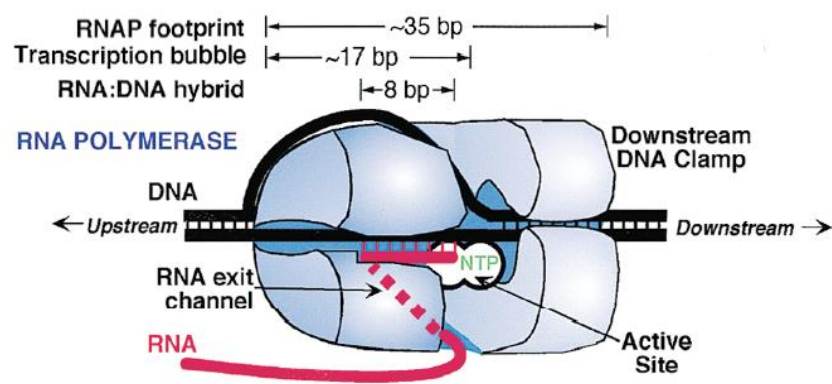


bičíky

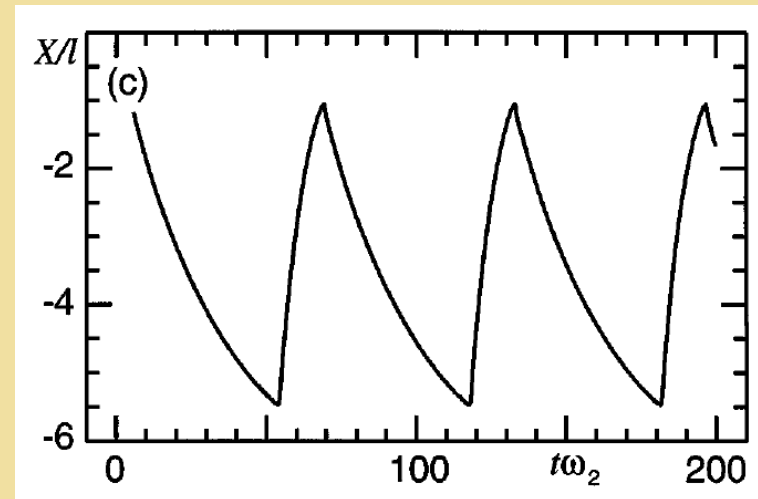
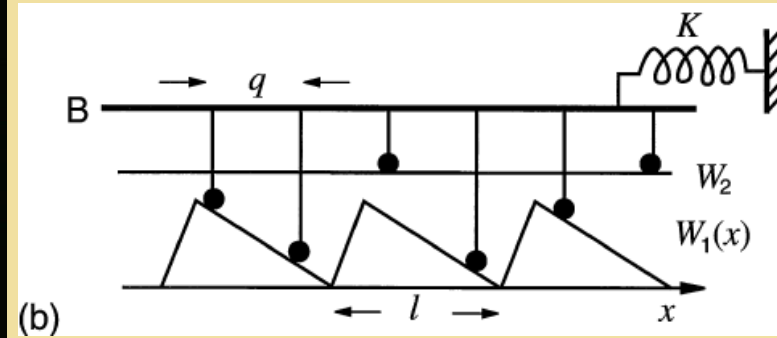
RNA polymeráza

(DNA → RNA → bílkovina)

„dopravní zácpy“

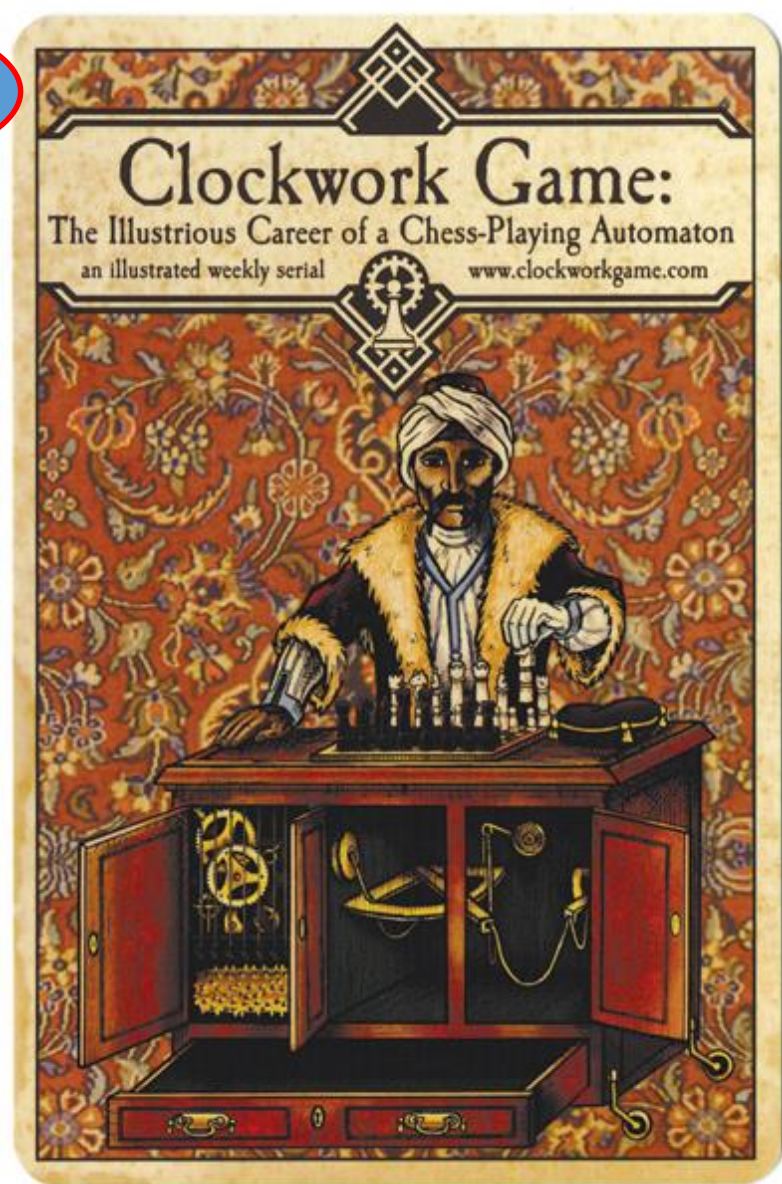


Chvění hmyzího křídla



Descartes

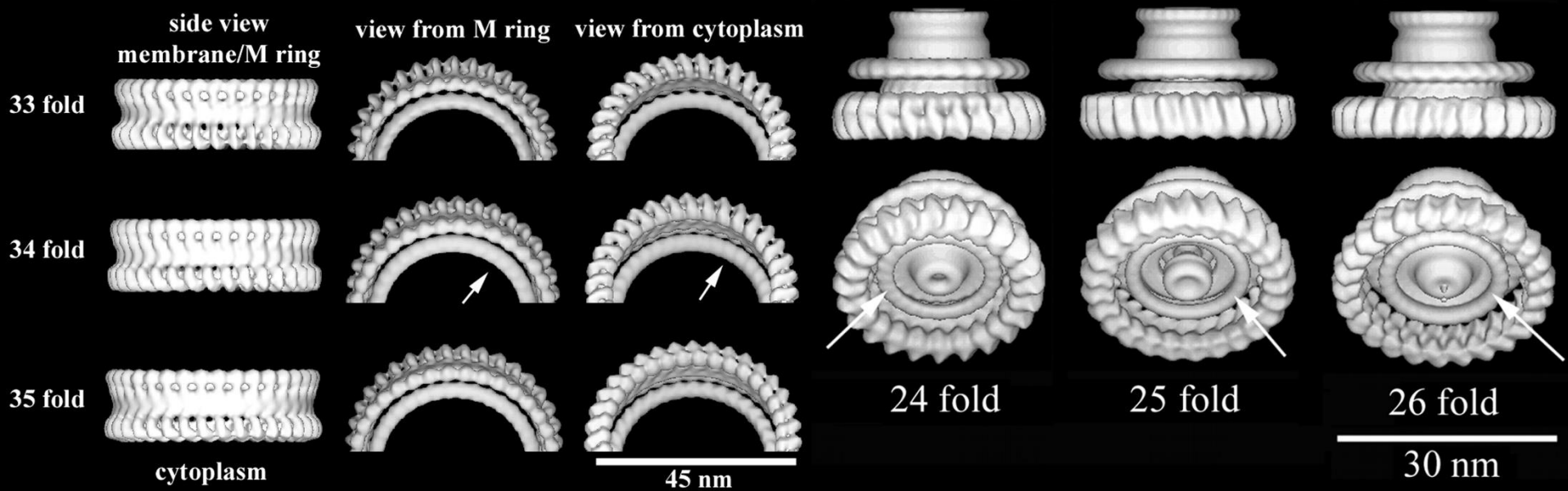
Člověk je
stroj!



Descartes měl
pravdu



Jsme jen
stroječky....



Lze to
vyrobit
uměle?

The Nobel Prize in Chemistry 2016



Ill: N. Elmehed. © Nobel
Media 2016

Jean-Pierre Sauvage

Prize share: 1/3



Photo: Northwestern
University

**Sir J. Fraser
Stoddart**

Prize share: 1/3



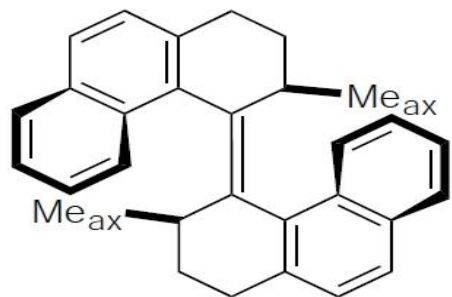
Ill: N. Elmehed. © Nobel
Media 2016

Bernard L. Feringa

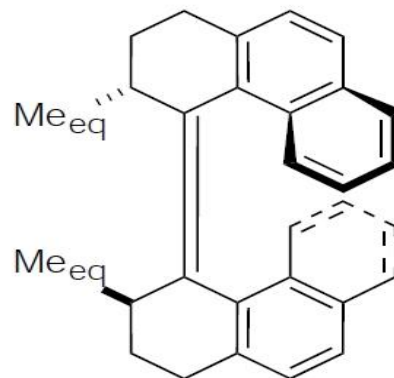
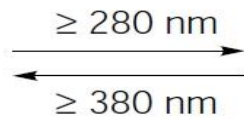
Prize share: 1/3

Stator a rotor

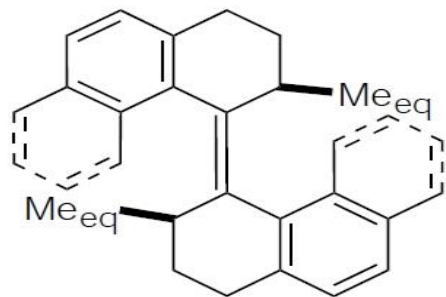
pohon:
ultrafialové světlo



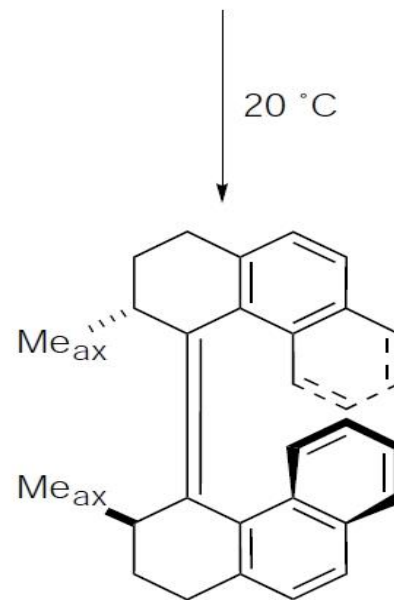
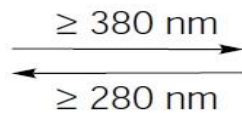
(P,P)-*trans*-**1**



(M,M)-*cis*-**2**



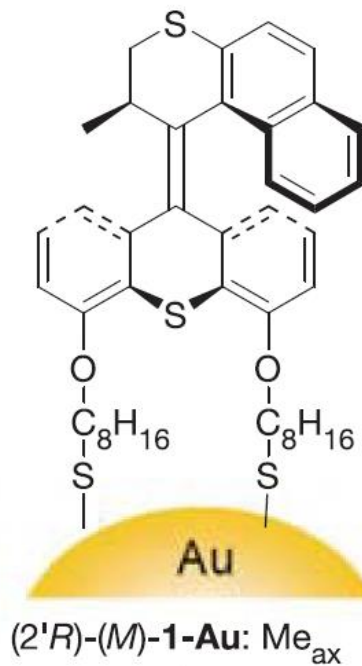
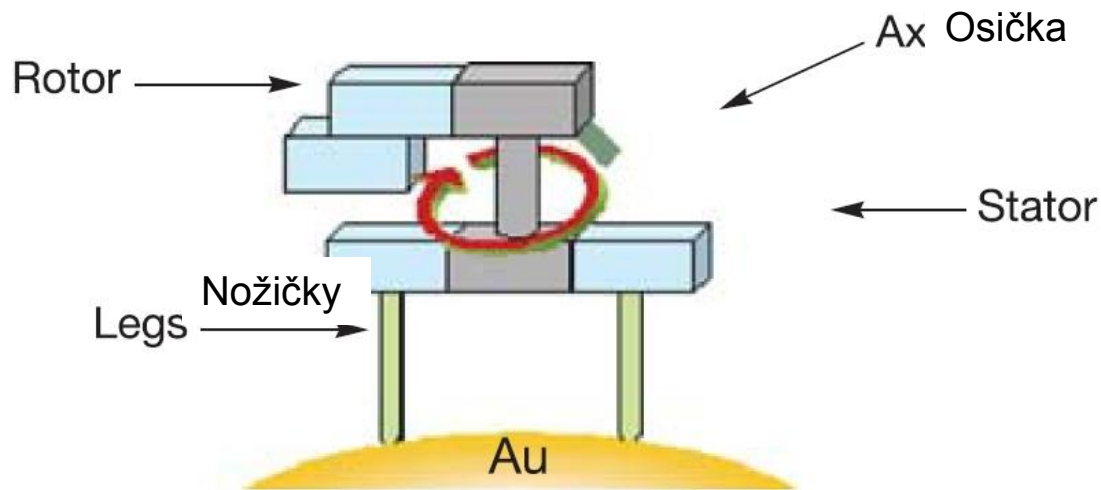
(M,M)-*trans*-**1**



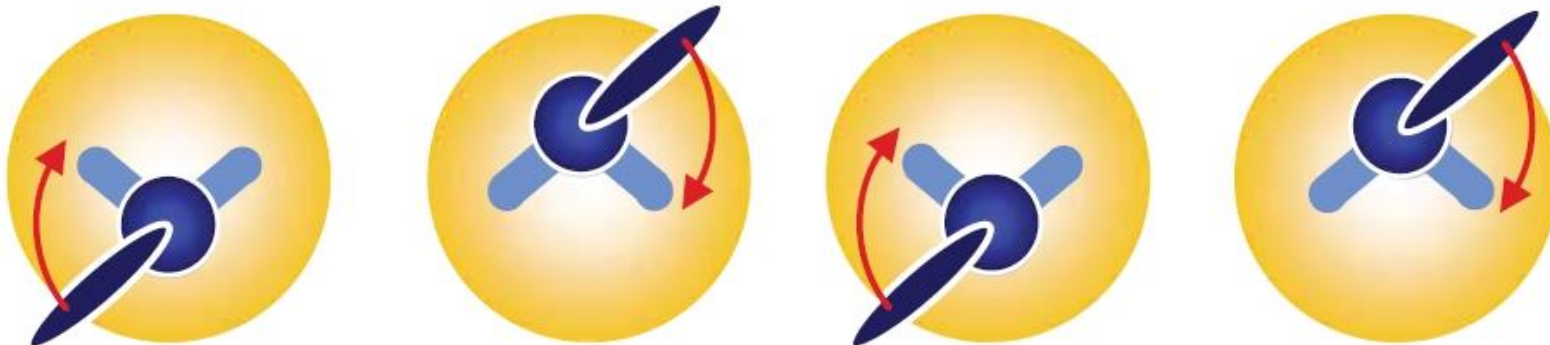
(P,P)-*cis*-**2**



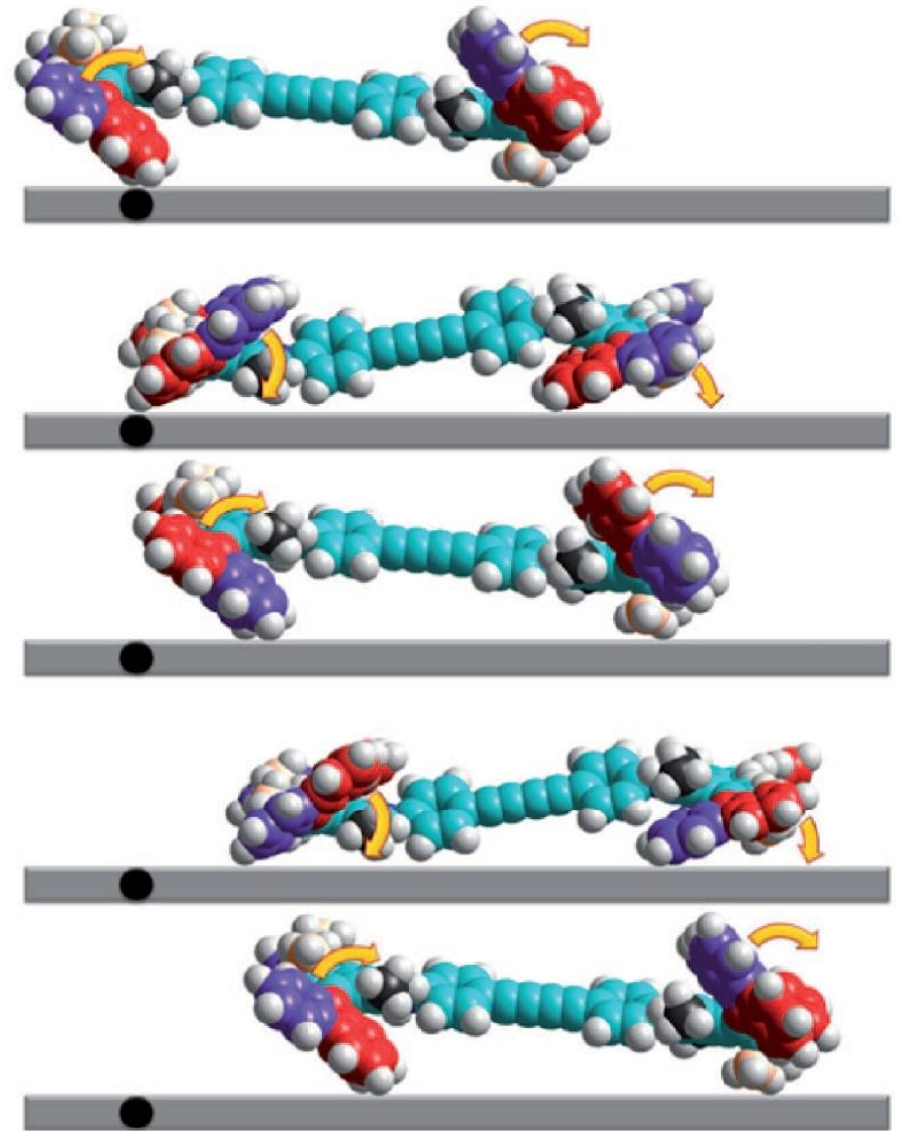
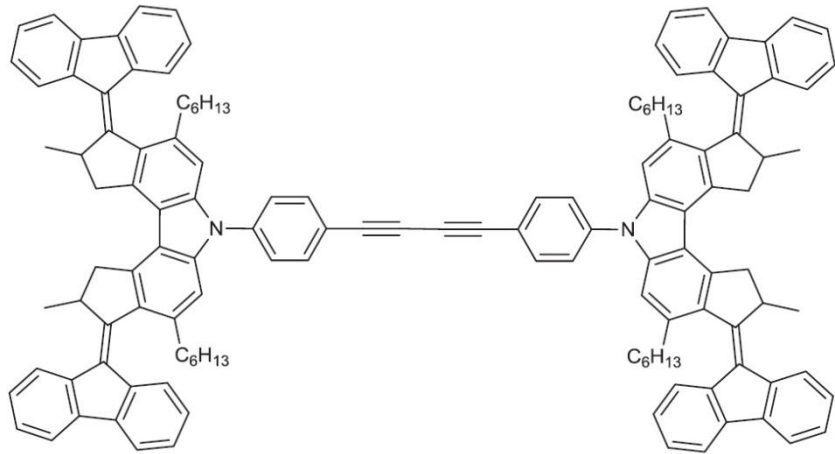
Molekulární ventilátor



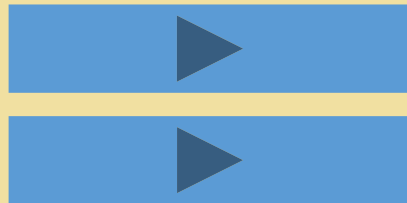
Pohled shora



Molekulární autíčko

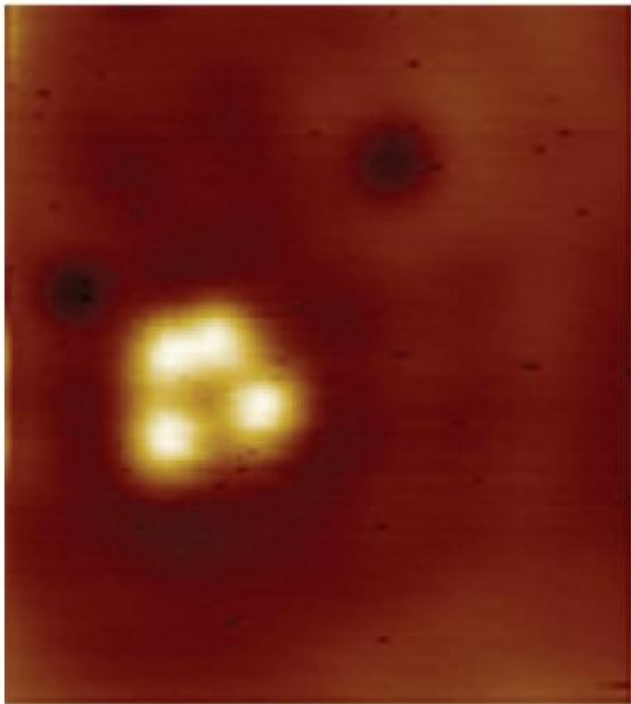
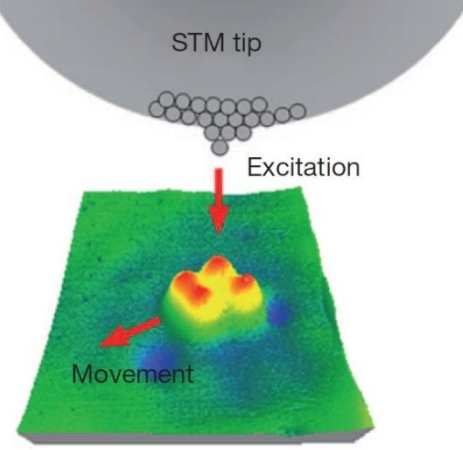


Spíš molekulární
krtek!

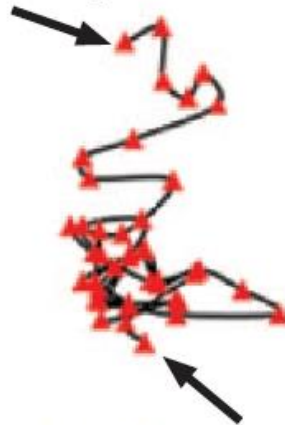


Jak to můžeme vidět?

STM = skenovací tunelovací mikroskop



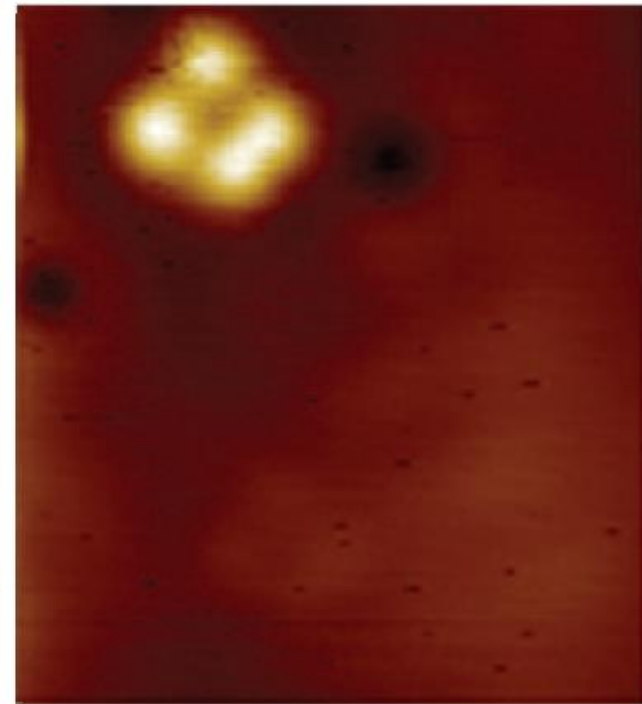
Koncová poloha



Počáteční poloha



40 krát excitace



Co ty na to, Jene Ámosi?

Jen jediného
jest zapotřebí!

