Biological applications of elasticity theory

18.354 - L11

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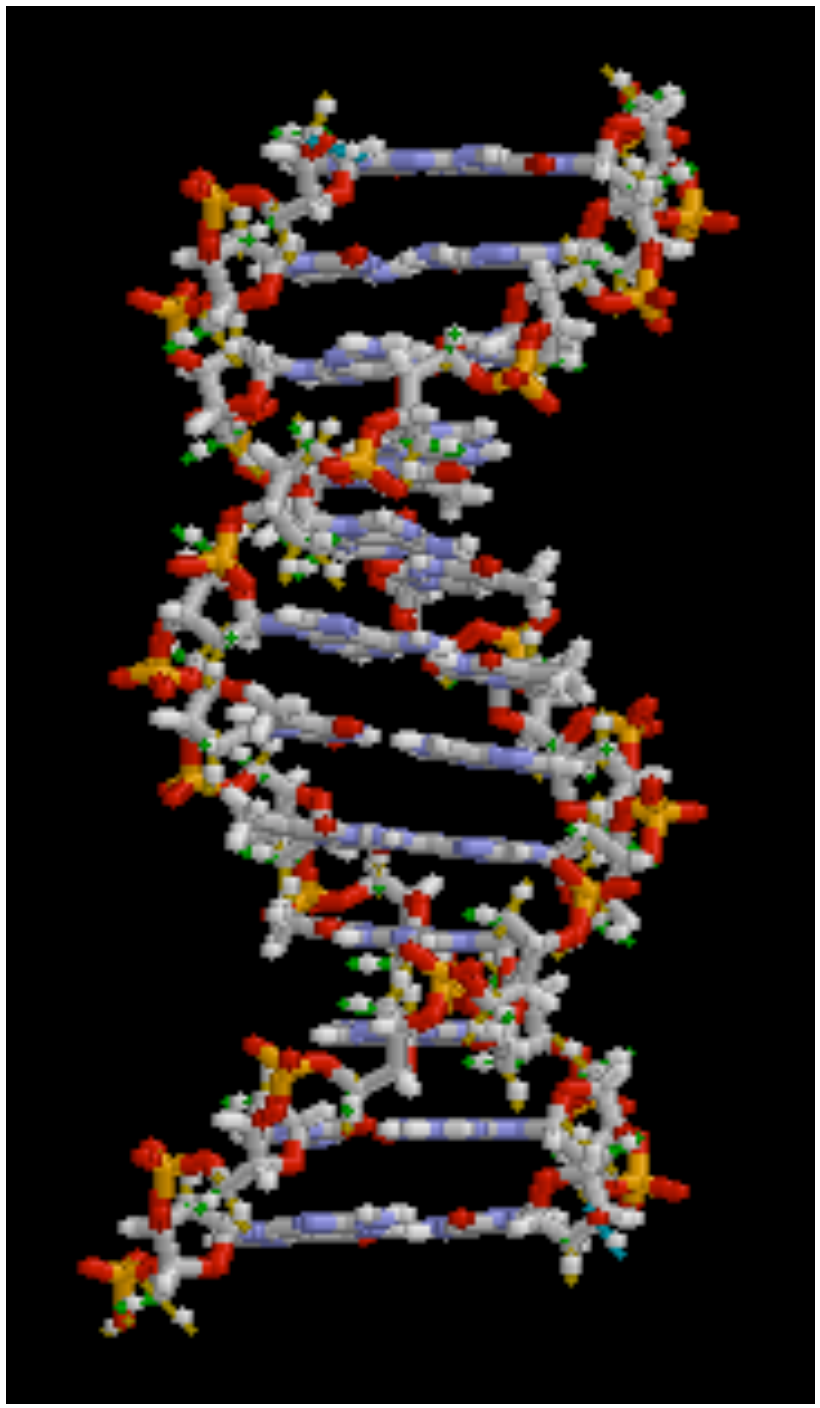
Polymers

DNA = biopolymer pair



~ 3m per cell

~ 10^14 cells/human

> max. distance between Earth and Pluto (~50 AU = 7.5 x 10^12 m)

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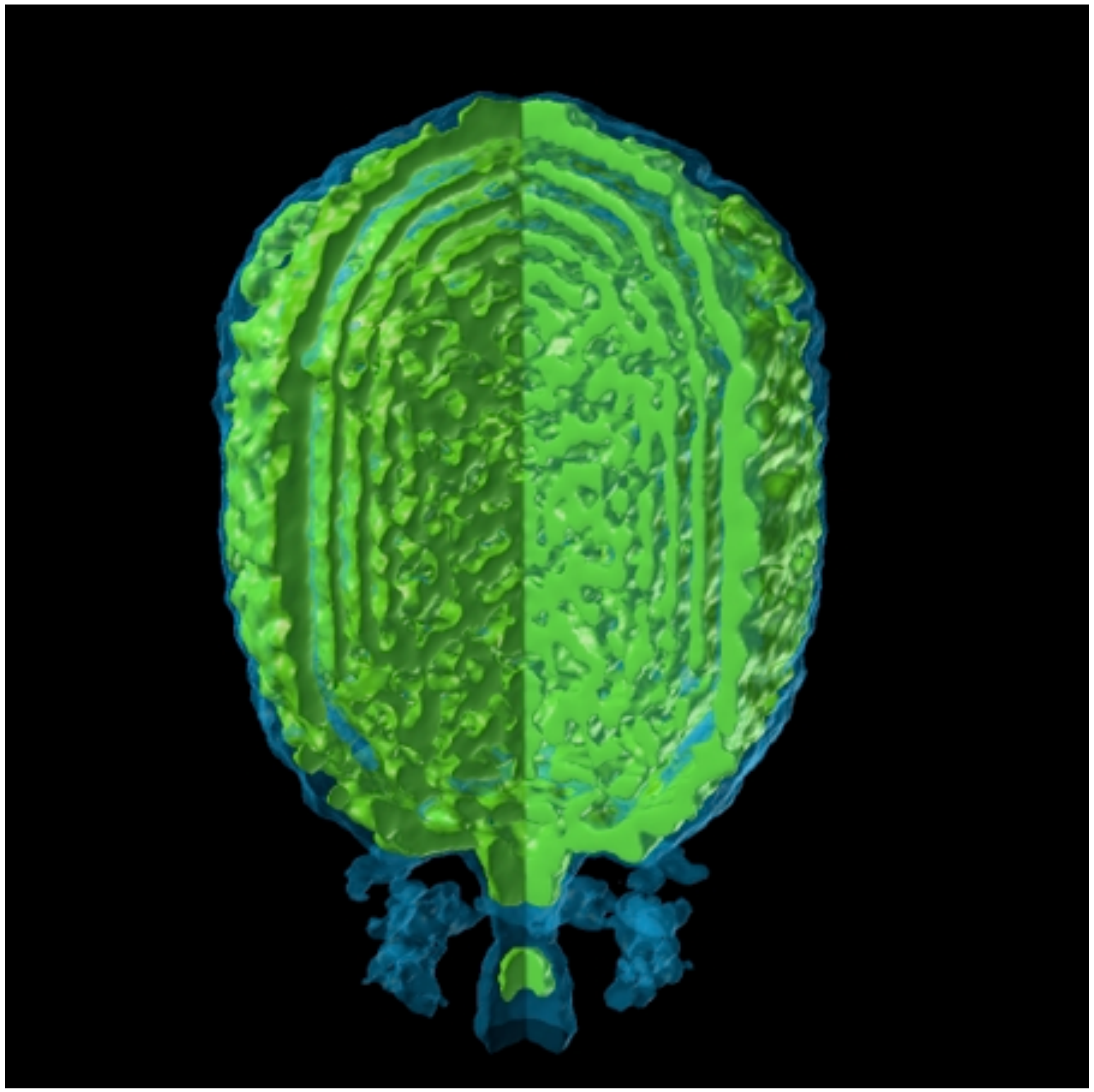
DNA packaging



Virus Phi-29

http://www.mit.edu/~kardar/teaching/projects/dna_packing_website/

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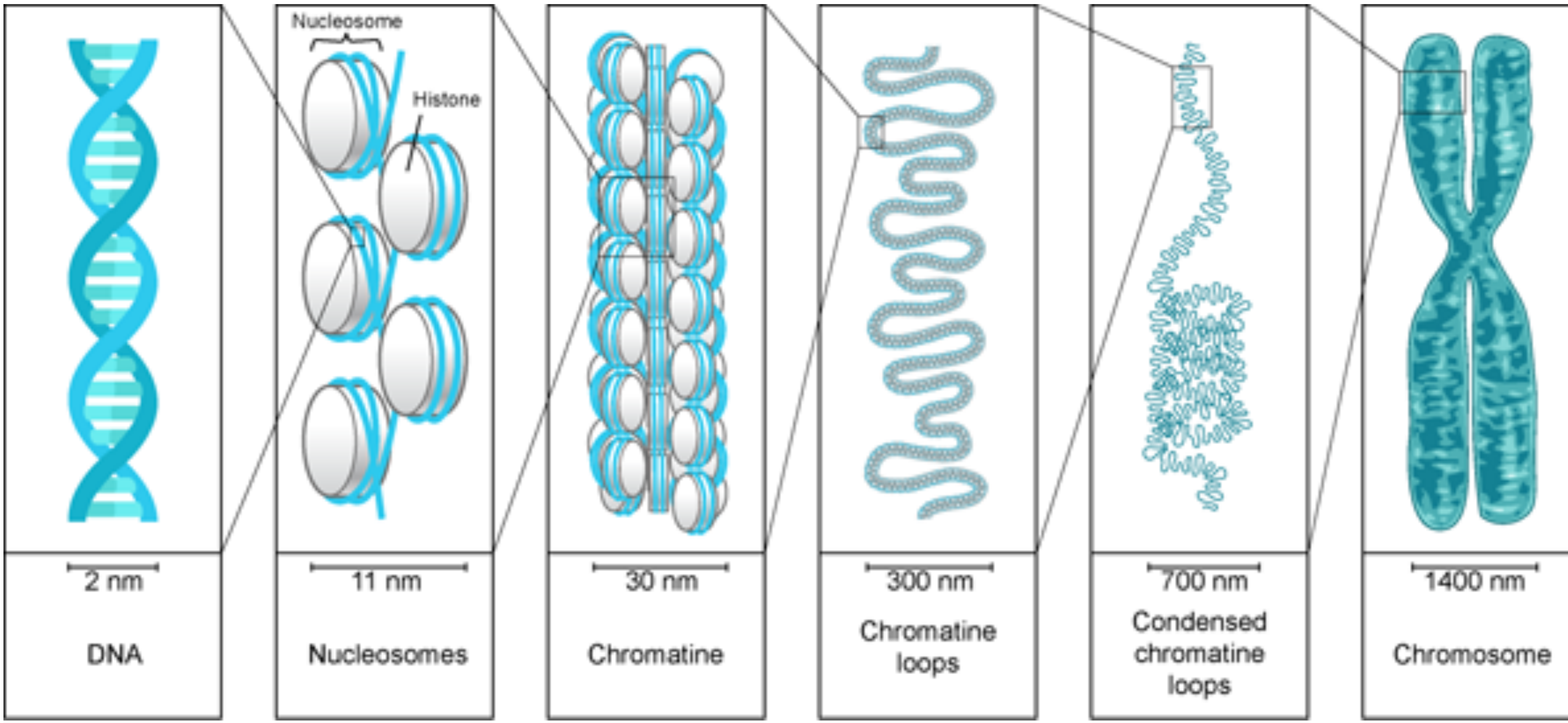
DNA packaging in eukaryotes



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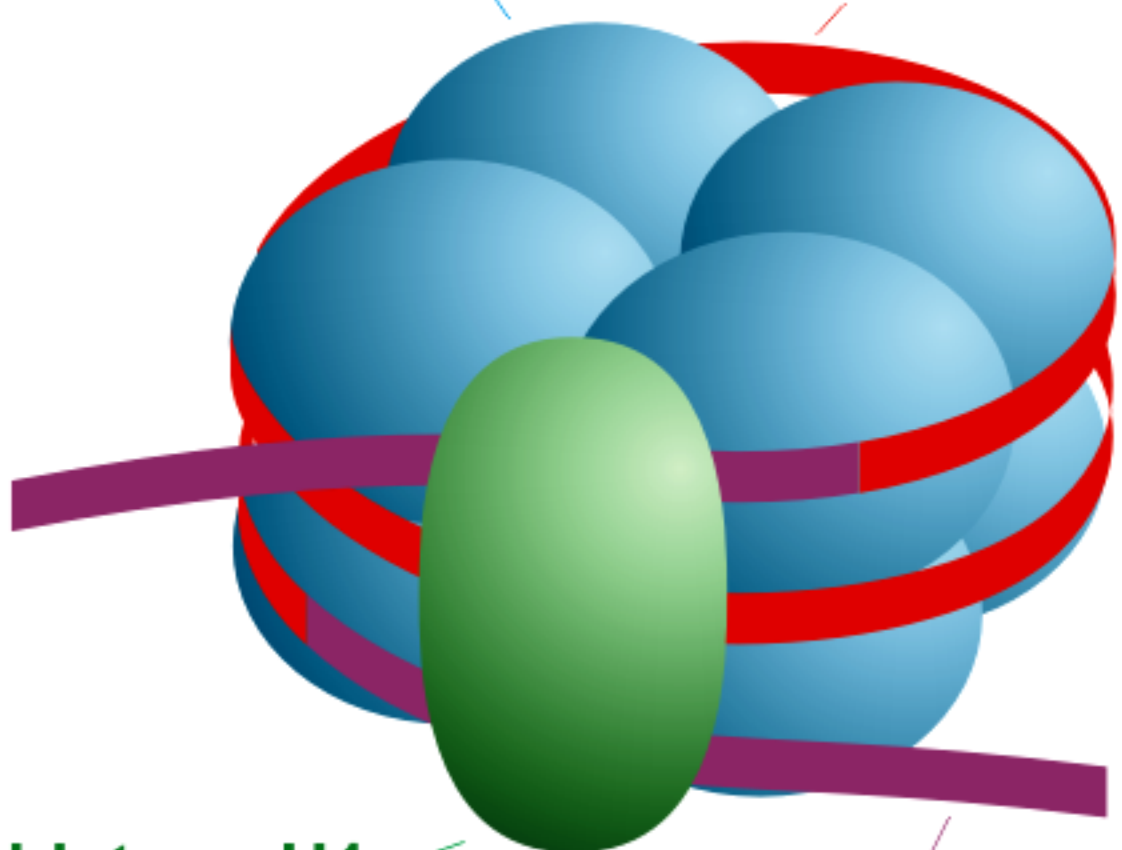
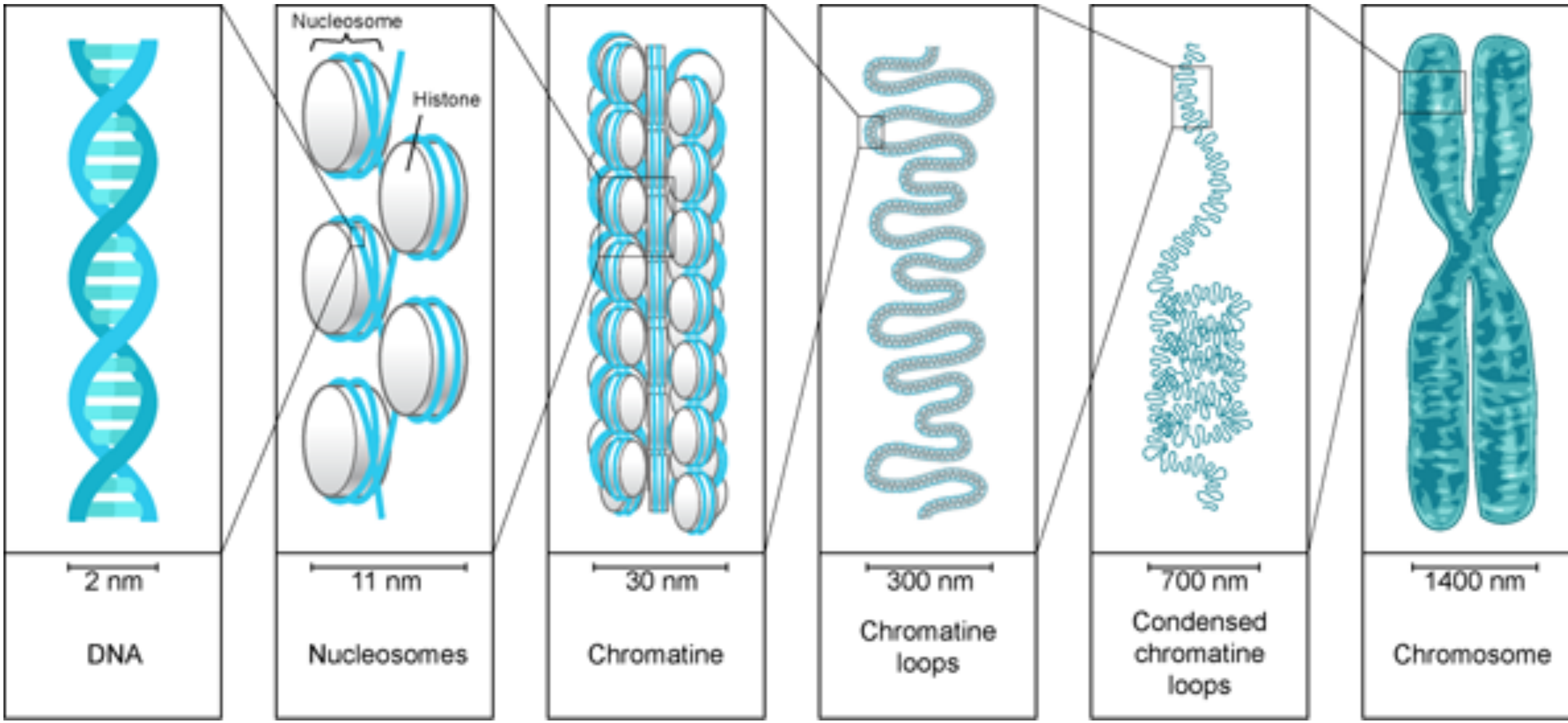
Nucleosomes



DNA packaging in eukaryotes



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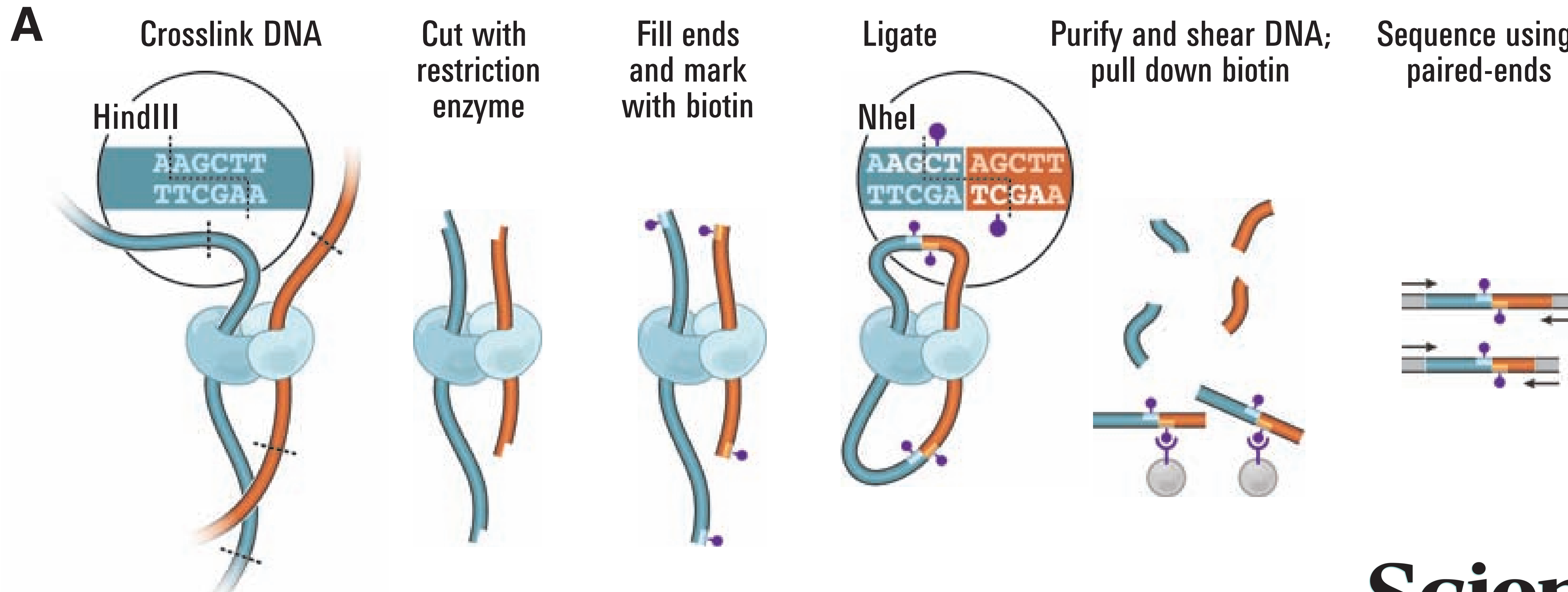
DNA packaging in humans



Lieberman-Aiden et al.
(2011) Science

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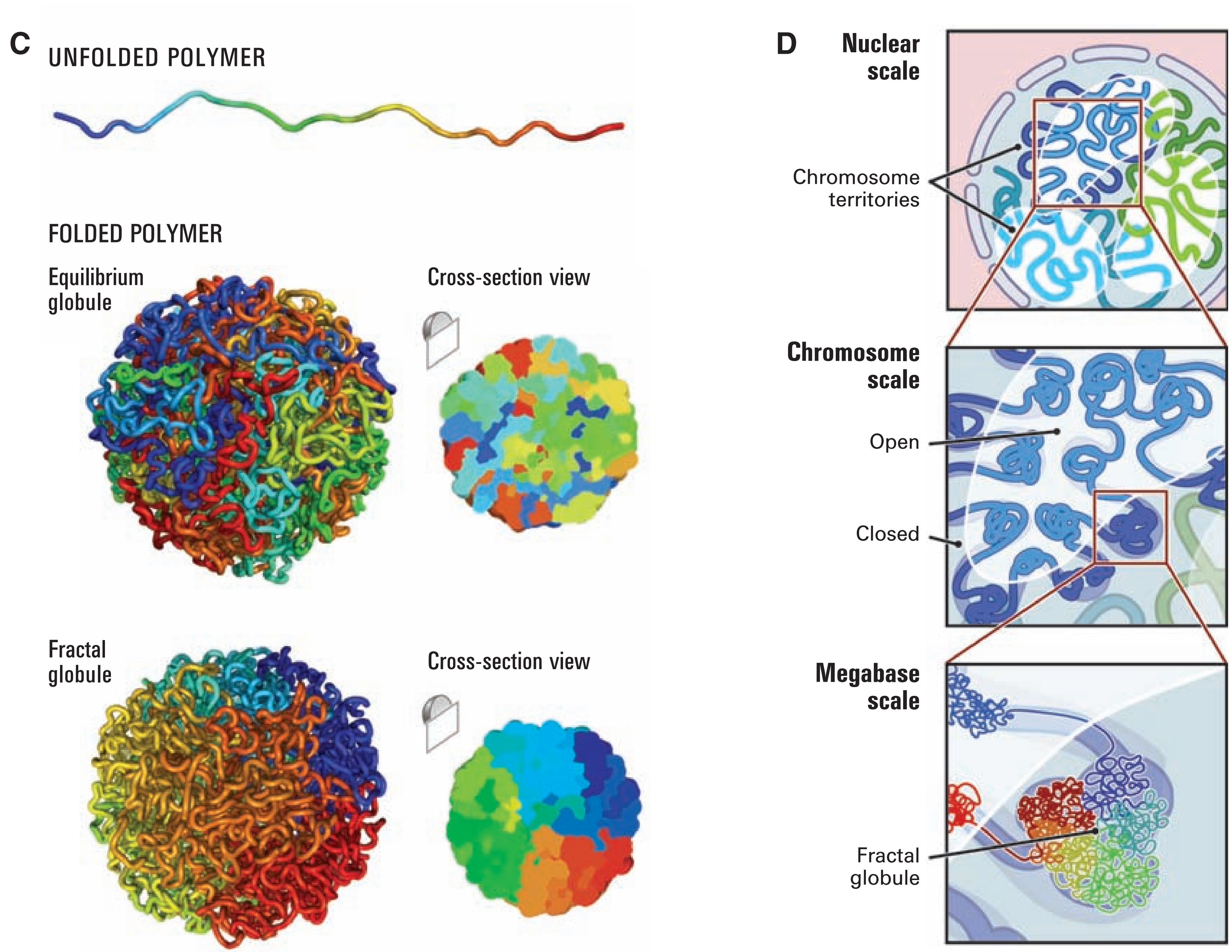
DNA packaging in humans



Lieberman-Aiden et al. (2011) Science

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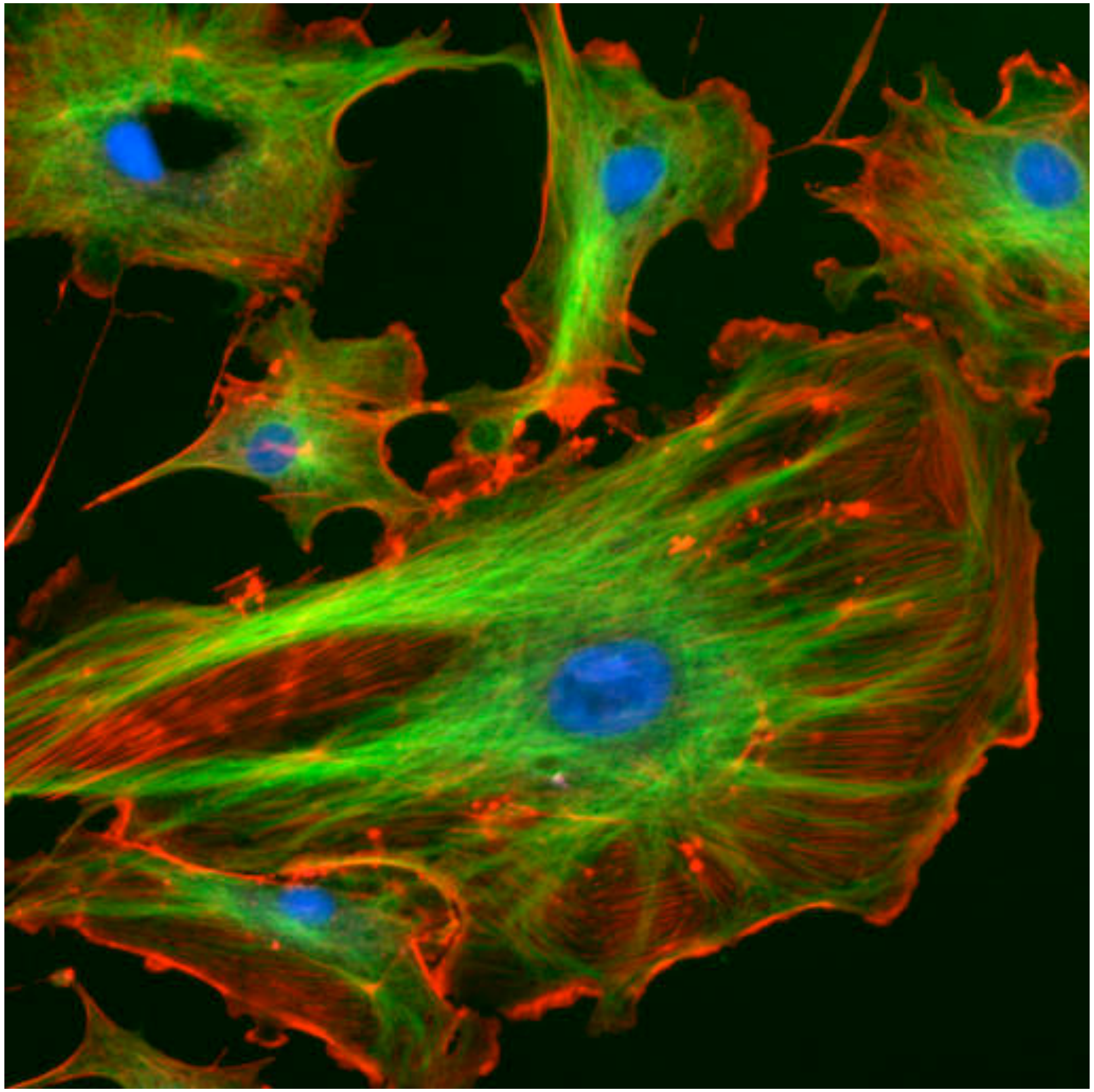
Cyto-skeleton



eukaryotic cells (source: wiki)

Nucleus

Actin

Microtubuli

mechanical properties, network topology, ...

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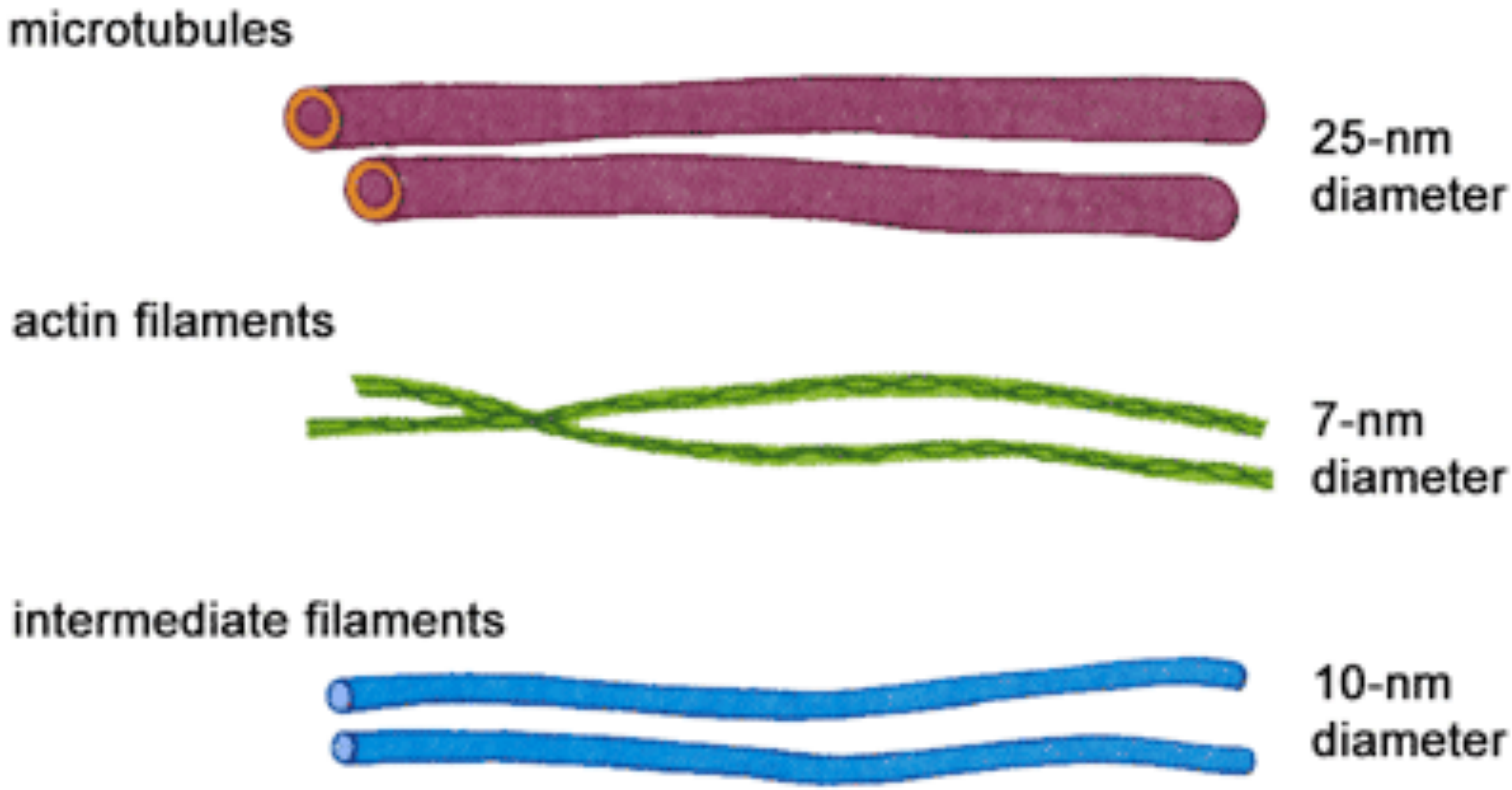
Cyto-skeleton



http://library.thinkquest.org/C004535/cytoskeleton.html

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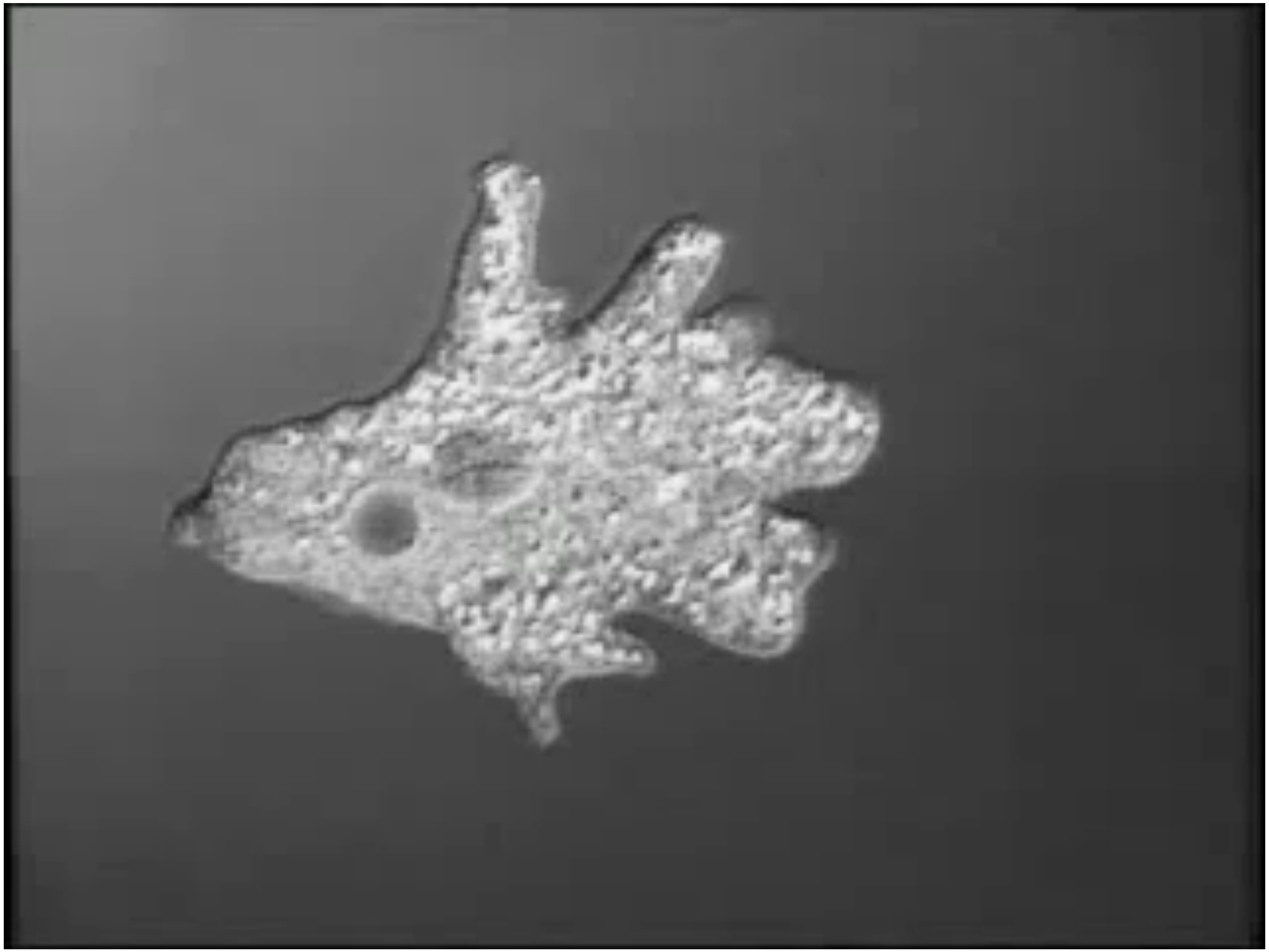
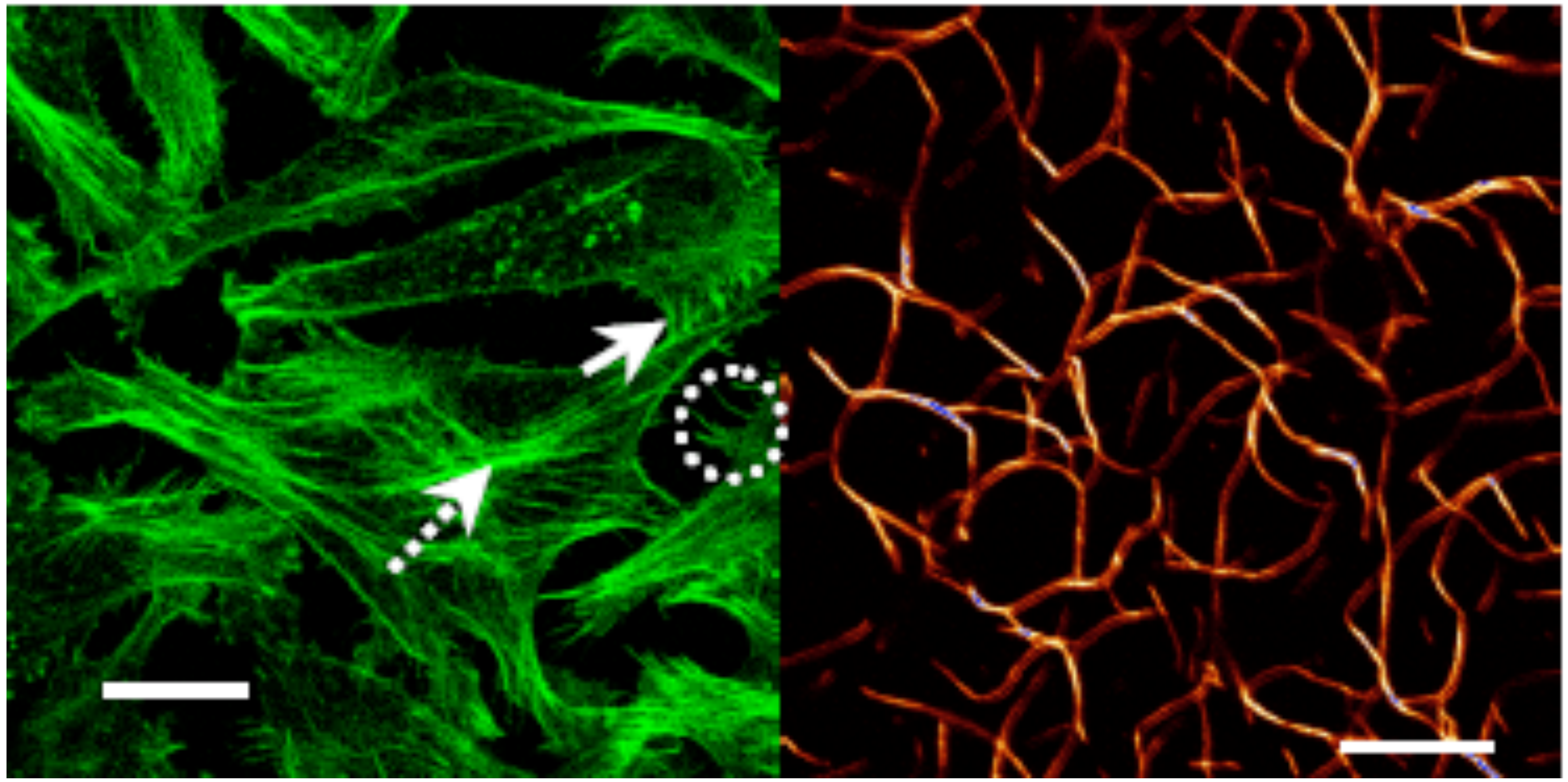
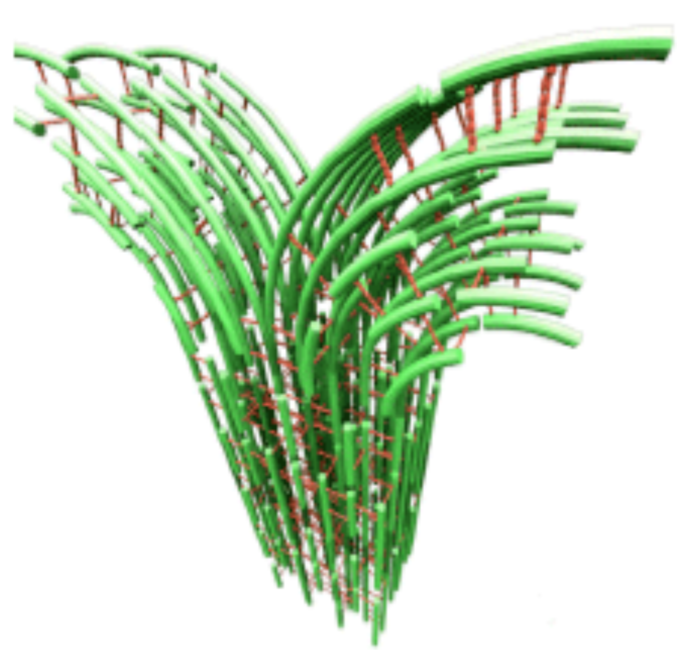
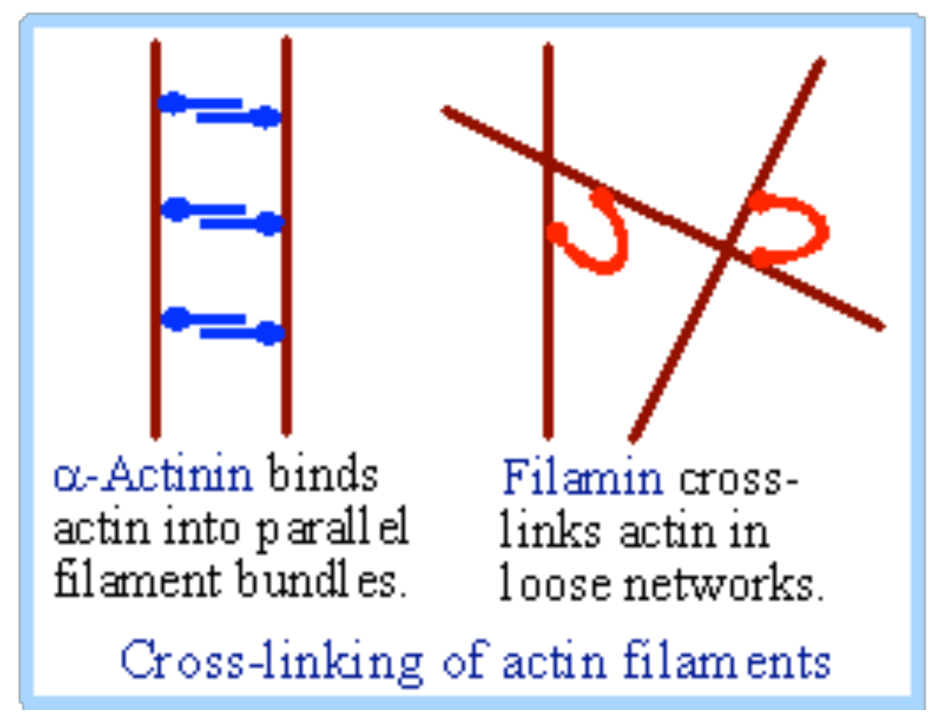
Amoeba



Actin bundles







http://www-ssrl.slac.stanford.edu/research/highlights_archive/actinin.html

Cyto-skeleton

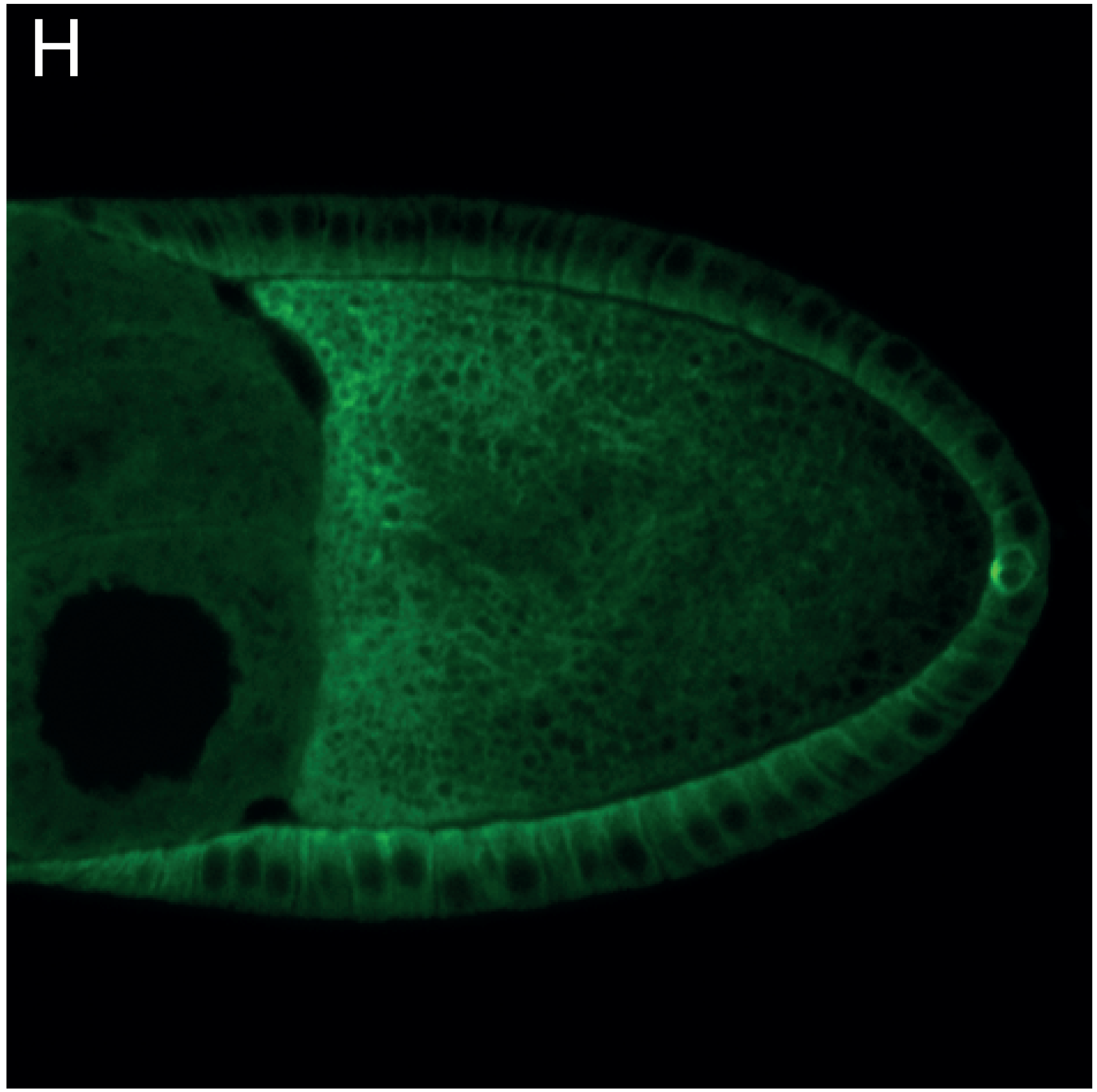
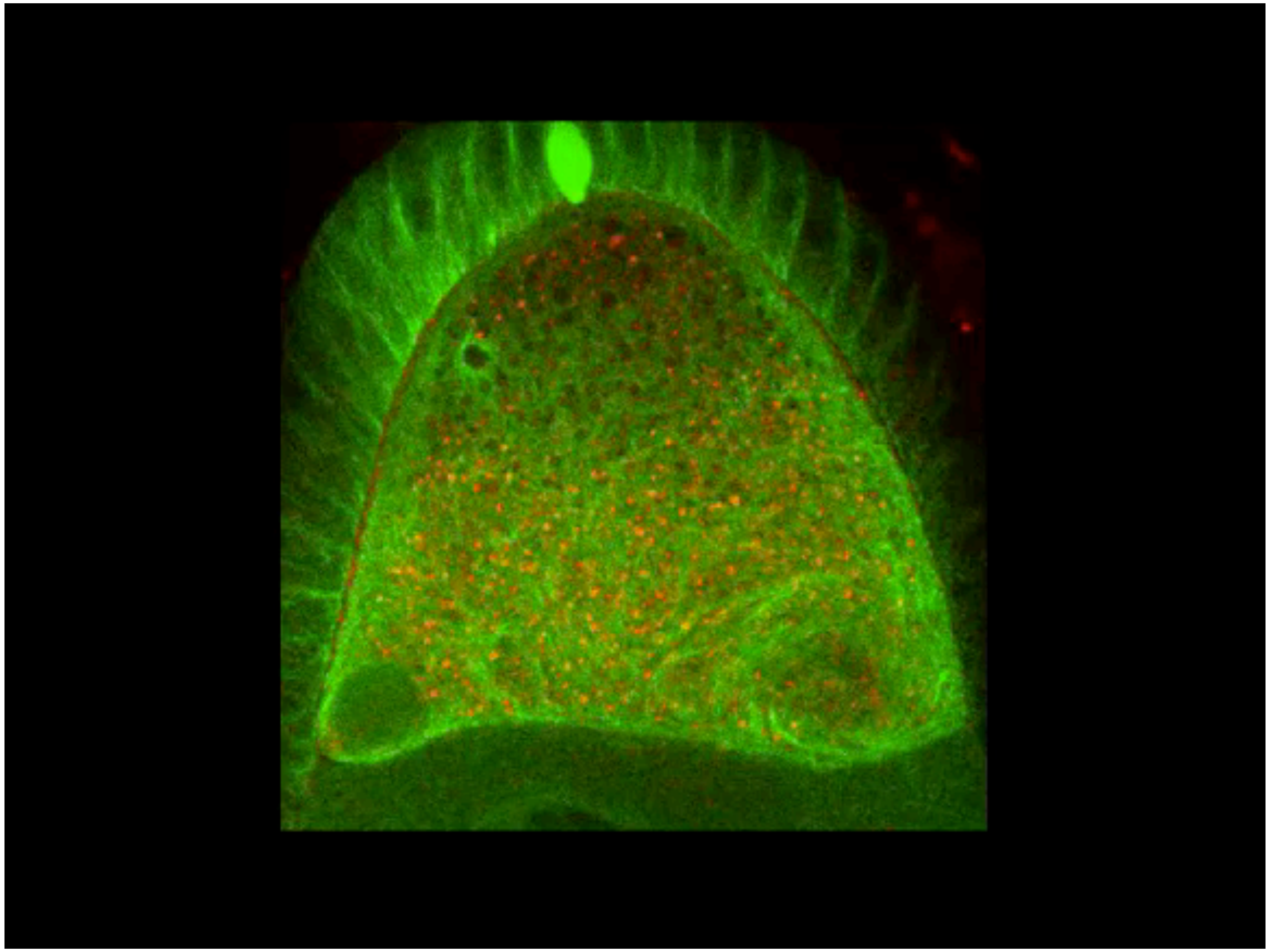


photo:
Philipp Khuc- Trong

Microtubuli network in Drosophila embryo

Polymers & filaments



Drosophila oocyte

Physical parameters (e.g. bending rigidity) from fluctuation analysis

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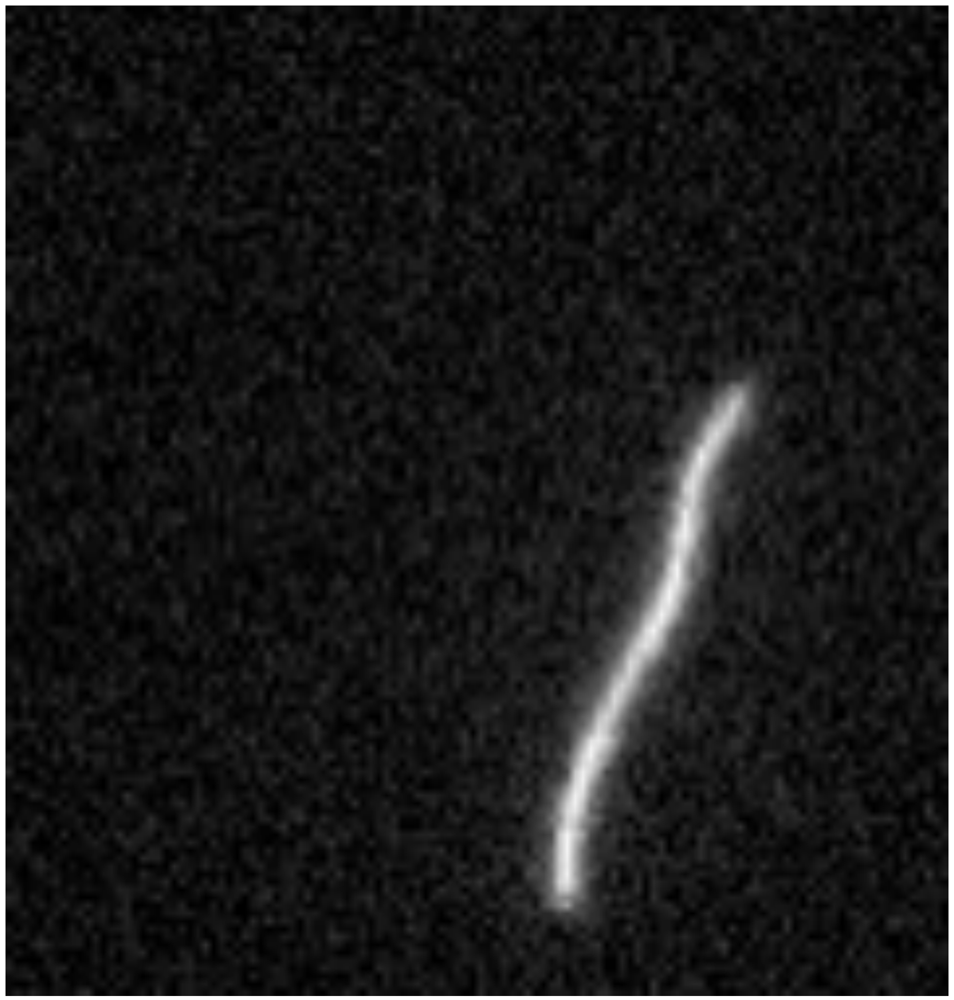
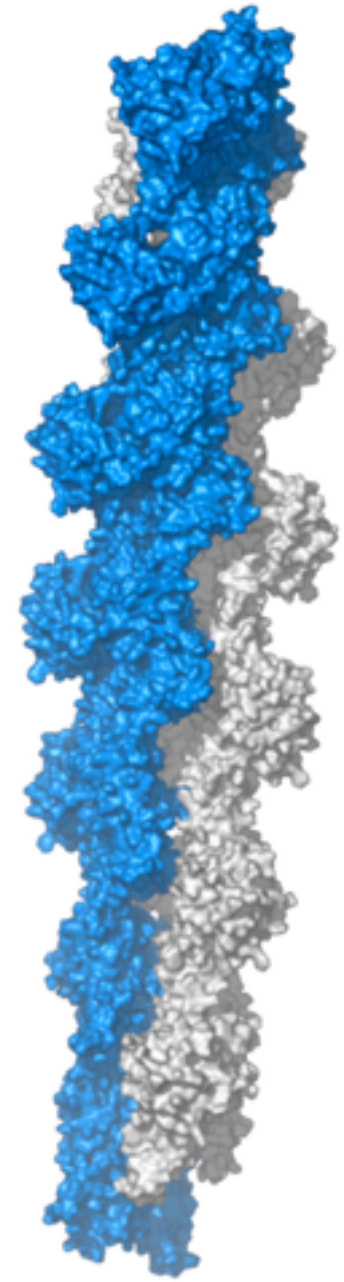
Actin in 2D



Dogic Lab (Brandeis)



F-Actin

helical filament

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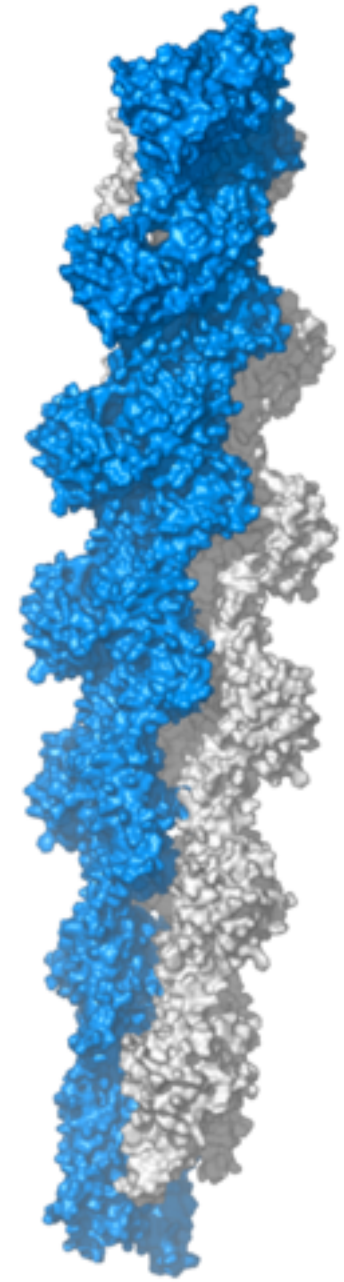
Actin in 2D



F-Actin

helical filament

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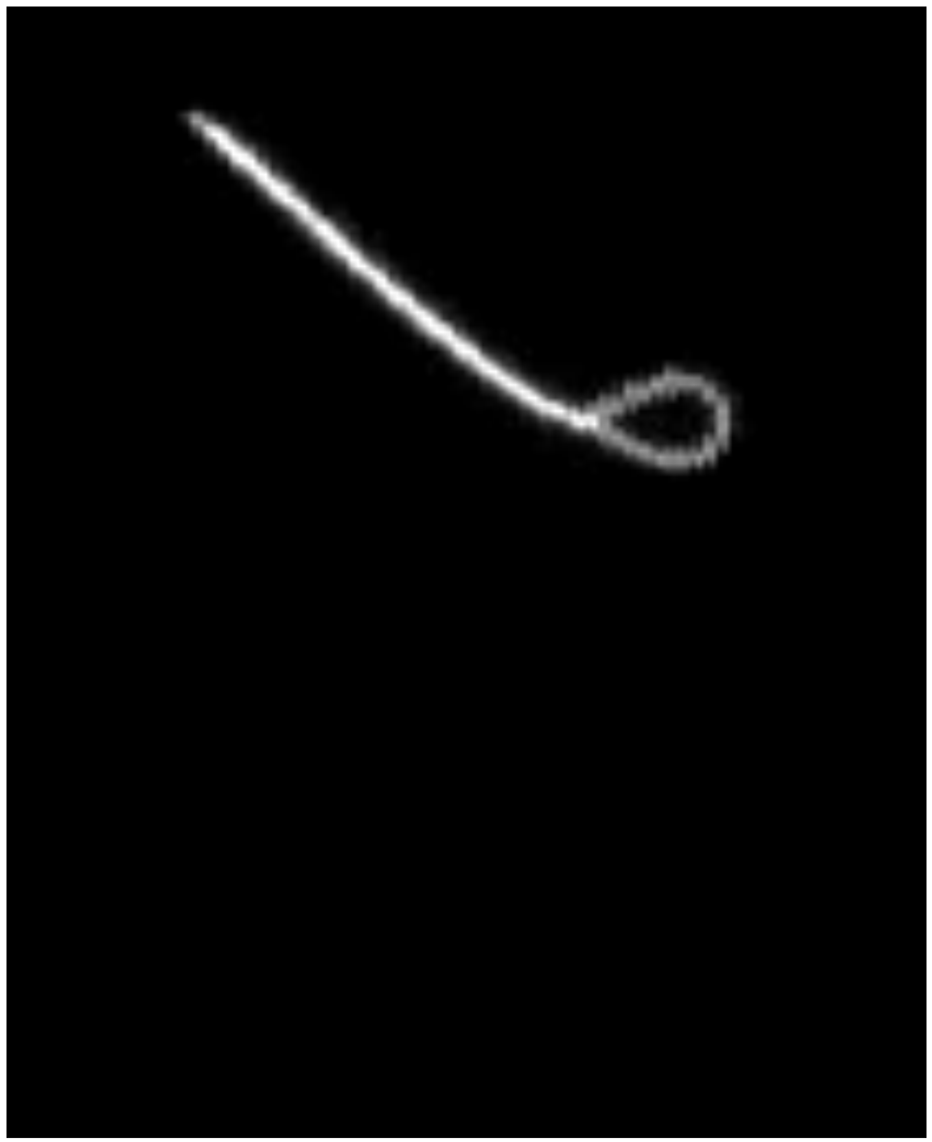
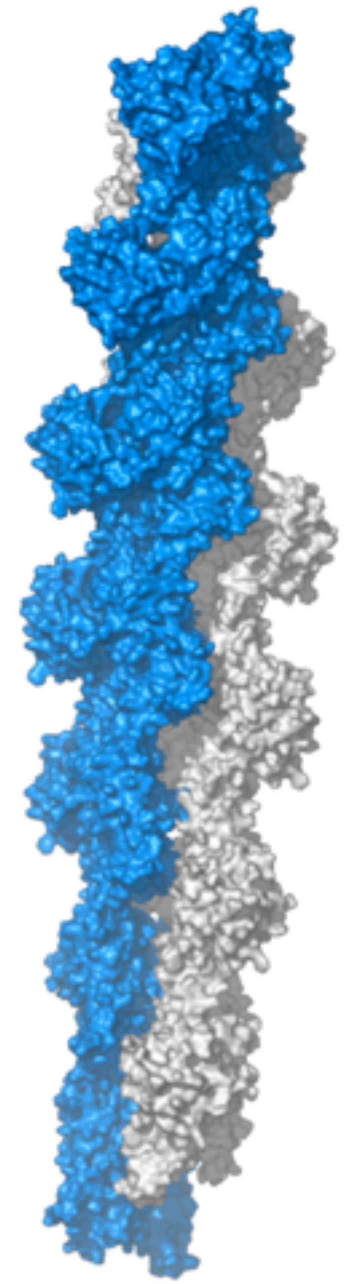
Actin in 2D



with attractive solvent



F-Actin

helical filament

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Actin in flow

PRL 108, 038103 (2012) PHYSICAL REVIEW LETTERS week ending 20 JANUARY 2012

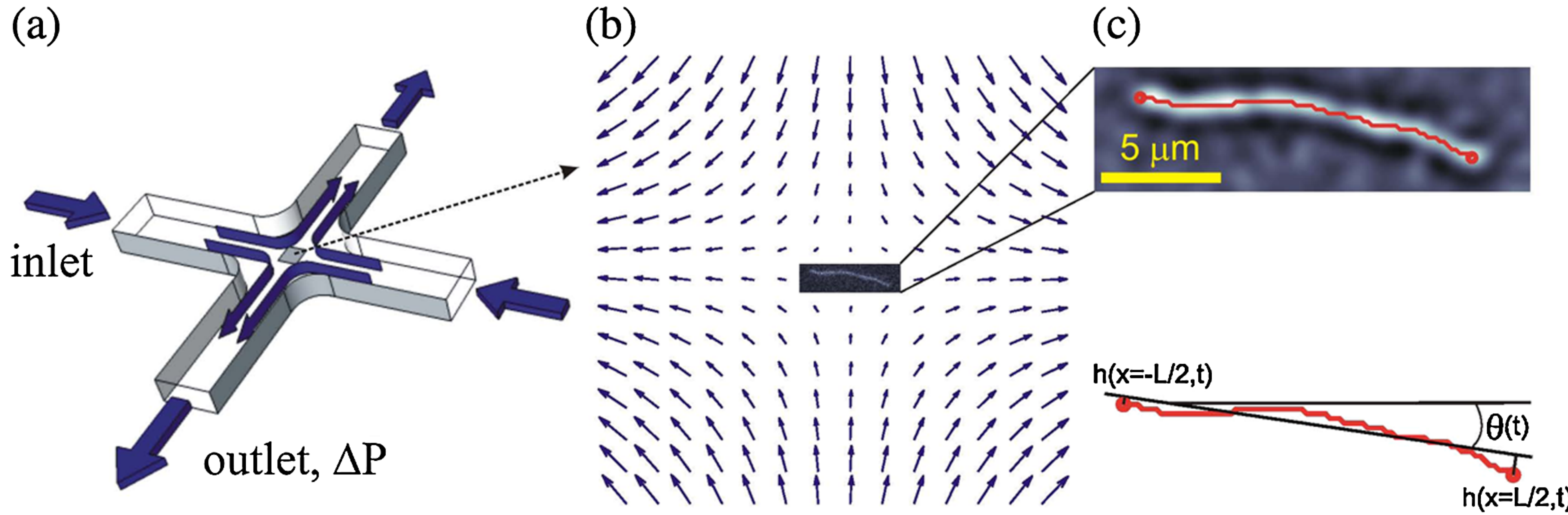
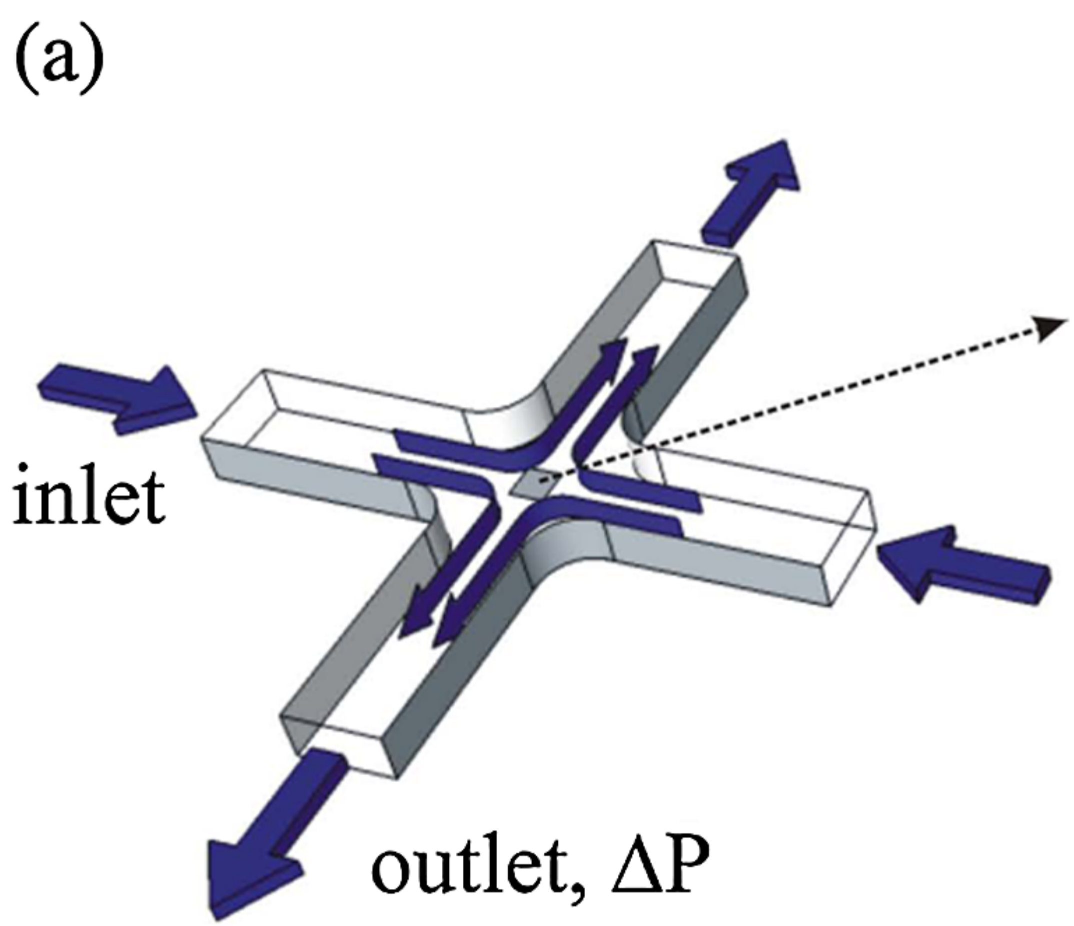
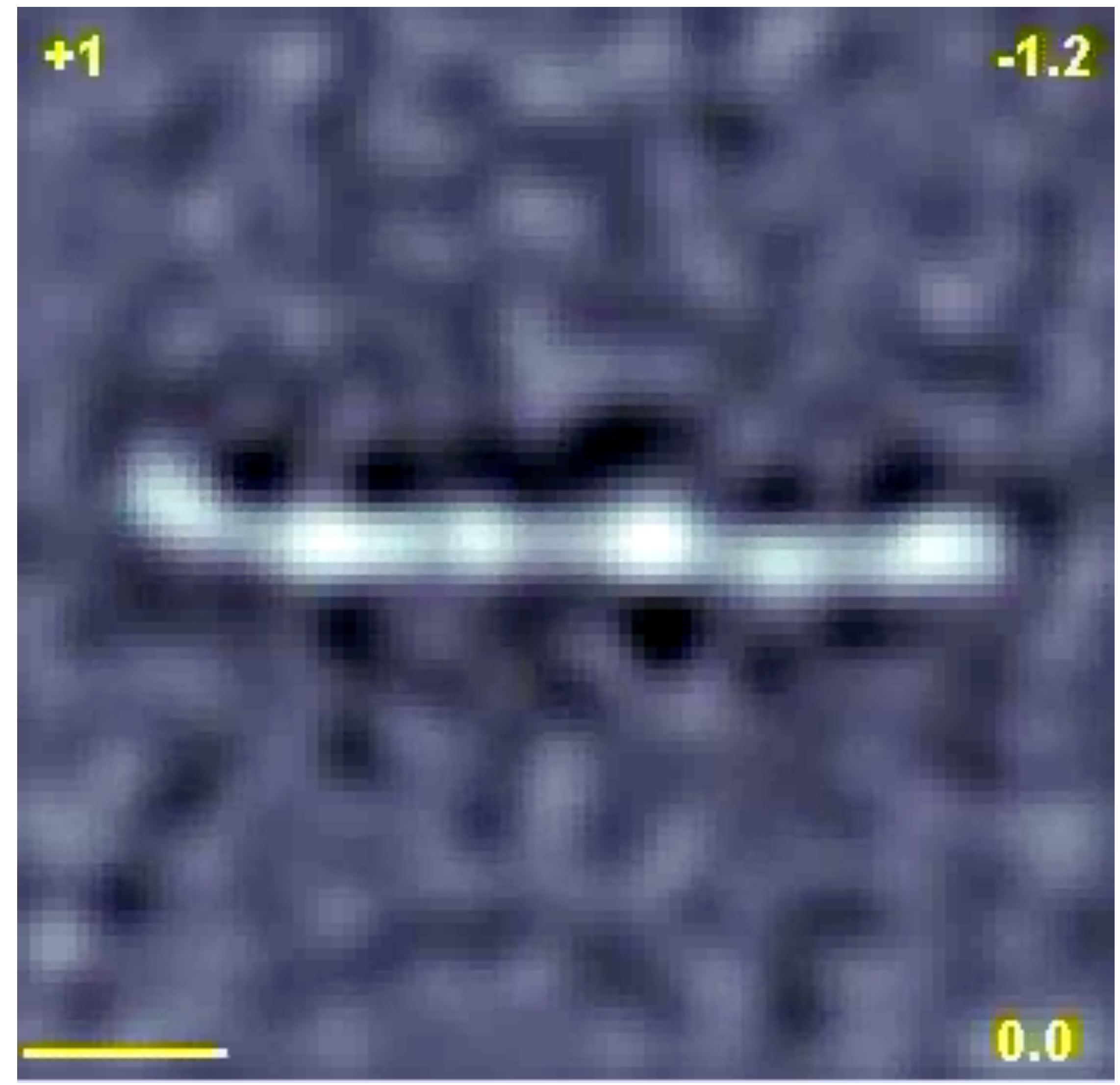


FIG. 1 (color online). Experimental setup. (a) Microfluidic cross-flow geometry controlled by a pressure difference ΔP between inlet and outlet branches. (b) Close-up of the velocity field near the stagnation point, showing a typical actin filament. (c) Raw contour (red) of an actin filament and definition of geometric quantities used in the analysis.

Kantsler & Goldstein (2012) PRL

Actin in flow





Kantsler & Goldstein (2012) PRL

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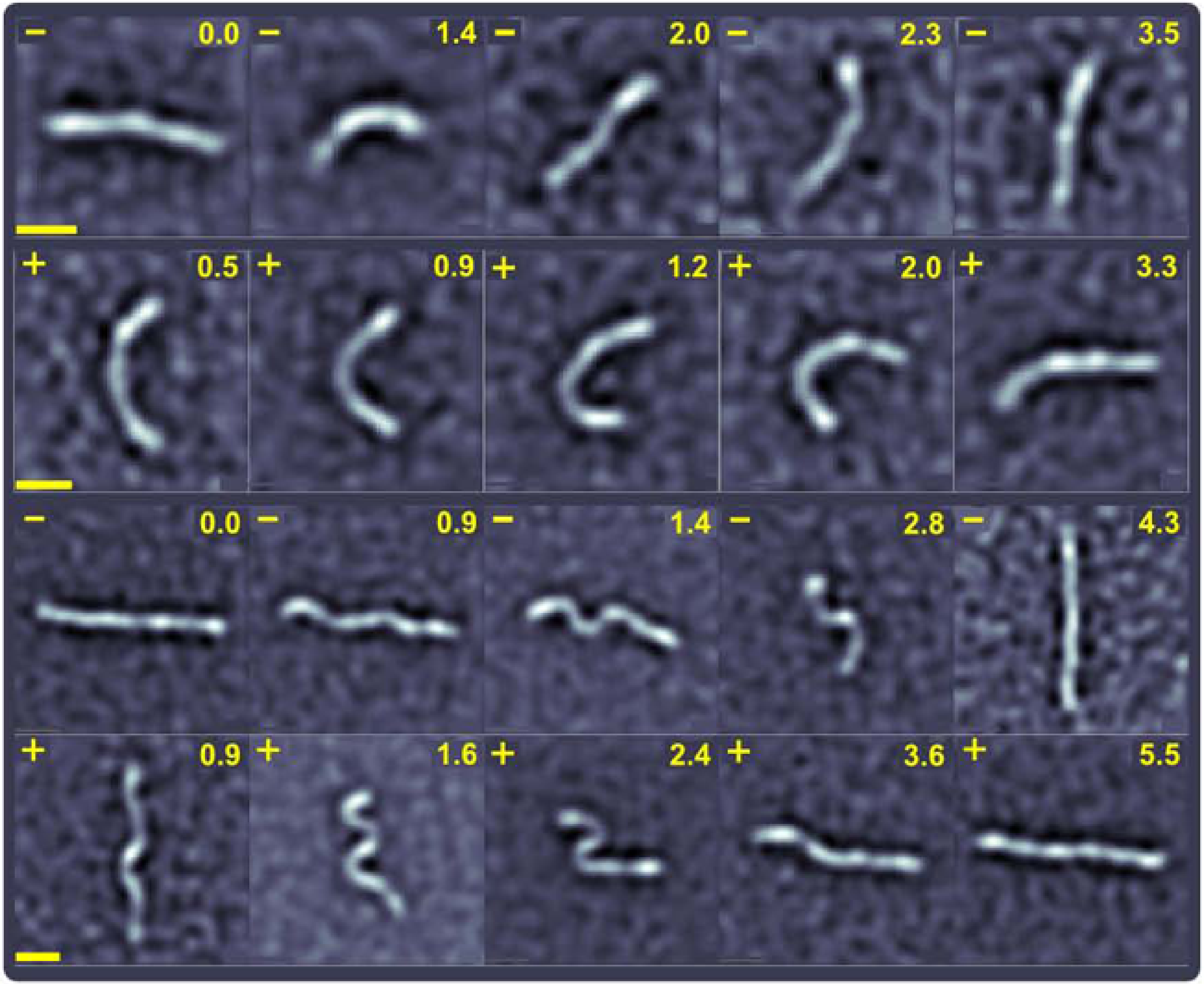
Actin in flow

(a)

(b)

(c)



Kantsler & Goldstein (2012) PRL

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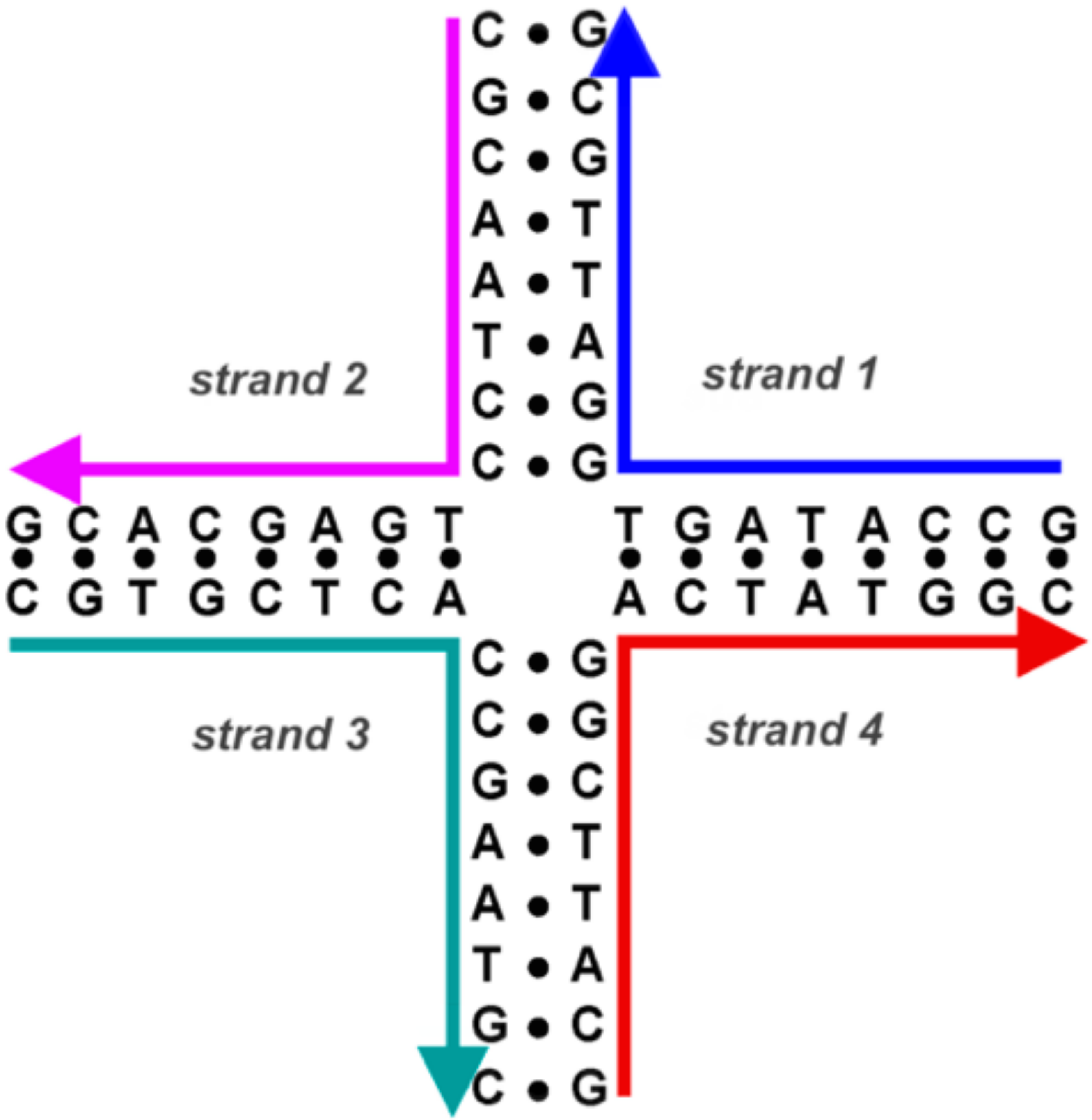
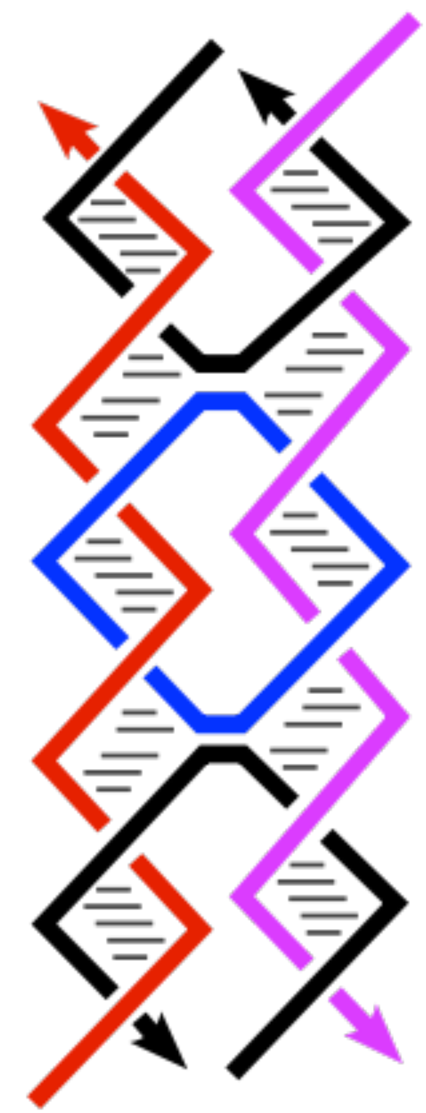
DNA Origami - principle





source: wiki

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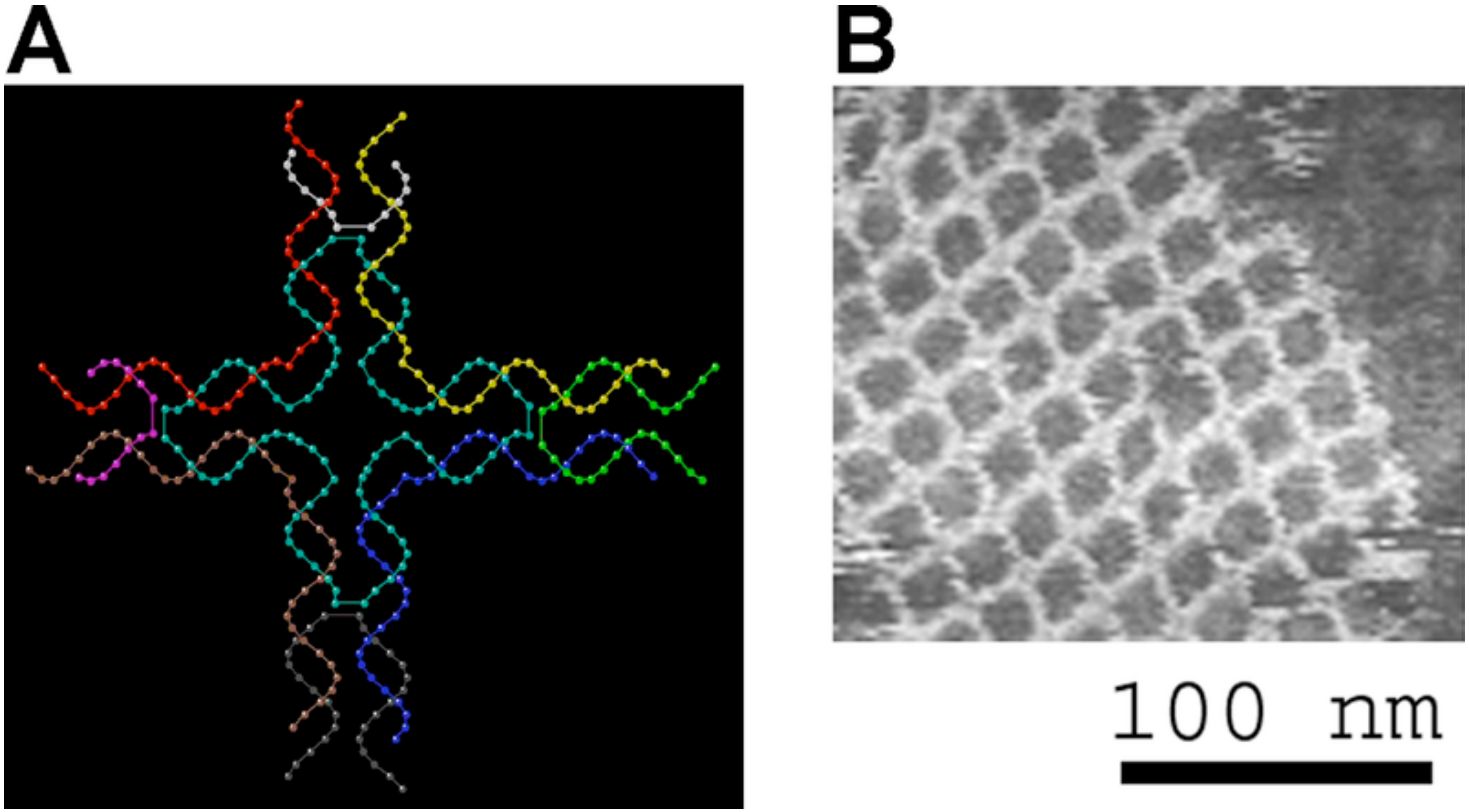
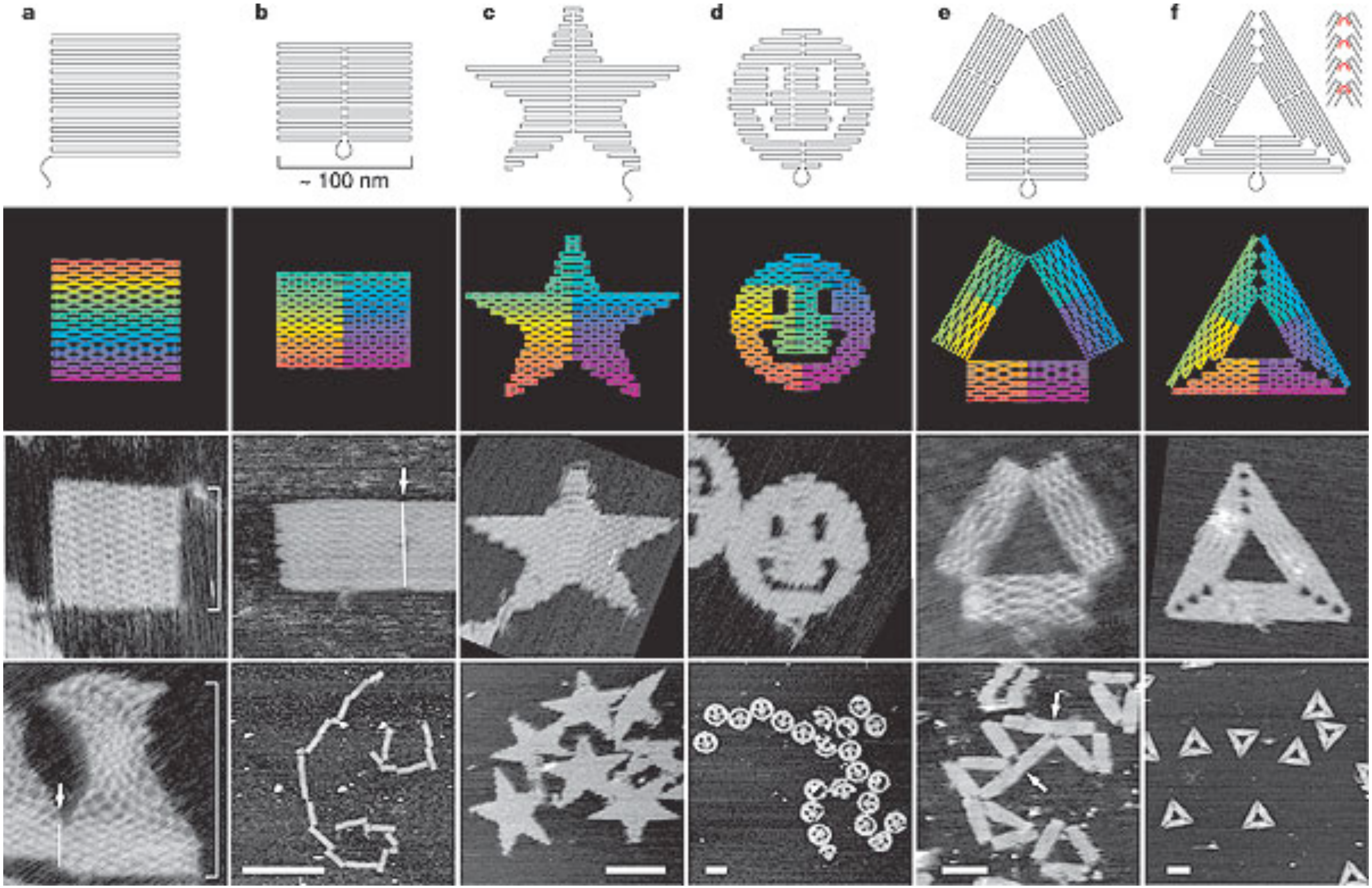
DNA Origami - principle



Strong M: *Protein Nanomachines.* PLoS Biol 2/3/2004: e73

DNA Origami - 2D



http://www.nature.com/scitable/blog/bio2.0/dna_origami

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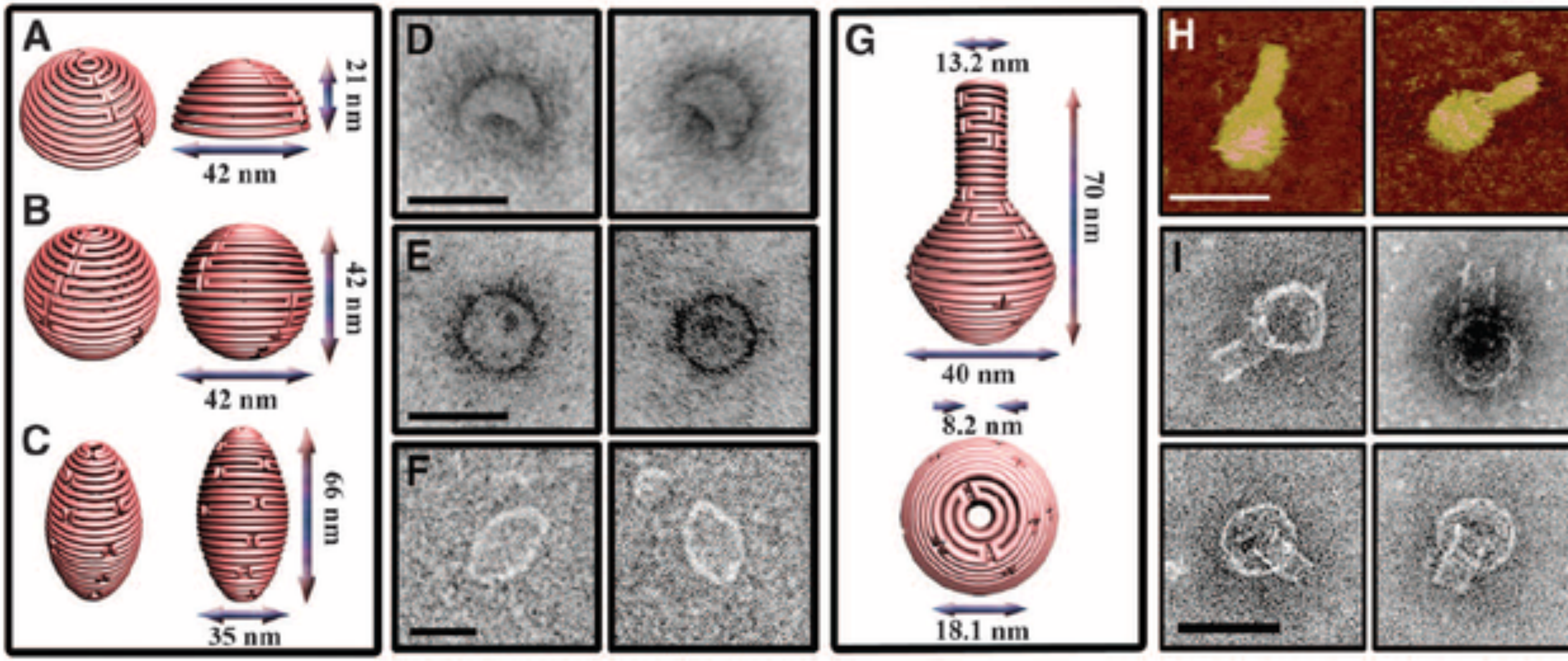
DNA Origami - 3D



http://www.nature.com/scitable/blog/bio2.0/dna_origami

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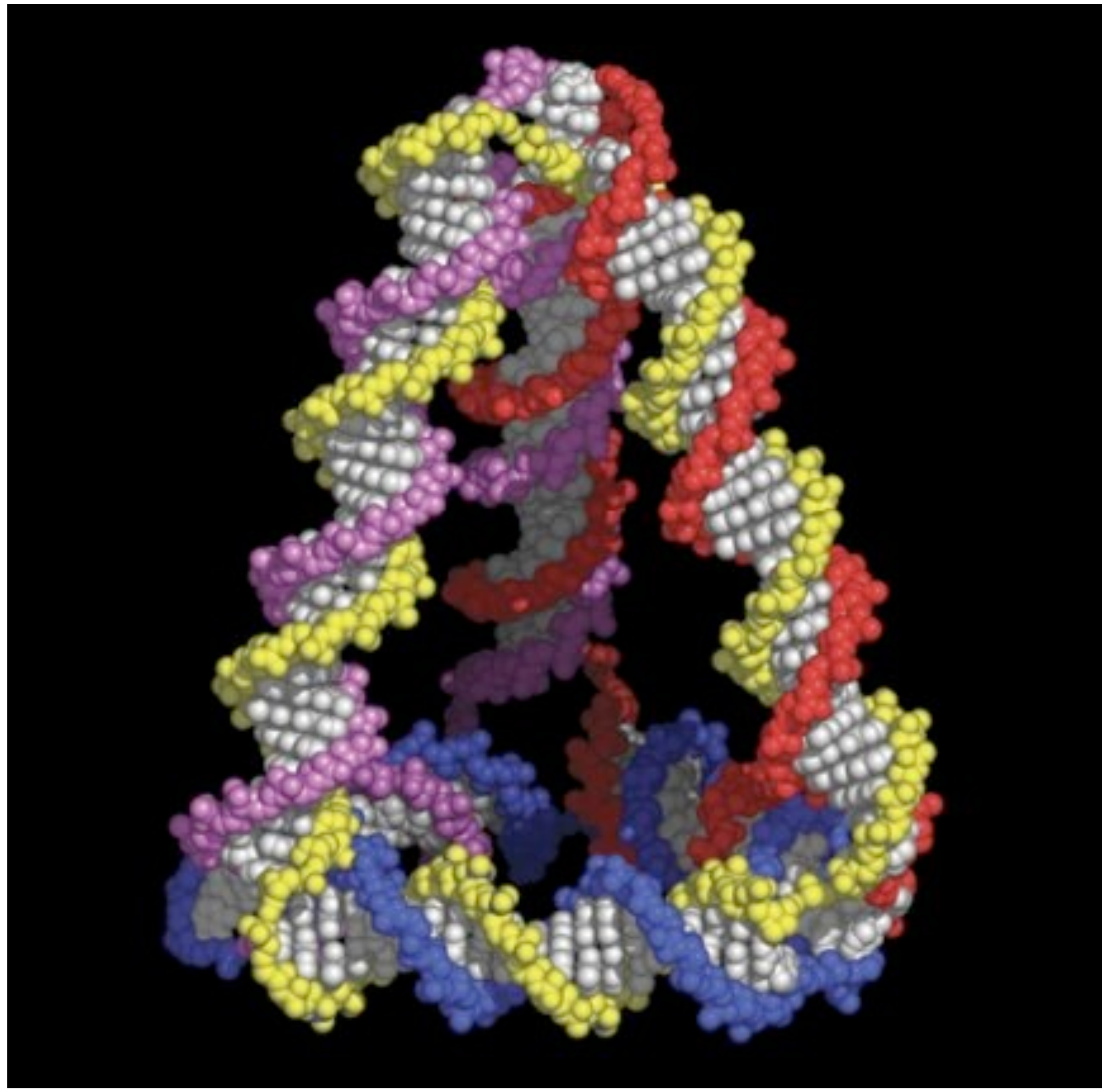
DNA polyhedra



edge ~ 10nm

A rigid tetrahedron formed by self-assembly from DNA,
figure from [Goodman et al, Science 310 p1661 (2005)]

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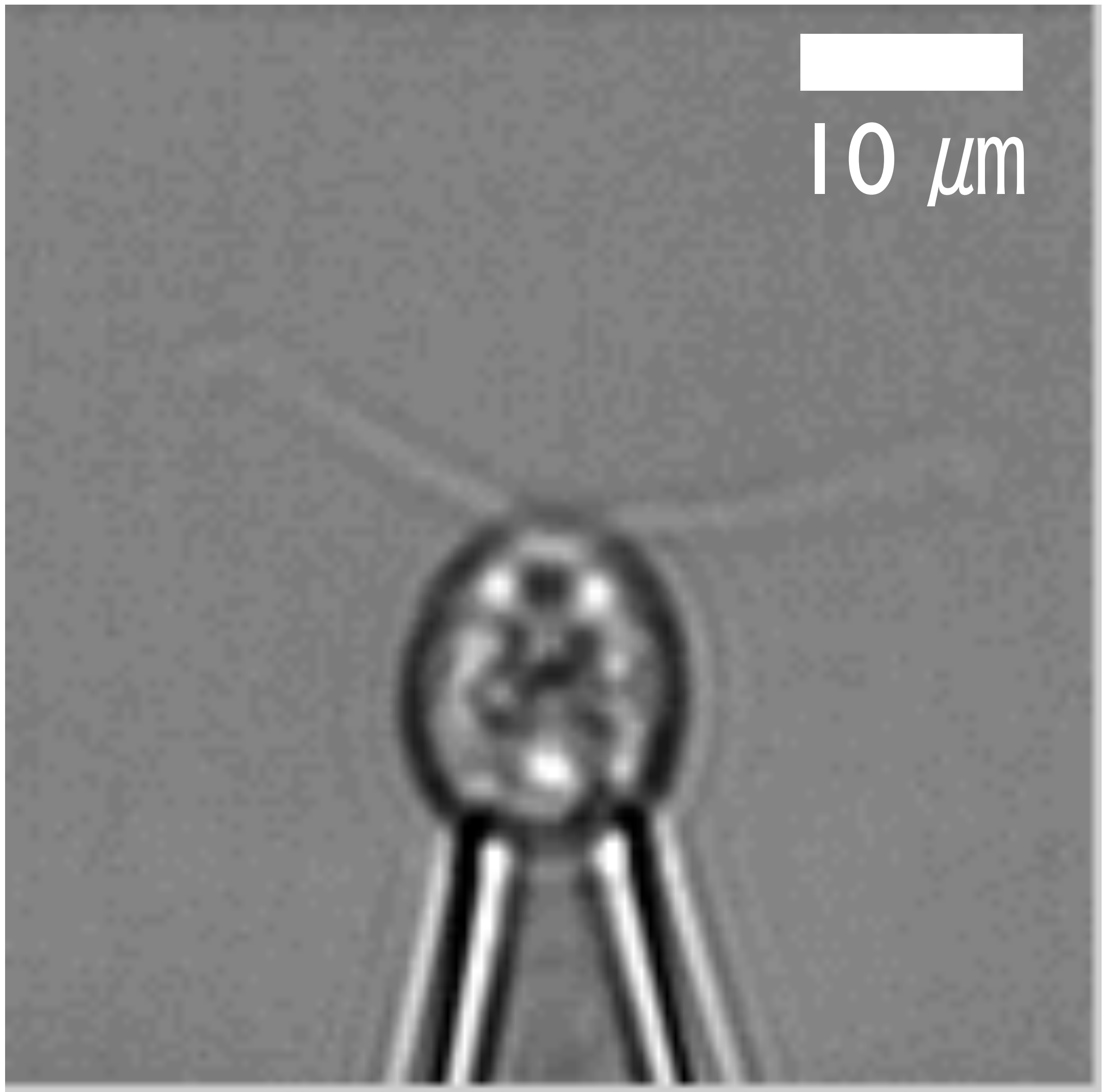
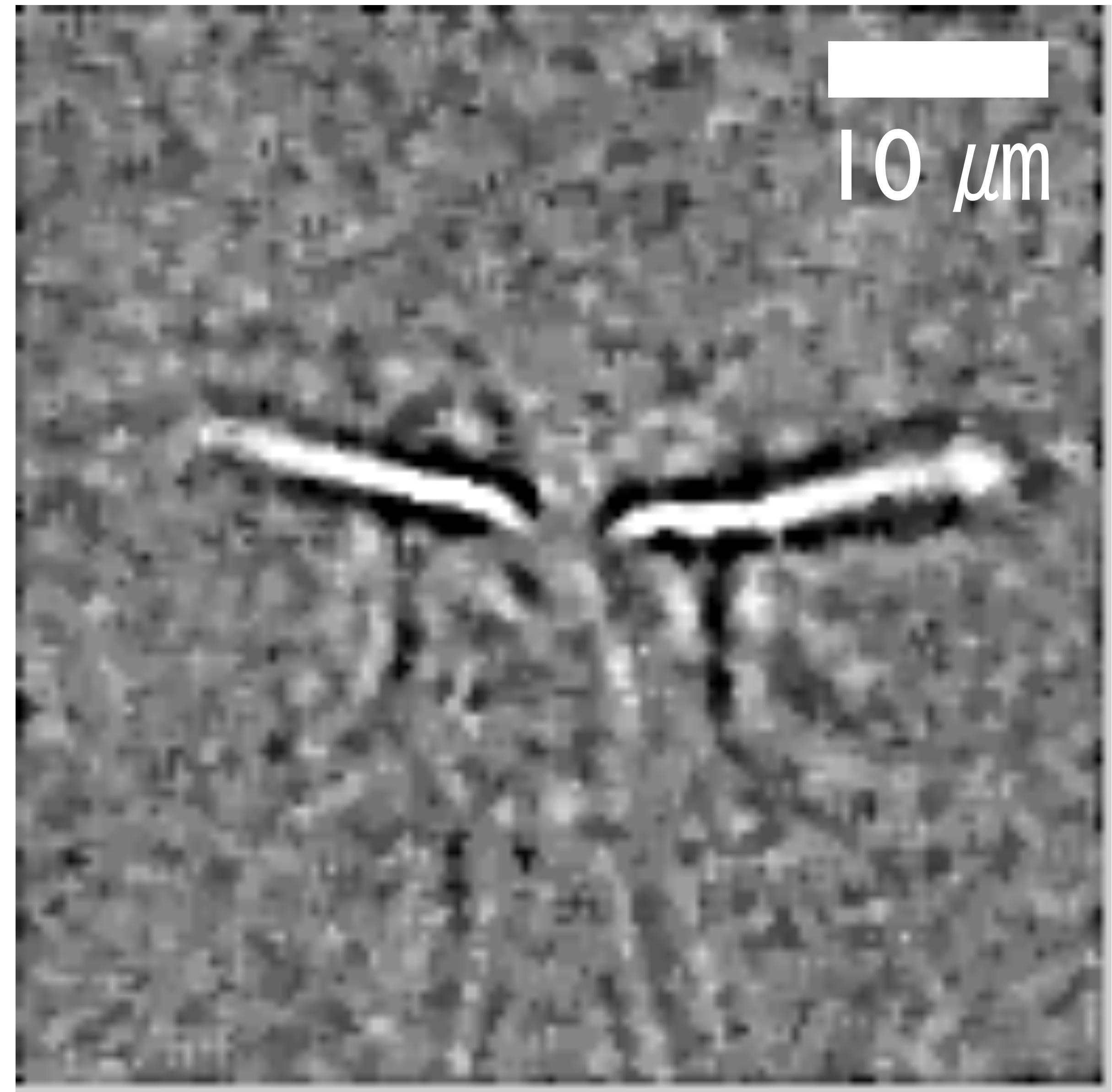
Artificial cilia





~ 50 beats / sec

speed ~100 μm/s

Goldstein et al (2011) PRL

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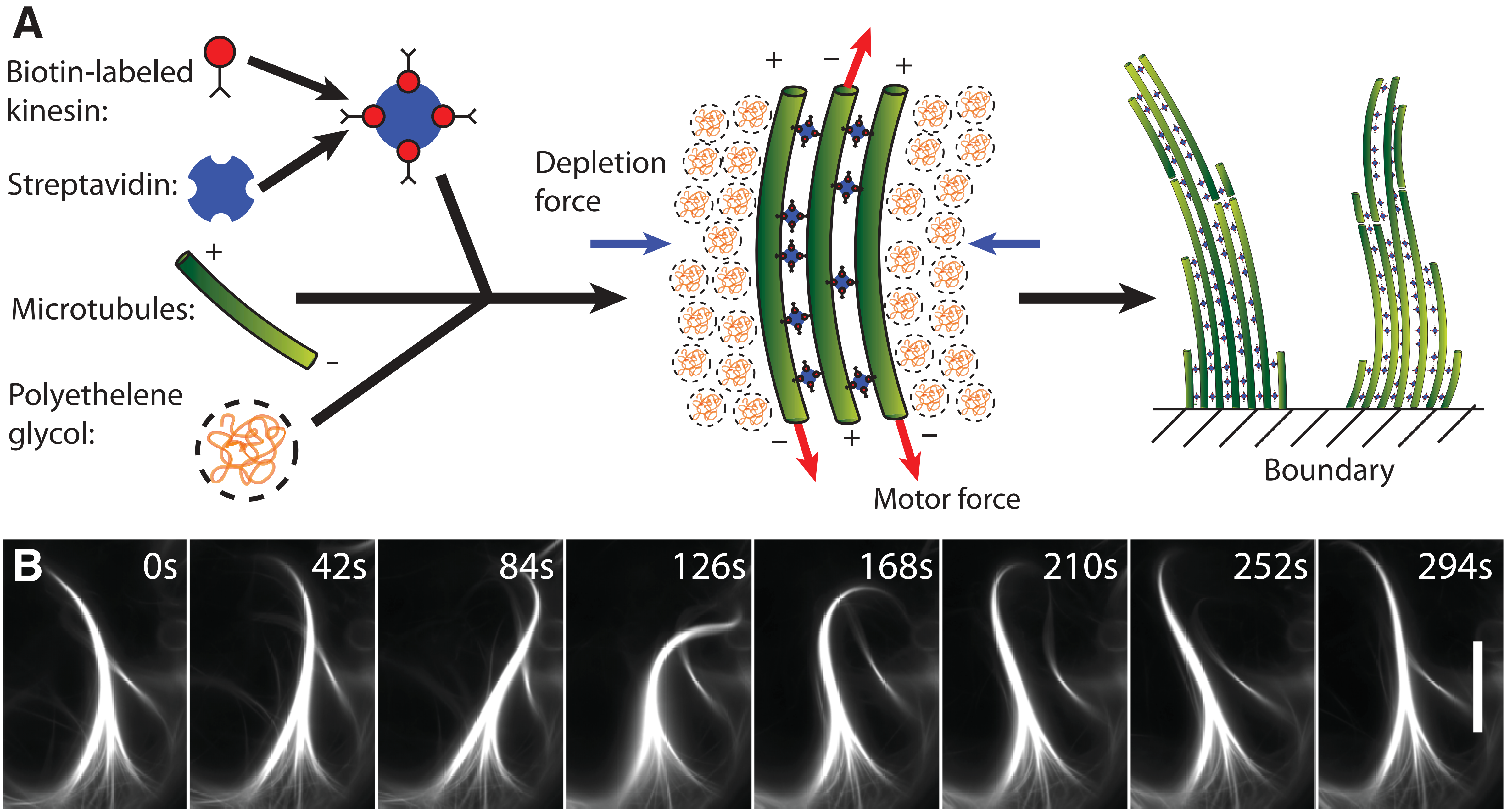
Artificial cilia



Dogic Lab (Brandeis) Science 2011

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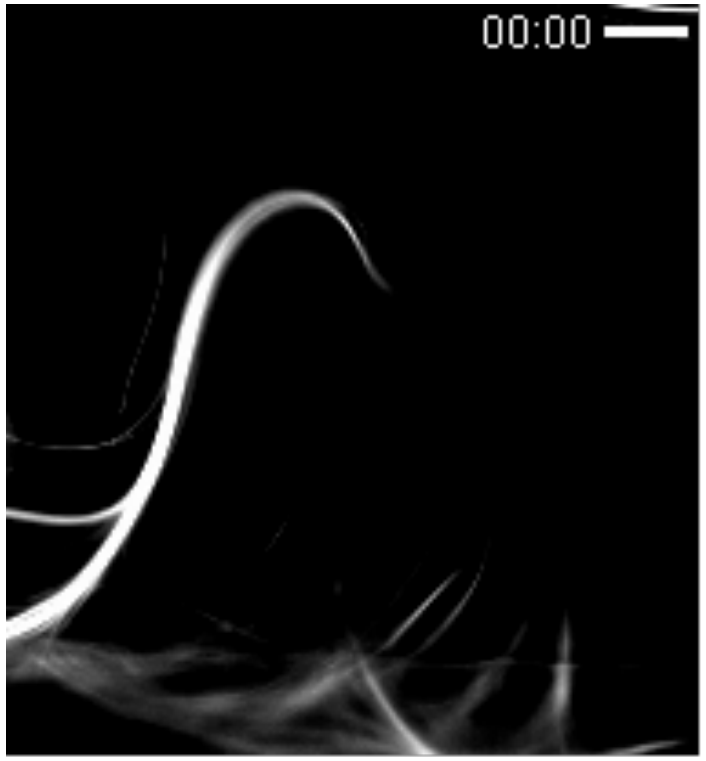
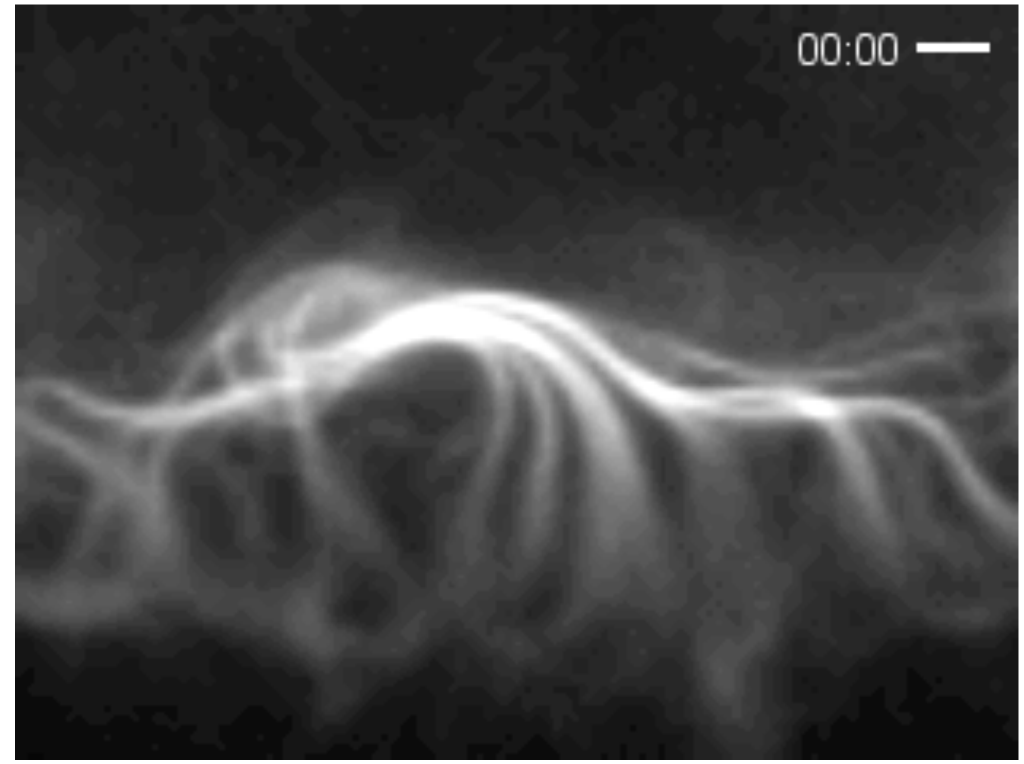
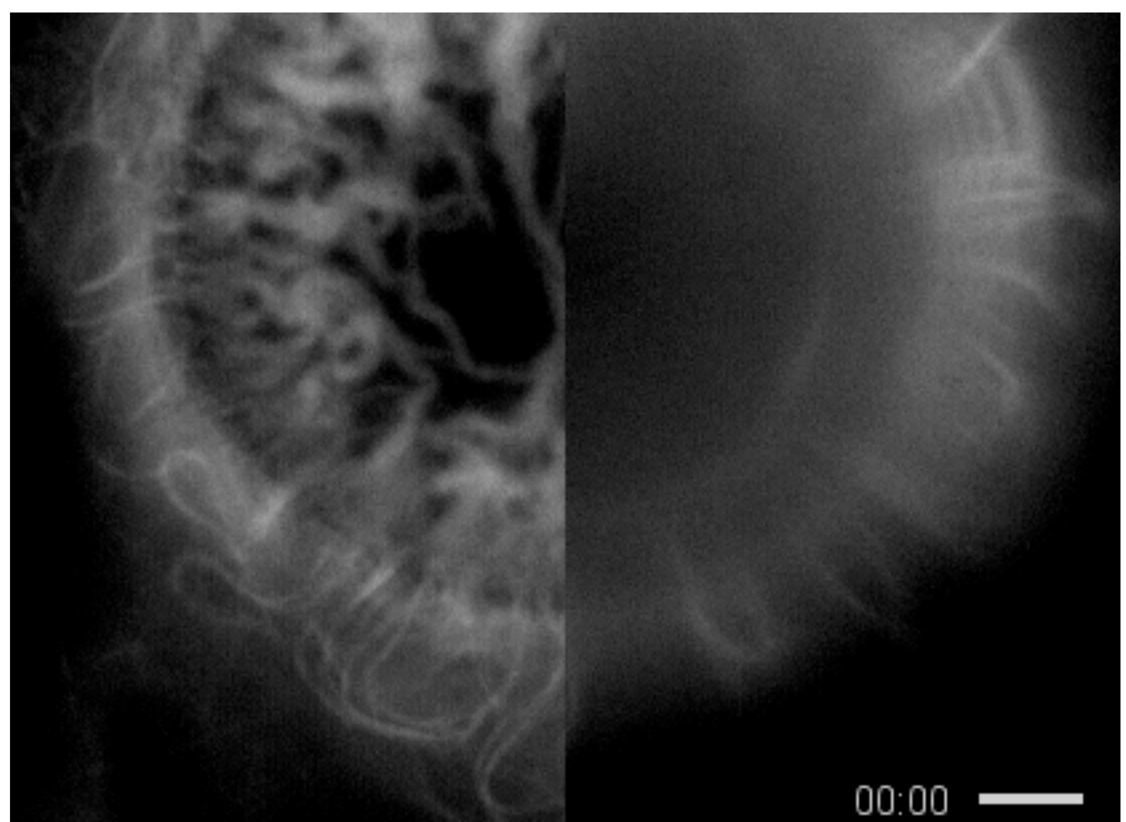
Artificial cilia





Dogic Lab
(Brandeis)

Science 2011



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