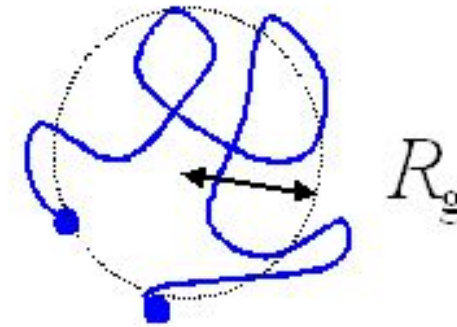
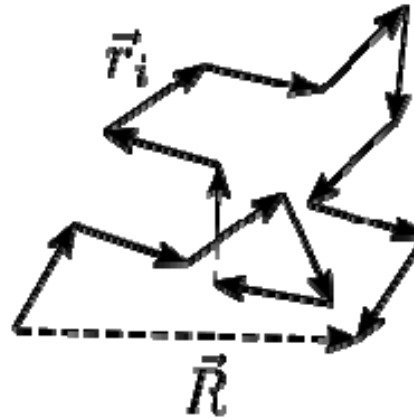
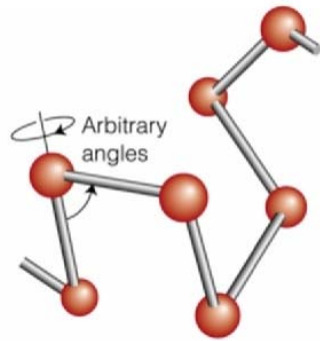
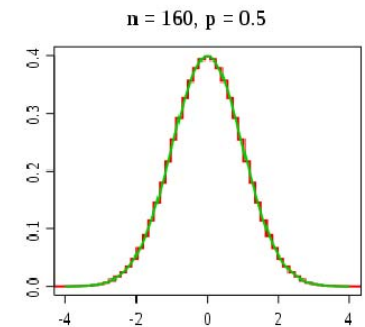
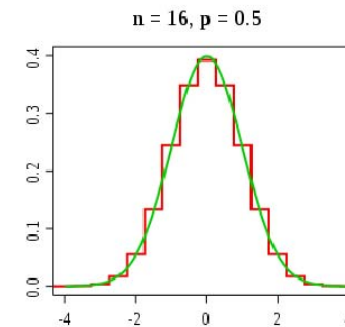
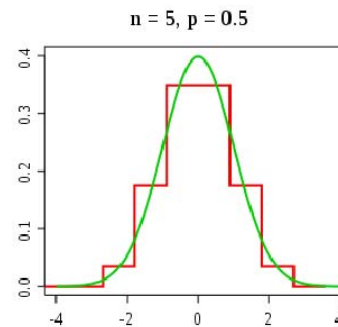
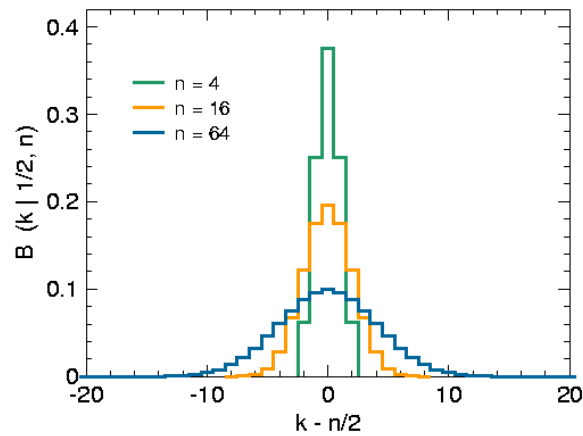


The Freely-Jointed Chain Model



https://en.wikipedia.org/wiki/Ideal_chain
<http://slideplayer.com/slide/4395311/>

Central Limit Theorem



<https://upload.wikimedia.org/wikipedia/commons/2/2e/Bindis-sym.png>
<https://upload.wikimedia.org/wikipedia/commons/b/b7/CLTBinomConvergence.svg>

Example: AFM Single Molecule Force Spectroscopy of PEG

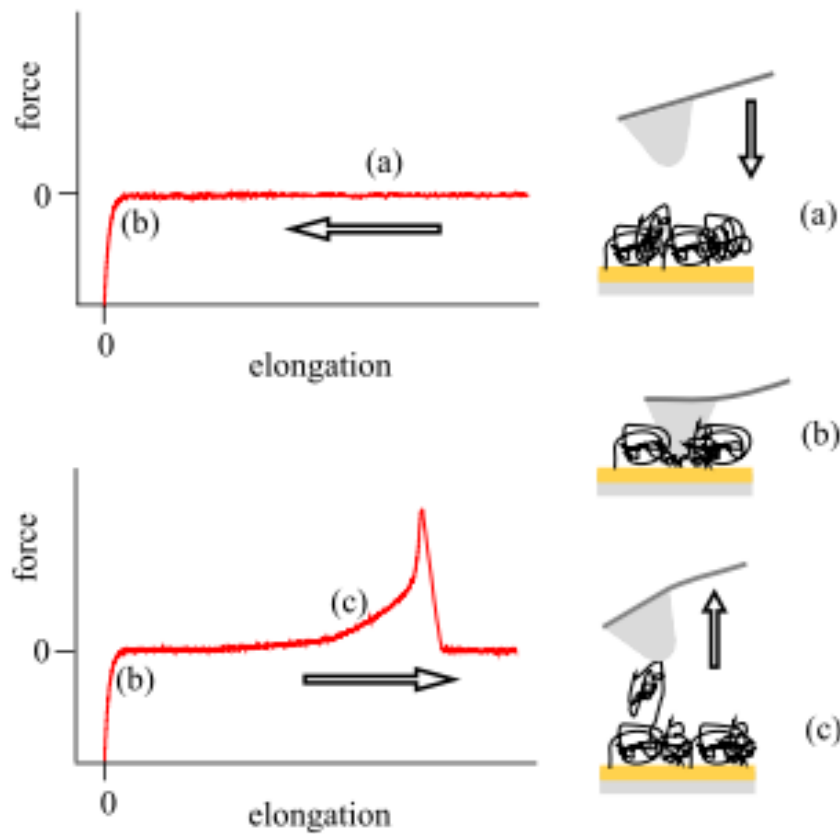


Figure 2

Oesterhelt *et al.* New J. Phys. 1 (1999)

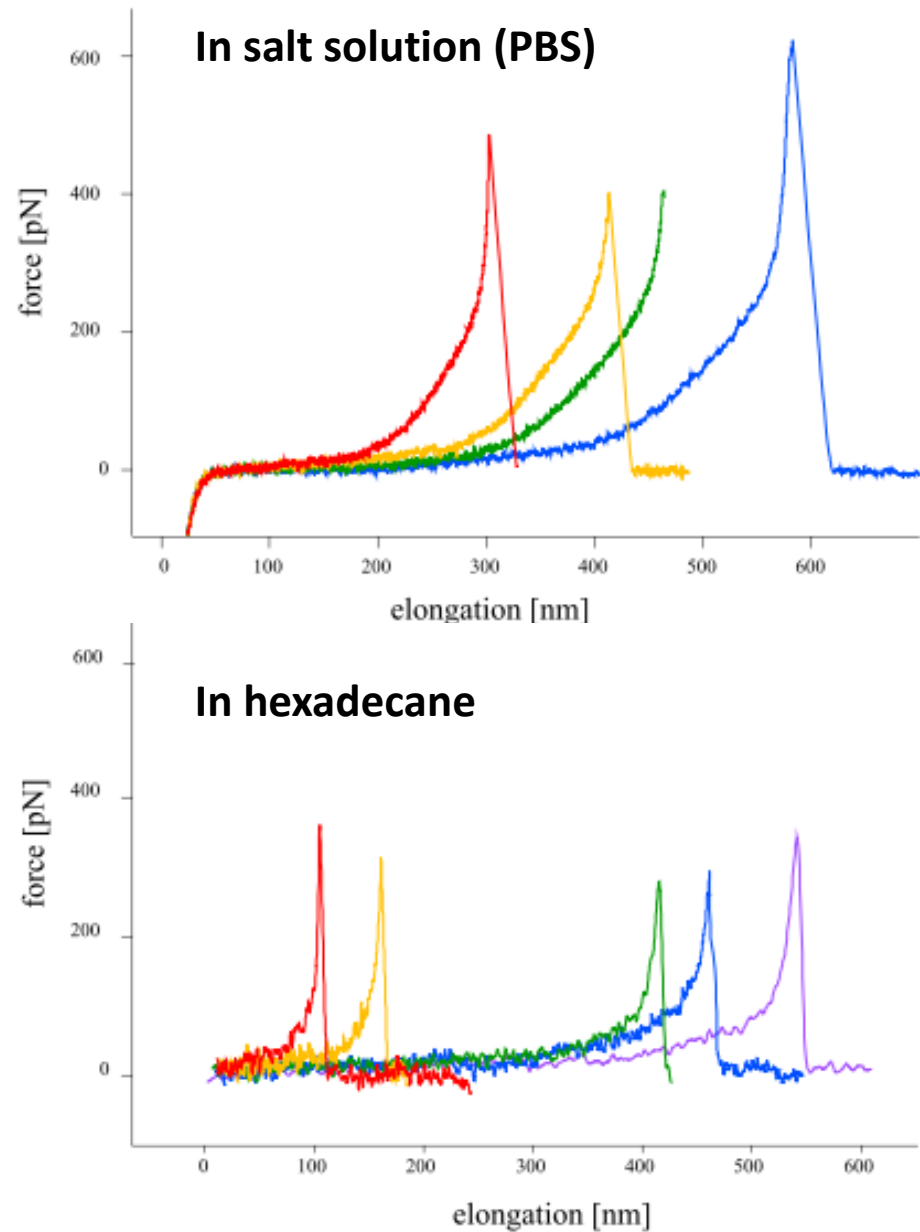


Figure 4

Example: AFM Single Molecule Force Spectroscopy of PEG

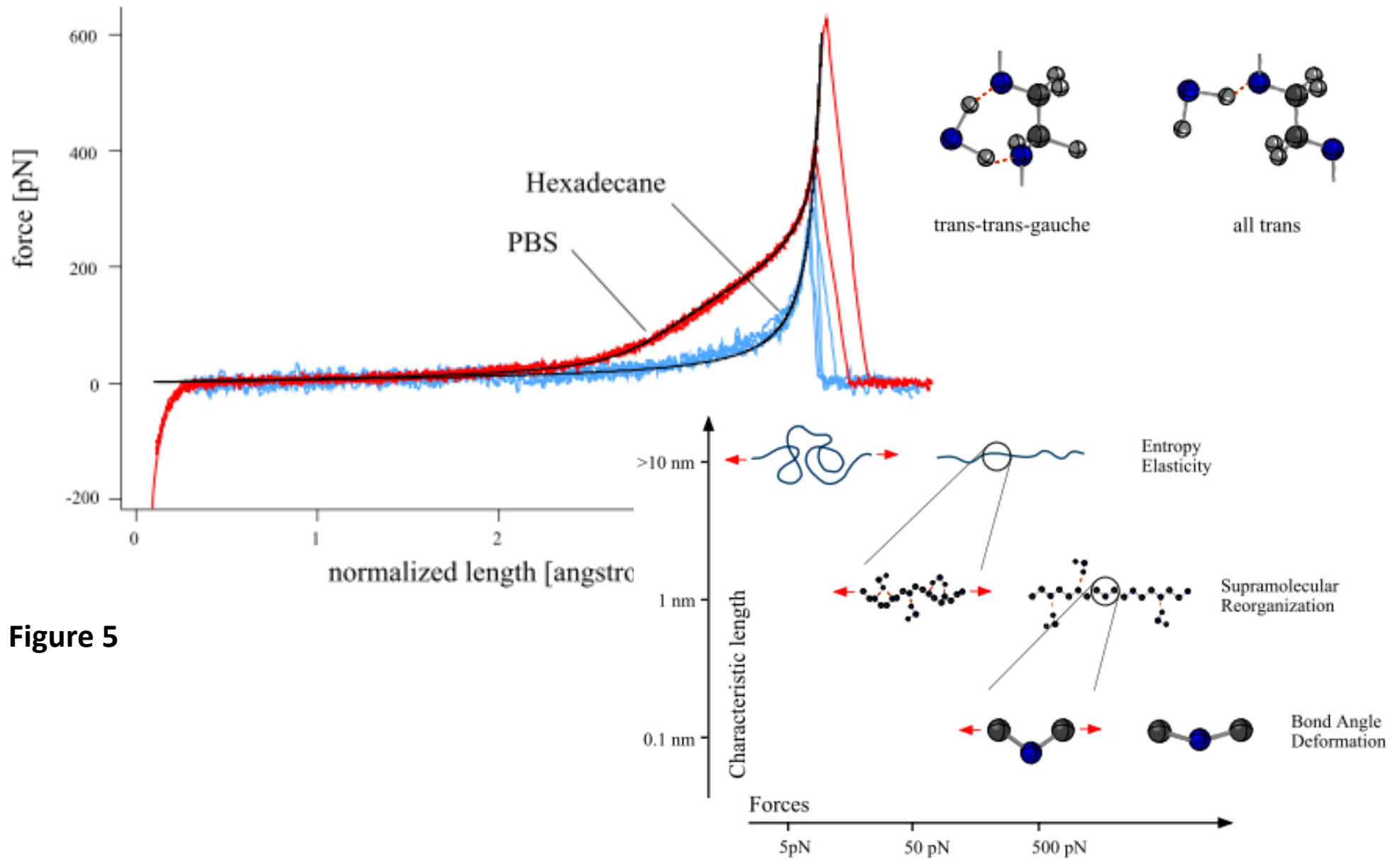
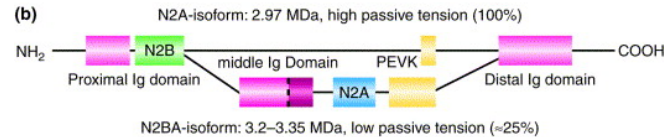
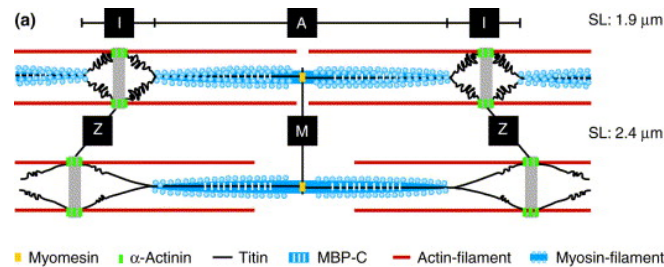


Figure 5

Example: AFM Single Molecule Force Spectroscopy of Titin



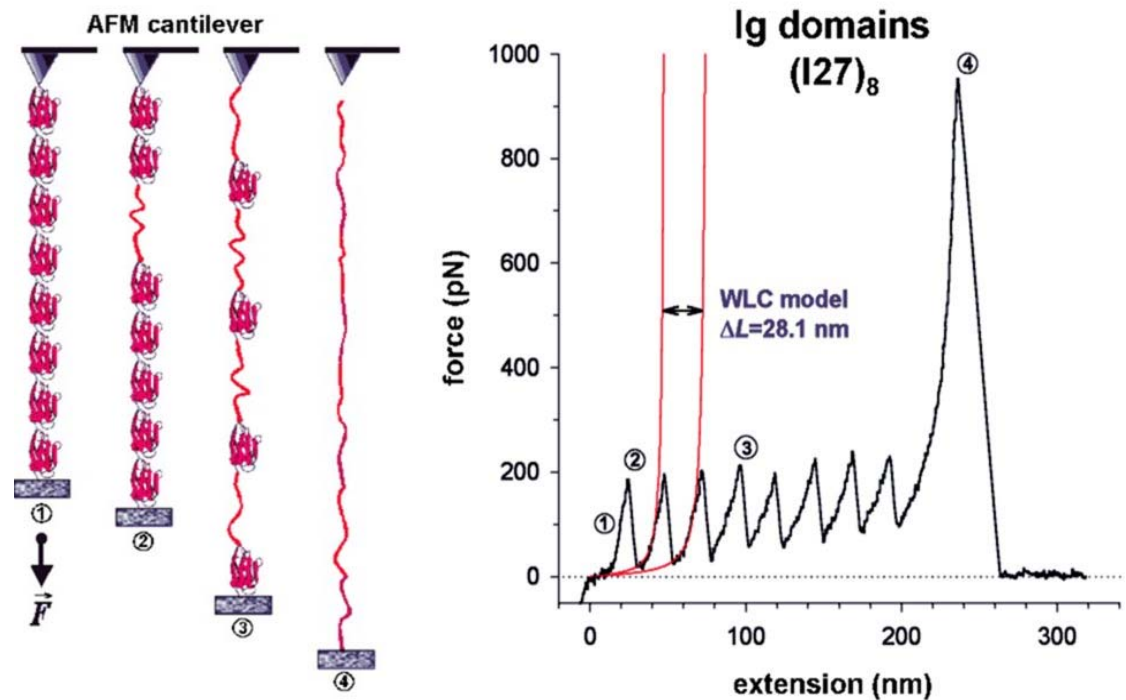
https://openi.nlm.nih.gov/imgs/512/149/2266601/PMC2266601_200509364f1.png

After myosin and actin, titin is third most frequent protein in muscle ($\approx$ 0.5 kg titin in human body).
Largest known protein ($\approx$ 30,000 amino acids).

Titin mutations associated with many myopathies

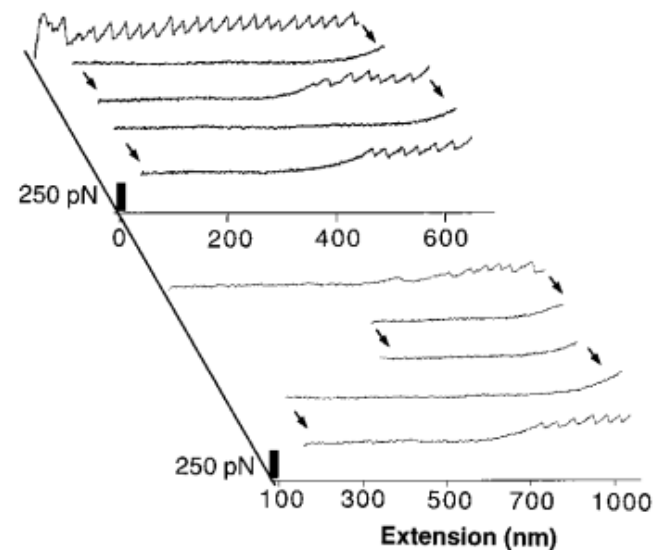
Hein & Schaper "Weakness of a giant: mutations of the sarcomeric protein titin" *Trends Mol. Med.* **8** (2002)

LeWinter *et al.* "Cardiac titin: Structure, functions and role in disease" *Clinica Chimica Acta* **375** (2007)



<http://www.uni-muenster.de/Biologie.AllgmZoo/AG-Linke/pages/general/research/research6.htm>

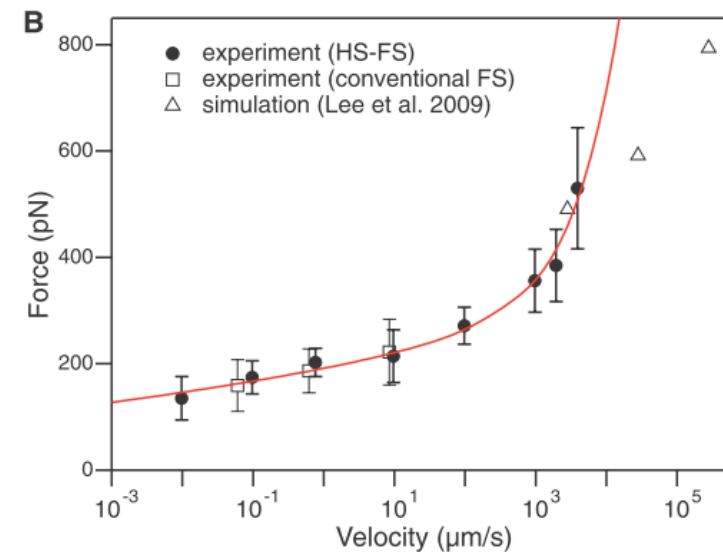
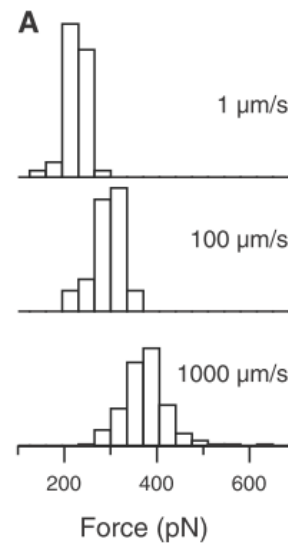
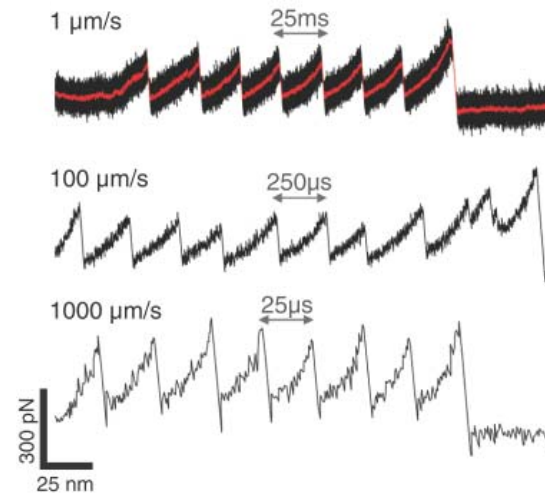
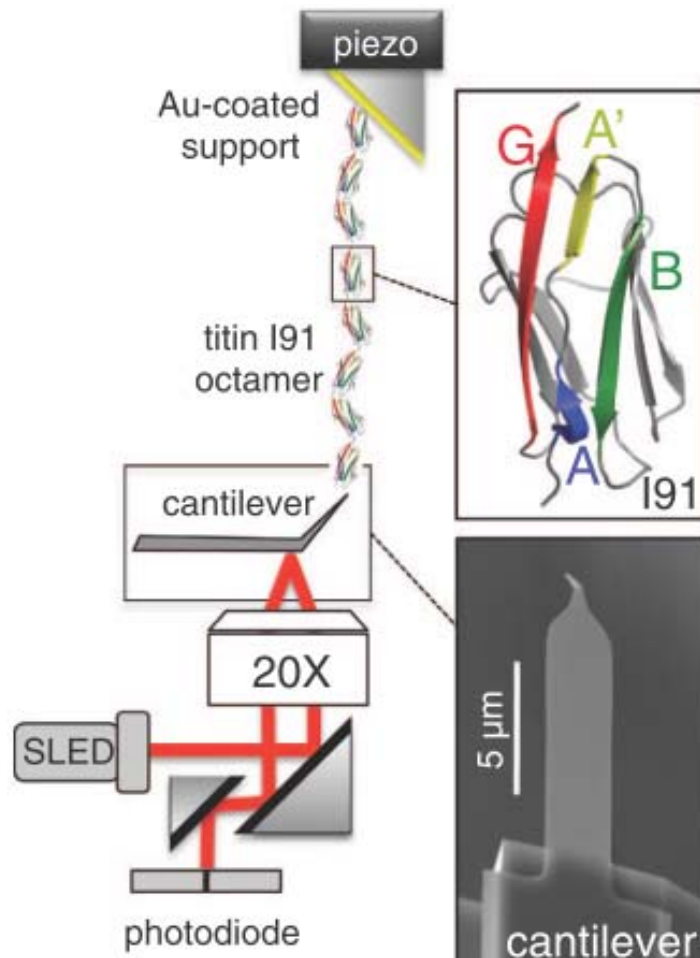
Reversible Unfolding Titin Ig Domains



Rief *et al.* *Science* **276** (1997)

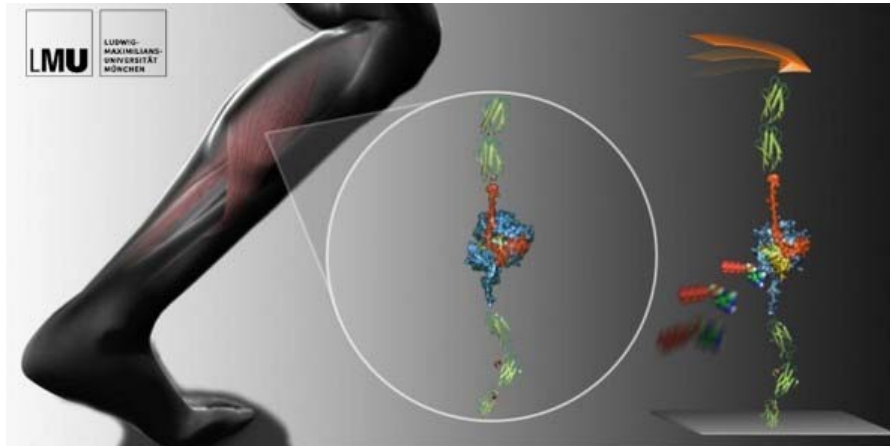
Example: AFM Single Molecule Force Spectroscopy of Titin

High-Speed-AFM Unfolding



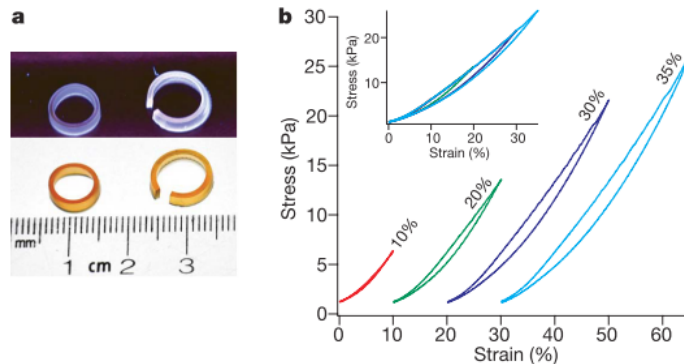
Example: AFM Single Molecule Force Spectroscopy of Titin

Titin is the “shock absorber of the muscle”

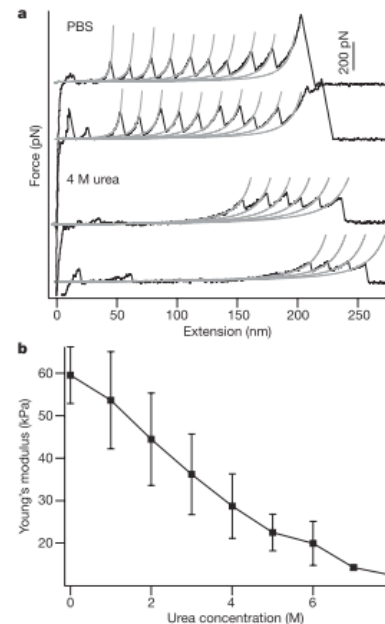


Biomaterial from “artificial titin”

Highly elastic and bio-compatible material,
stiffness tunable on single-molecule level



Lv *et al.* Nature **465** (2010)
doi:10.1038/nature09024

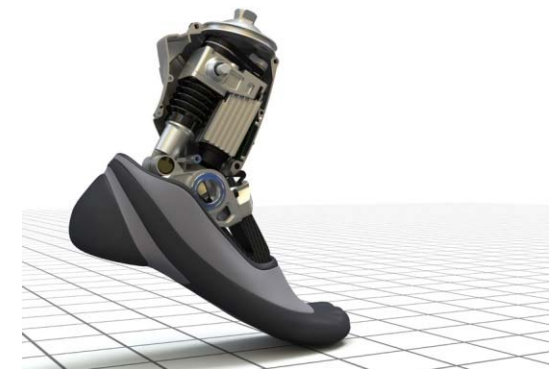


iWalk BiOM ankle-foot prosthesis

Mimicking elastic behavior of Titin molecules

2015 University Northern Arizona

<http://nau.edu/cbi/nishikawa-lab/research/>

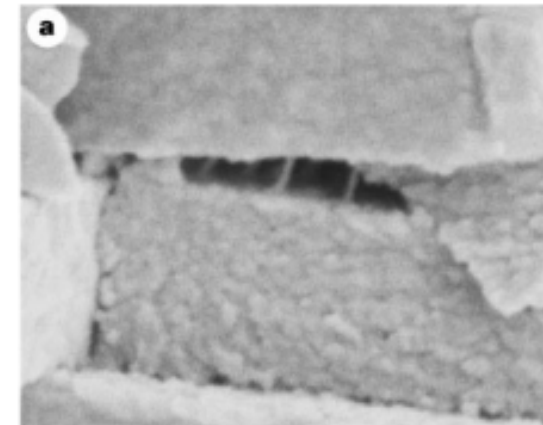


Example: AFM Single Molecule Force Spectroscopy of Shell Protein



Abalone shell:

- “bio-composite” material of calcium carbonate plates with organic “glue” (few weight percent)
- approx. 3,000 times more fracture resistant than pure mineral

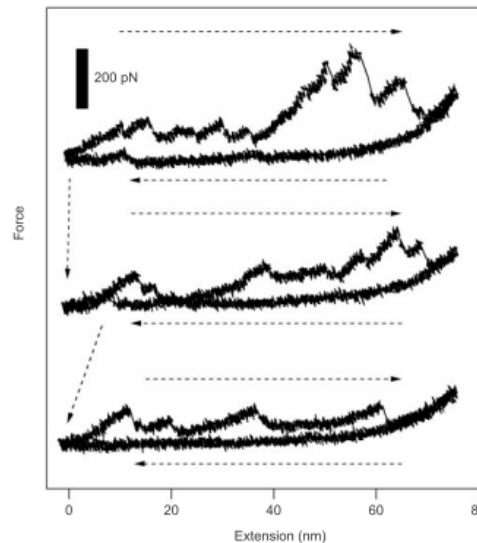


FRONTISPIECE: Department of Fish and Game fisheries research boat *Mai*, just off Pt. Lobos, California. Air hose and life line lead to submerged diver whose exhaust bubbles can be seen on the water surface just in front of the ladder.

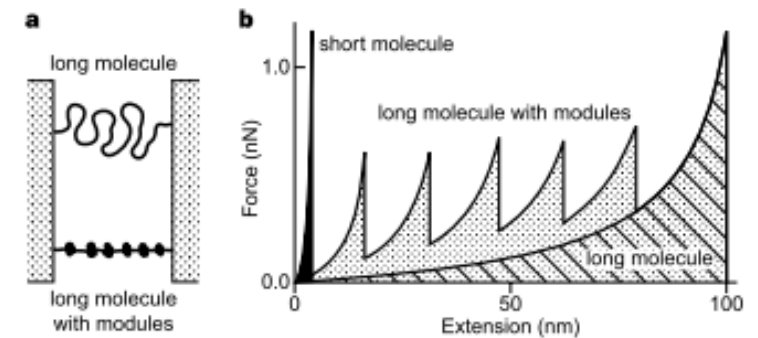


FIGURE 44. The “diver” separates the muscle from the shell in one continuous movement with the “shucking bar.” Photo by Otto Bickford, 1965.

“Shucker” at the “shucking bar”
Cox *et al.* Fish Bulletin **118** (1962)

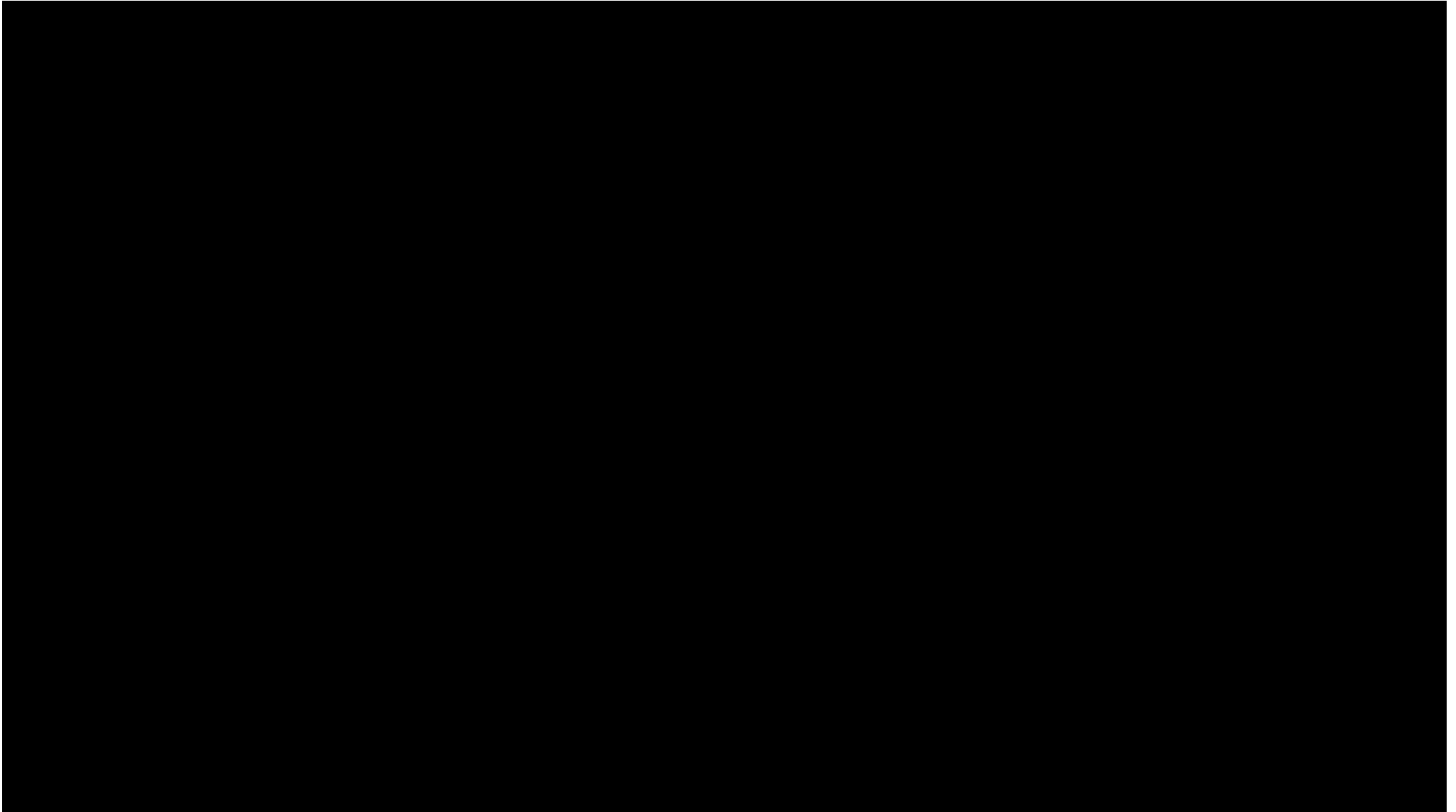


Smith *et al.* Nature **399** (1999)



Example: AFM Single Molecule Force Spectroscopy of Shell Protein

Sea otter feeding habit:



<https://www.youtube.com/watch?v=Uc7Ahp5--eE>