

Session 6

# CELL POKING

# Class Organization

- ◆ Hw3 online. Due Wed 1/30/13

# 31 years ago...

- ◆ U.S. President: Ronald Reagan
- ◆ Lebanon war begins
- ◆ Graceland opens
- ◆ USA Today is first published
- ◆ AT&T “monopoly” is broken apart
- ◆ Compact discs hit the market
- ◆ First artificial heart implanted in Barney Clark



# 31 years ago...

1 January 1982, Volume 215, Number 4528

## SCIENCE

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### Luck, Merit, and Peer Review

Every year the National Science Foundation spends a billion dollars, mostly on the support of research. A recent report commissioned by the foundation\* suggests that chance enters significantly into decisions of the peer review system by which NSF evaluates funding requests for scientific research. The report indicates that about 25 percent of NSF decisions would be reversed by a different panel.

“Capital punishment,” or loss of grant support, is cruel, but no longer unusual, in academia. The notion that chance enters into the decision-making process adds a special twist, and this study has raised calls from many quarters for elimination of the peer review system—a reaction not at all justified by the findings. Distribution of research funds in block grants to states or by random lottery, both of which have been suggested, would foster mediocre research.

We have become chary. We insist on certainty whether or not it is practical. We want zero levels for pollution, accountability of school teachers for what our children learn, and guarantees that the products we buy will not break, wear out, or cause injury. If disappointed, we sue for damages.

But honest scientific research is a gamble. The peer review system is probably the best method the NSF has for placing its chips. Every time a bet is placed, something is risked. We might reduce the uncertainty considerably by doubling the number of readers for each proposal. Would this be worthwhile?

In the peer review system, a proposal is evaluated independently by “peers” chosen from a pool of reviewers qualified in the area of the proposal. In most areas, only proposals rated “excellent” or “very good”

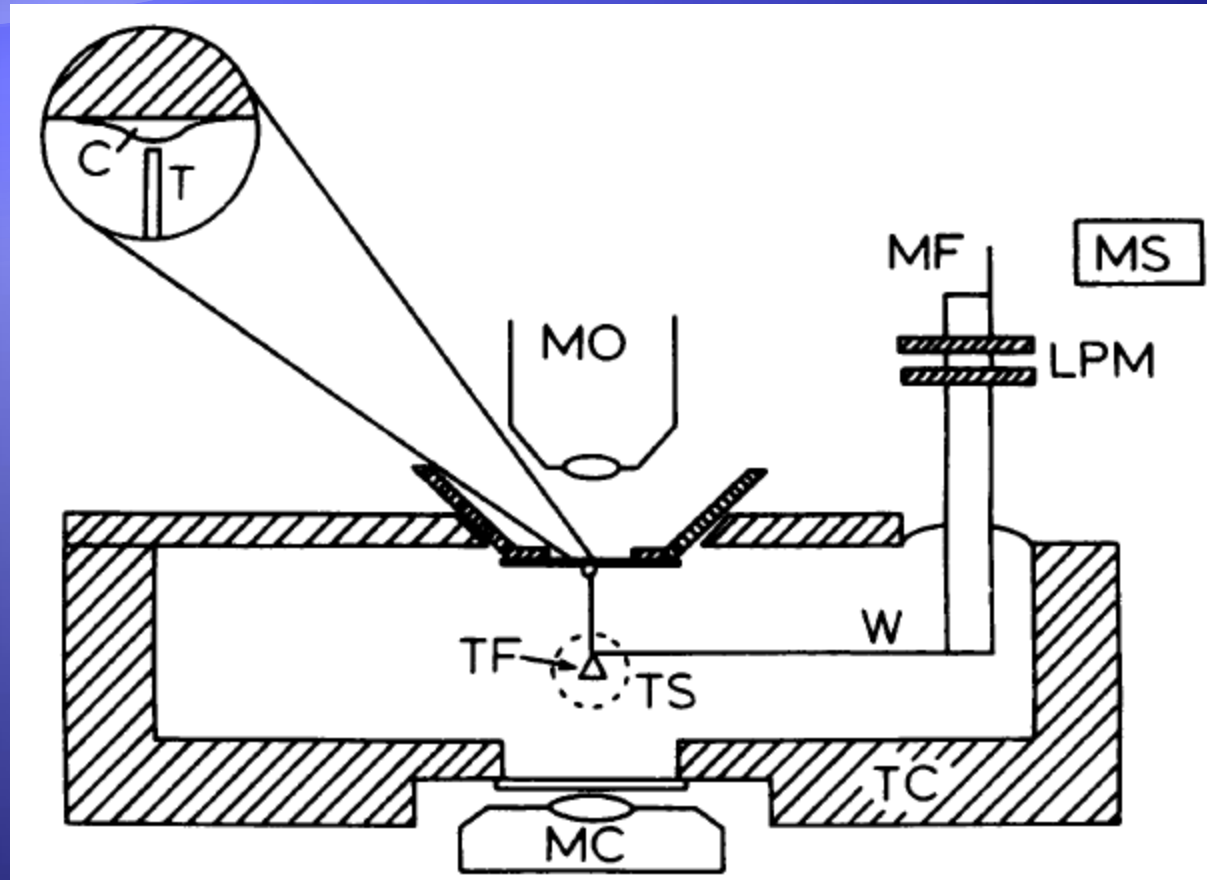
# The Hypothesis...

- ◆ Since cells function mechanically by changing shape, forces that control shape (e.g. actin polymerization) must be related to forces that drive mechanical activities

# The Impact...

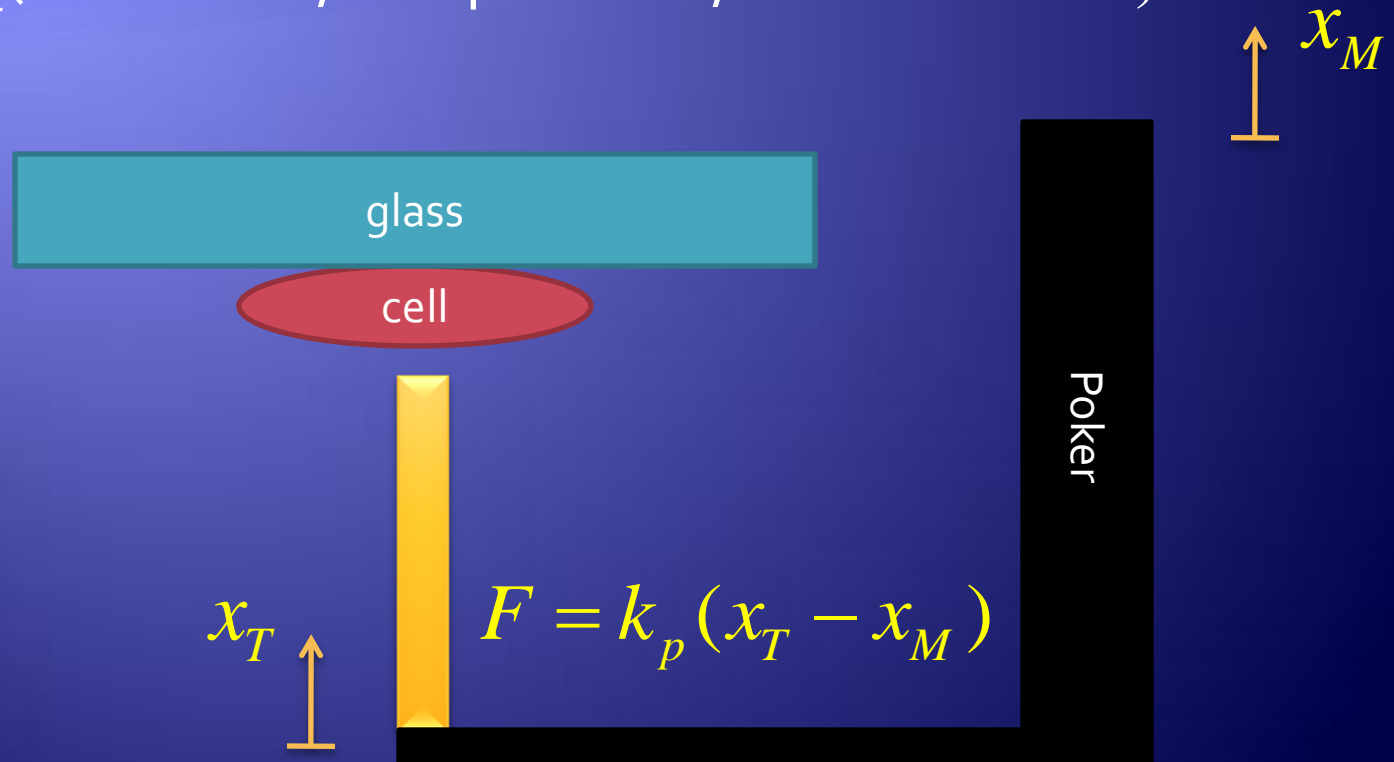
- ◆ Direct measurement of cellular mechanical properties
- ◆ Microfilaments (actin) determine cellular mechanical properties

# The Apparatus...



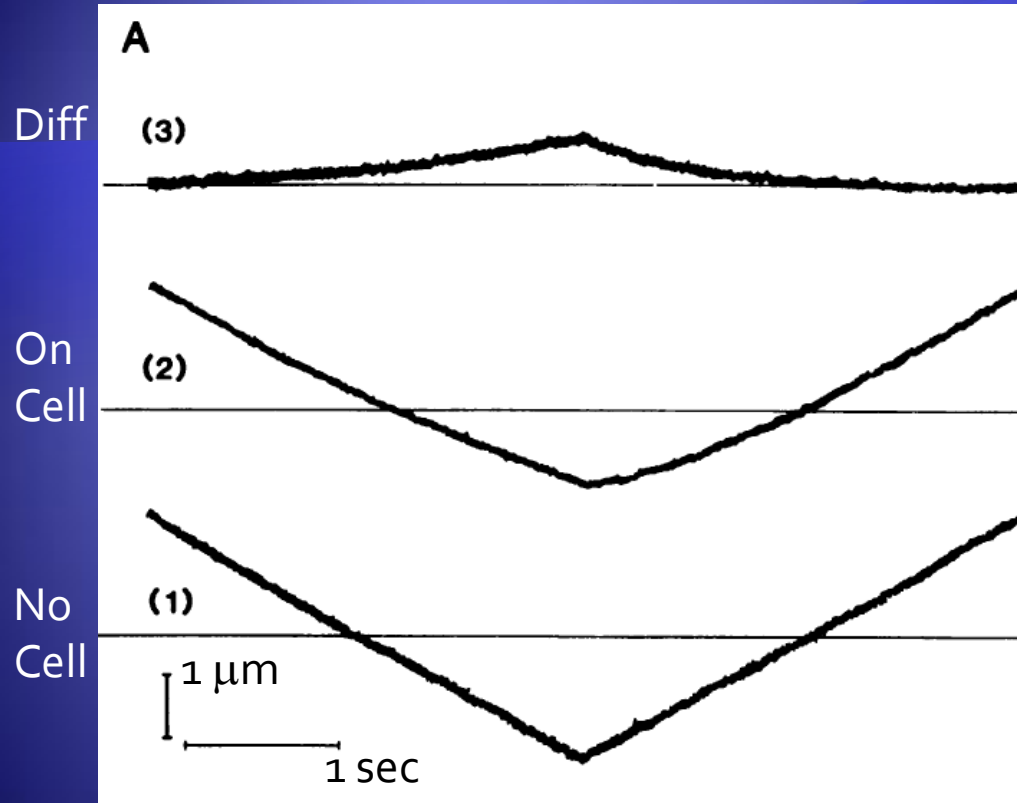
# The Measurement

- ♦ Two springs in series
  - ♦ Poker:  $k_p$  (modulus, dimensions)
  - ♦ Cell :  $k_c$  (strain rate, temperature, CSK structure)

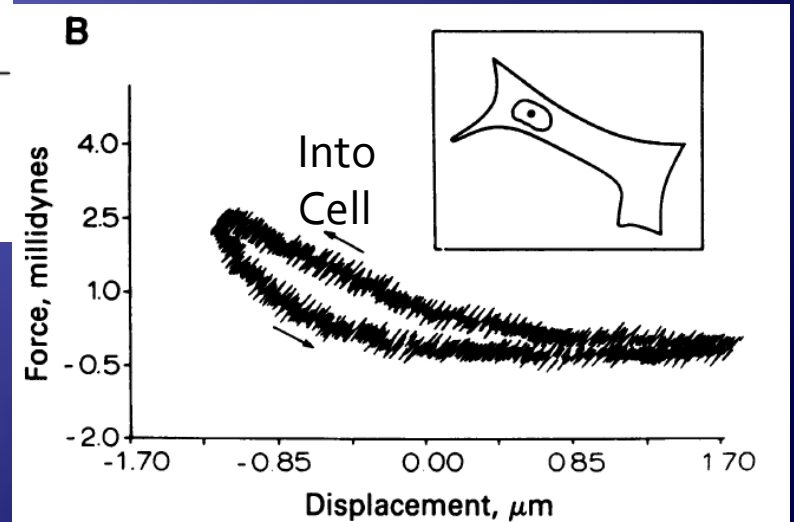




# The Test

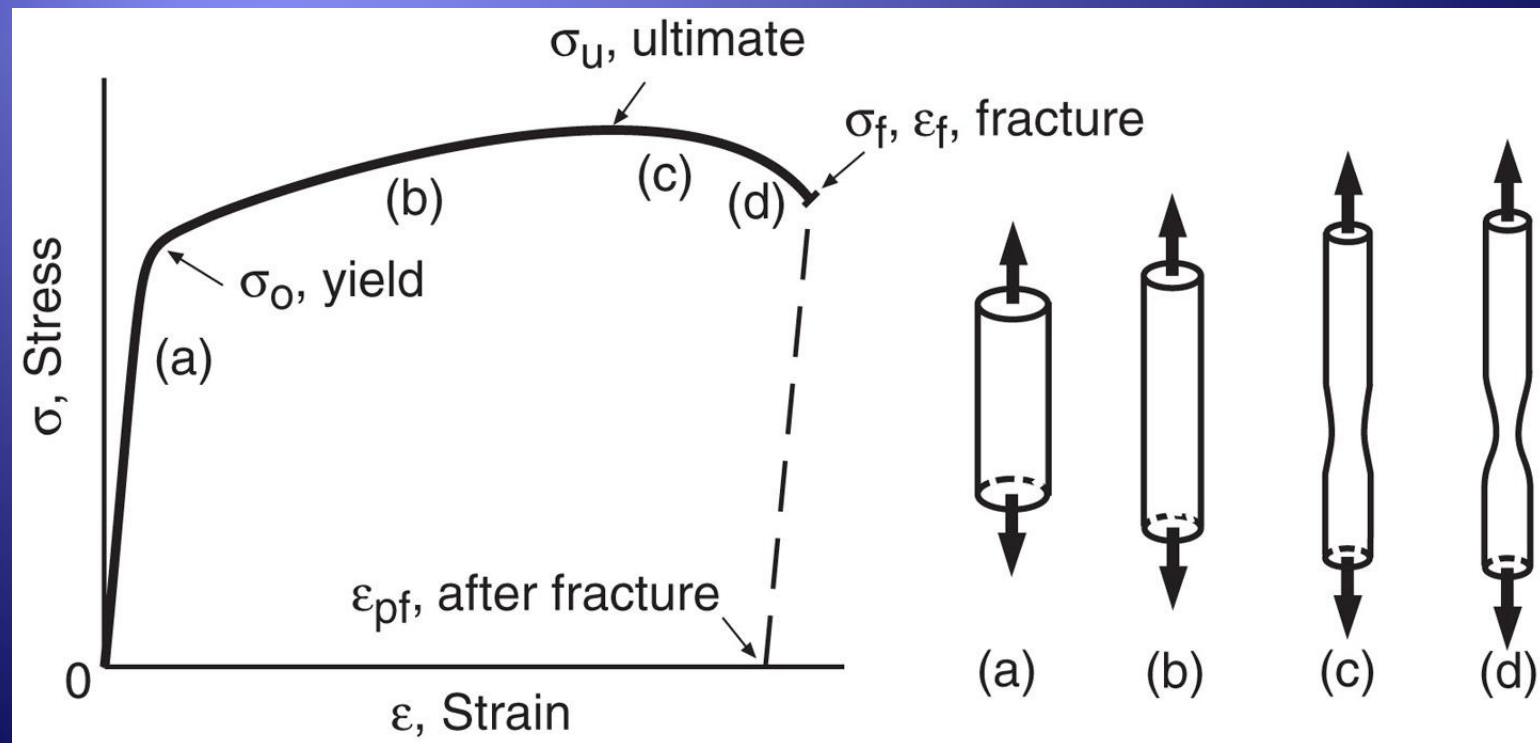


- ◆  $k = 3.8 \text{ millidynes}/\mu\text{m}$
- ◆  $1 \text{ dyne} = 1 \times 10^{-5} \text{ N}$
- ◆  $1 \text{ millidyne} = 10 \text{ nN}$
- ◆  $\rightarrow 38 \text{ nN}/\mu\text{m}$



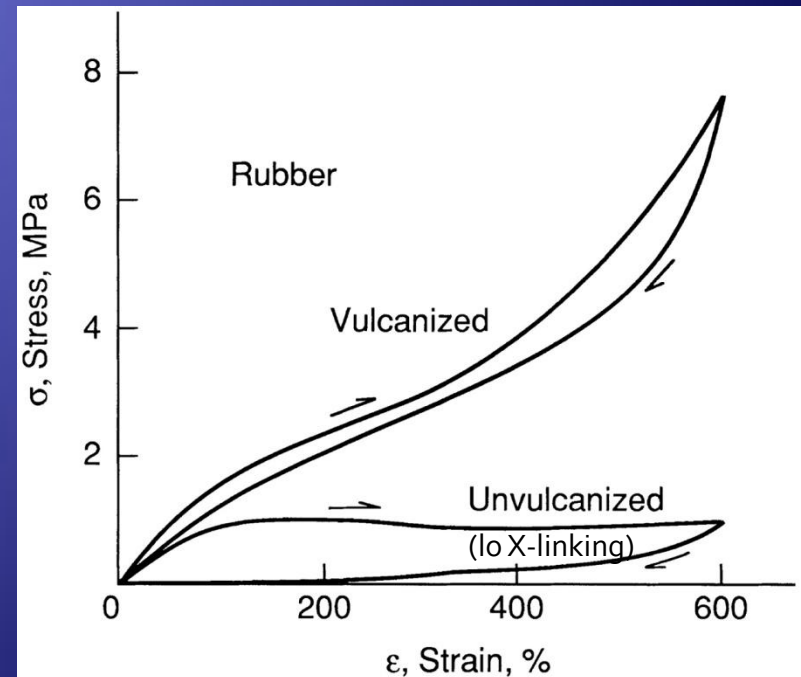
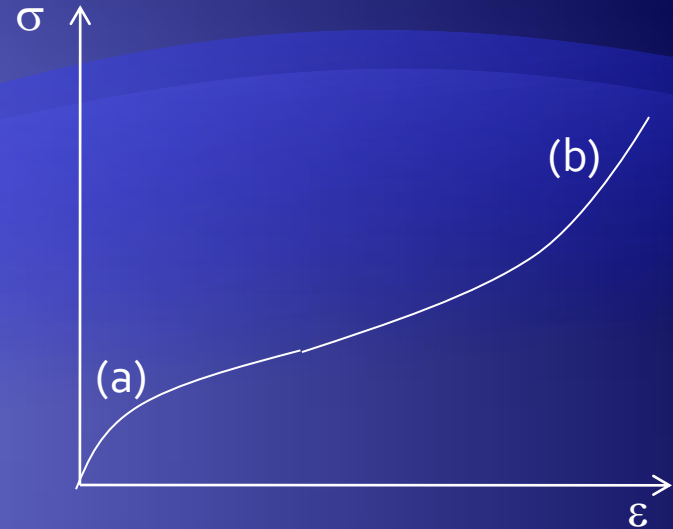
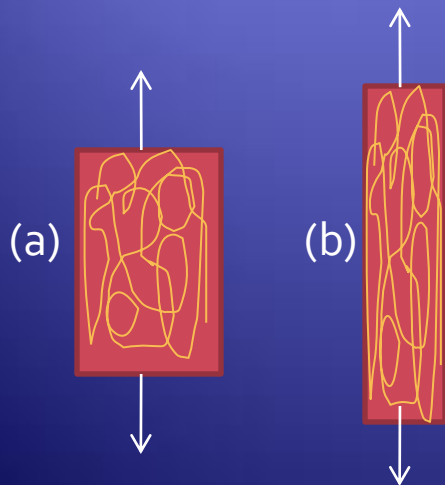
# Elasticity, Plasticity

- ♦ Metals deform elastically (recoverable) but after yielding they deform elastically but with permanent strain (unrecoverable)



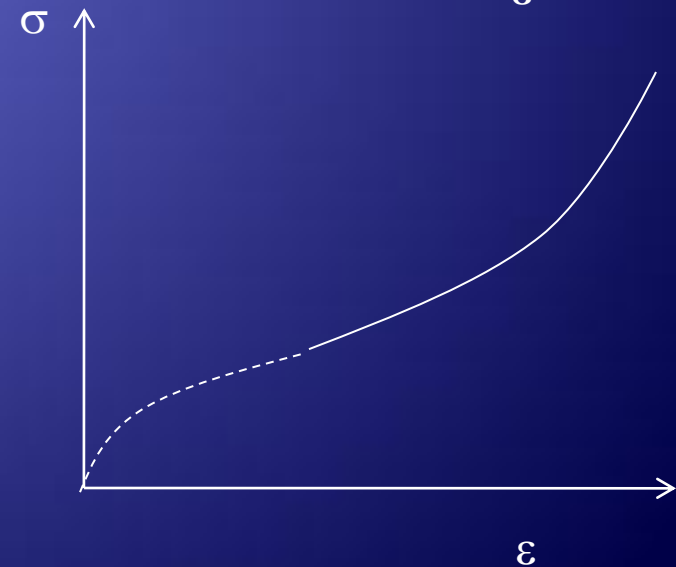
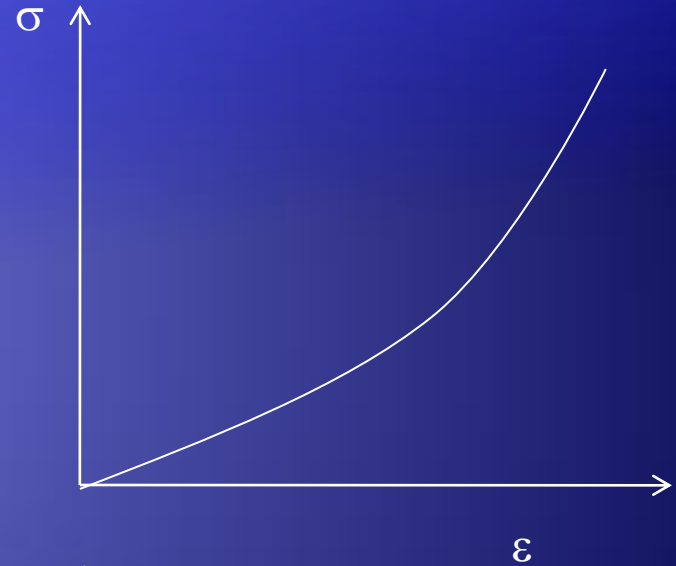
# Elastomers

- ◆ Rubber has S-curve
- ◆ Mechanics depends on polymer chains
- ◆ Hysteresis is path-dependence
- ◆ Vulcanizing promotes cross-linking between polymer chains



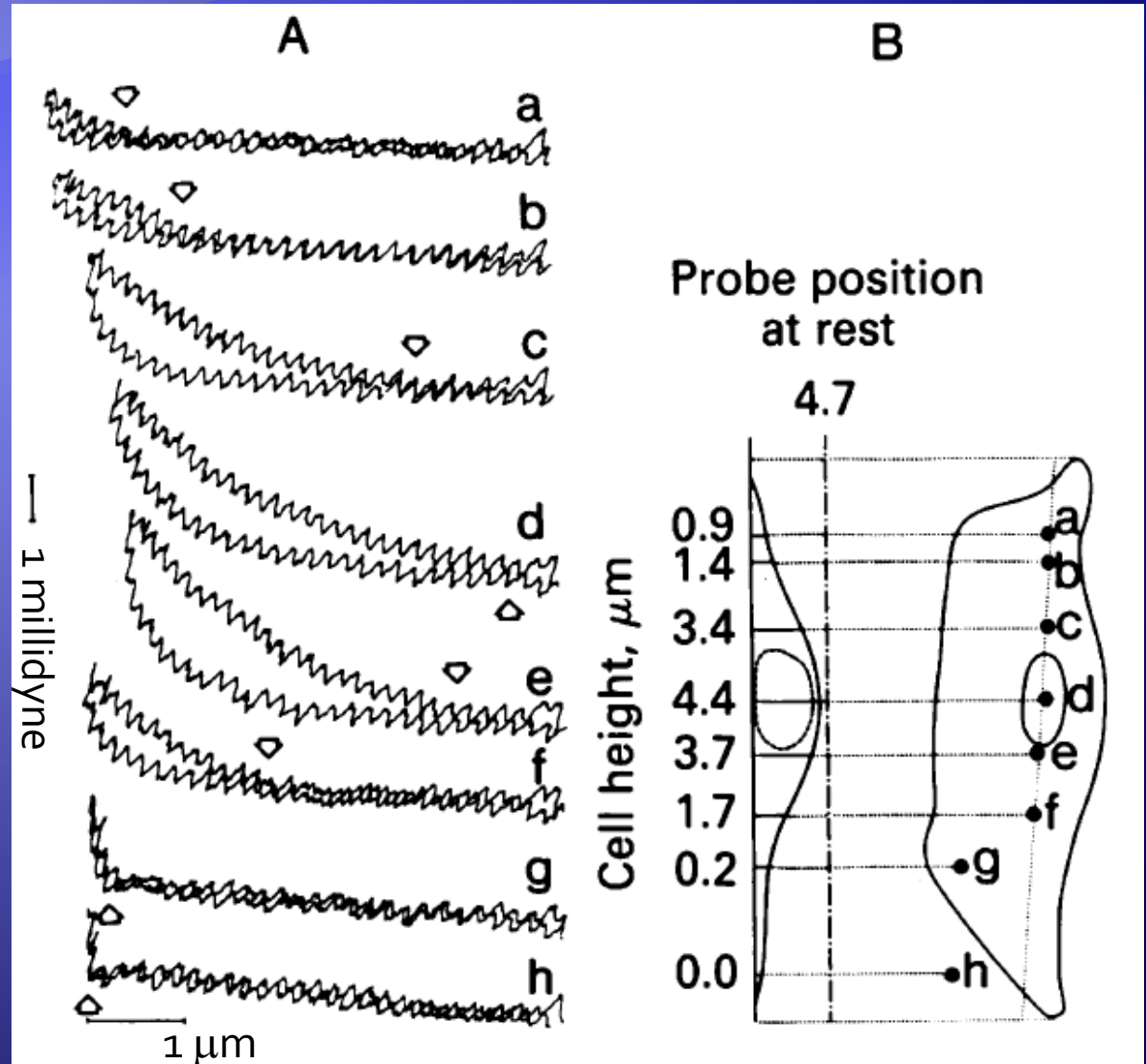
# Biomaterials

- ♦ J-curve
- ♦ Behavior due to increased alignment of fibers
- ♦ Think of stretching your earlobes
- ♦ J-curve is an S-curve with pre-stress



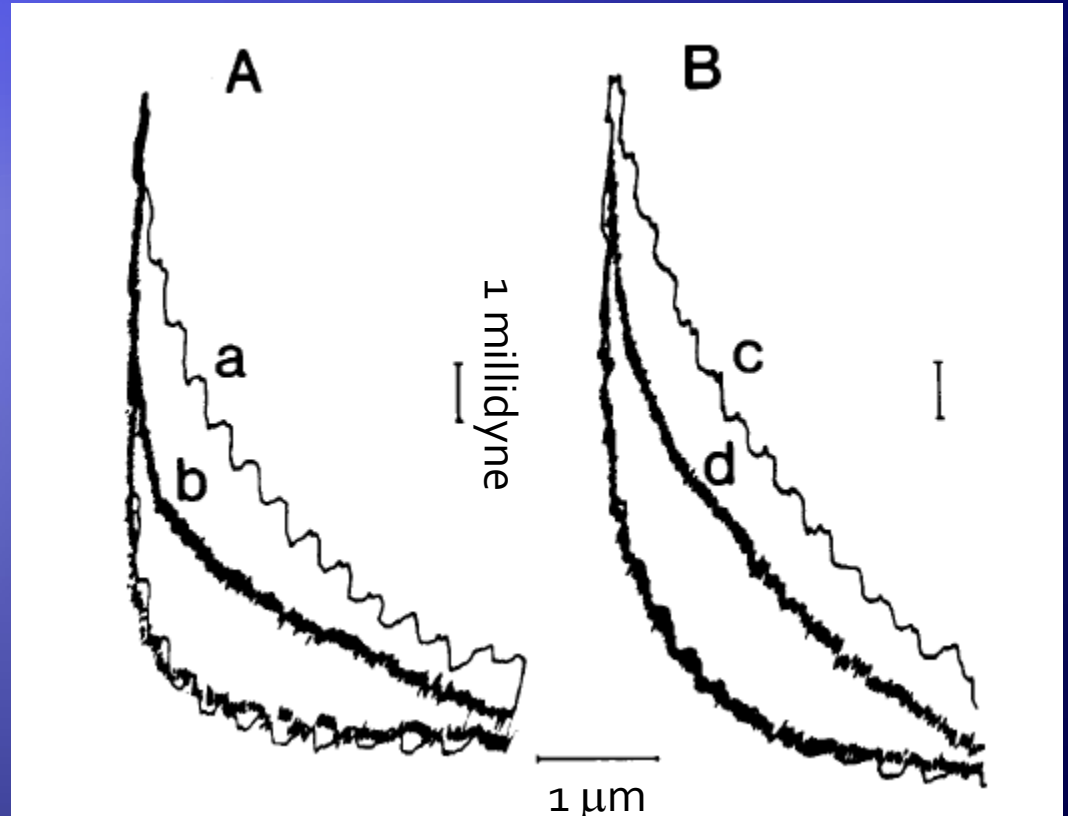
# Spatial Probing

- ◆ Arrows indicate point of contact
- ◆ Low hysteresis in thinner regions
- ◆ Initial  $k_{\text{cell}} = 0.6$  millidynes/ $\mu\text{m}$
- ◆ Increased  $k_{\text{cell}}$  with depth of penetration



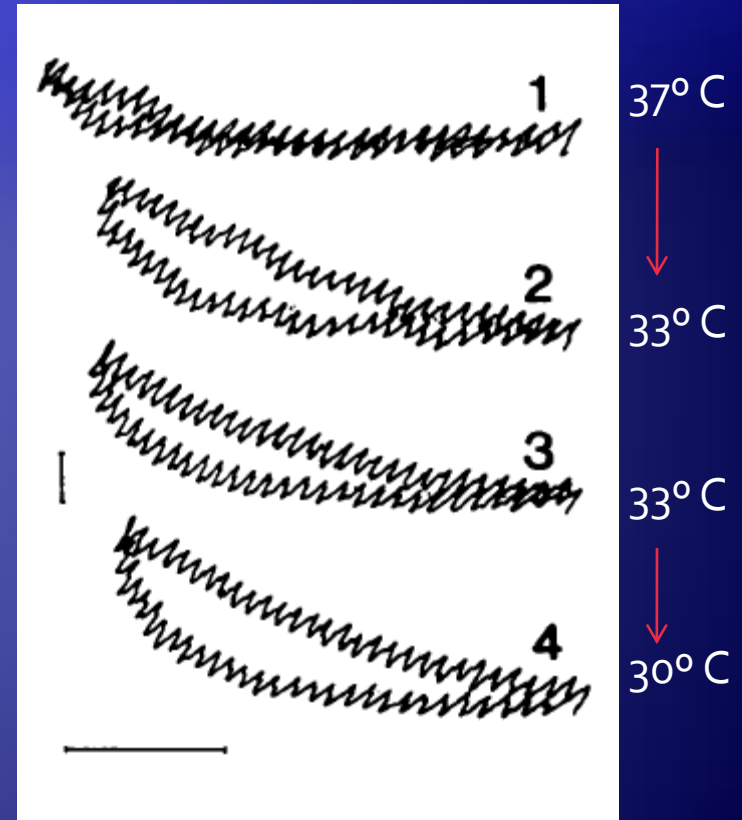
# Strain Rates

- ♦ 21 vs 2.1  $\mu\text{m/s}$
- ♦ Near nuclear (A)
  - ♦ Hi strain rate, hi stiffness
  - ♦ Lo strain rate, lo stiffness
- ♦ On nucleus (B)
  - ♦ Hi or Lo strain rate have same stiffness



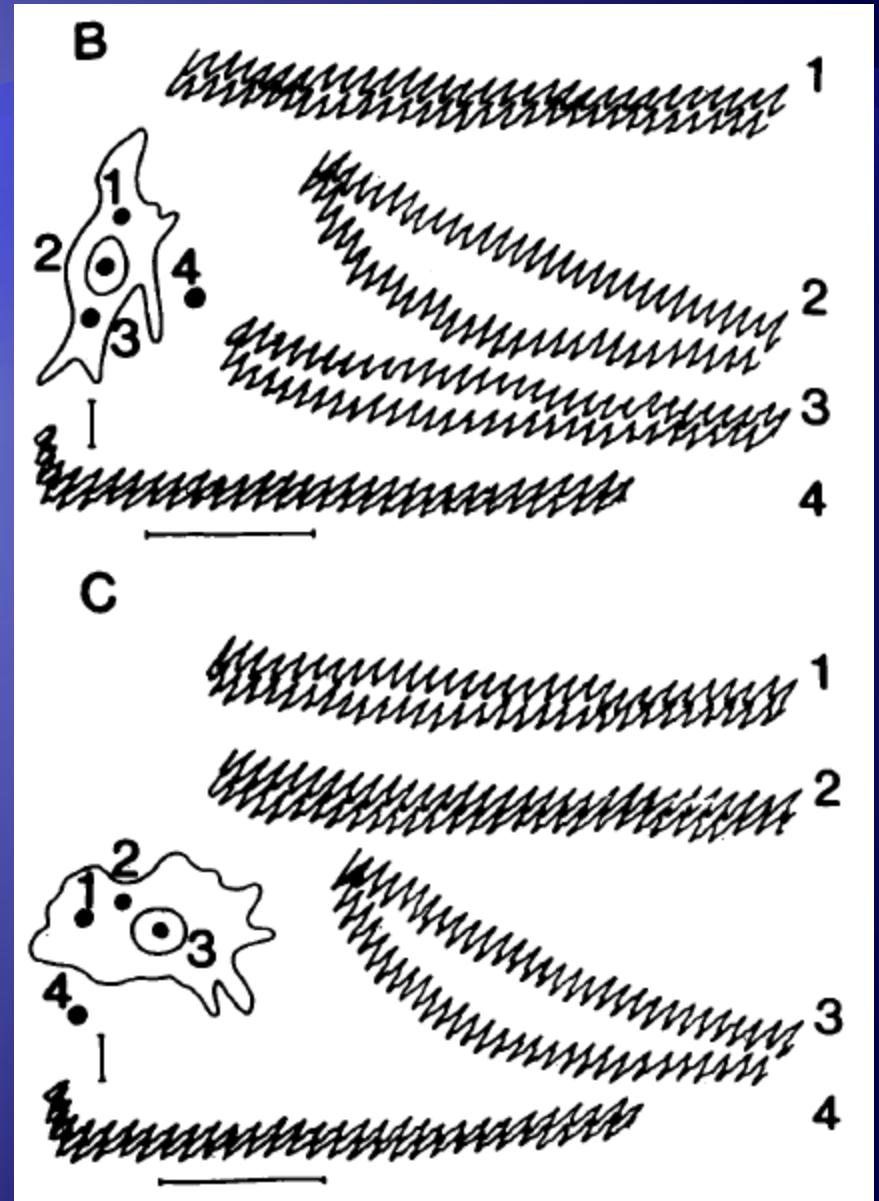
# Temperature

- ◆ Previous tests at 22° C
- ◆ Lower hysteresis at 37° C
- ◆ Lower stiffness at 37° C
- ◆ Thermal expansion problem in set-up?



# Cytochalasin B

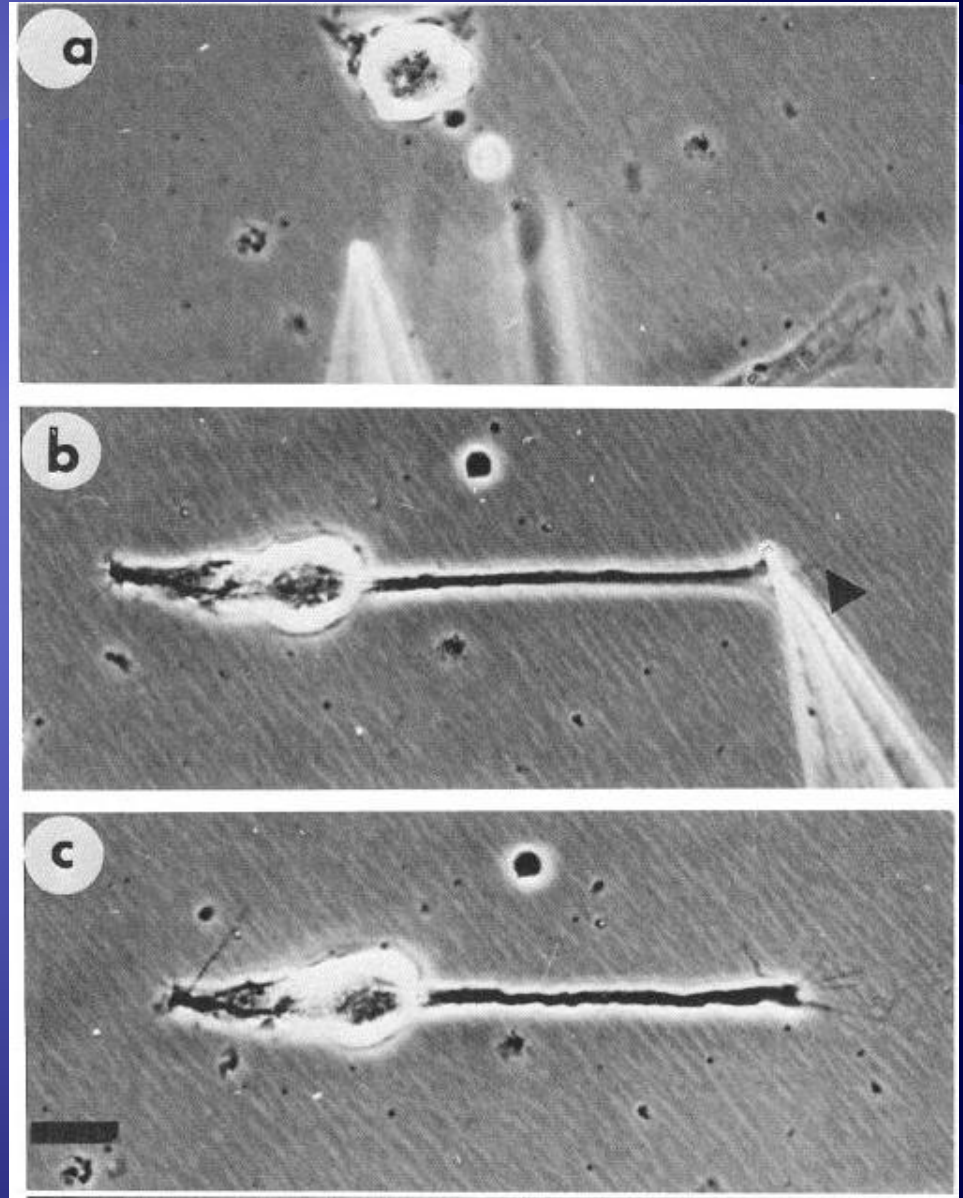
- ◆ Two cells incubated with 10  $\mu\text{g/ml}$  for 1 hr
- ◆ Cell 1 (tested 8-14 min after wash-off)
- ◆ Cell 2 (tested 23-32 min after wash-off)
- ◆ No effect to nuclei
- ◆ Cytoskeleton is softer





# Neuron Poking

- ◆ Tension from glass microneedle can form neurite extension from chick sensory neuron cells



**QUESTIONS?**