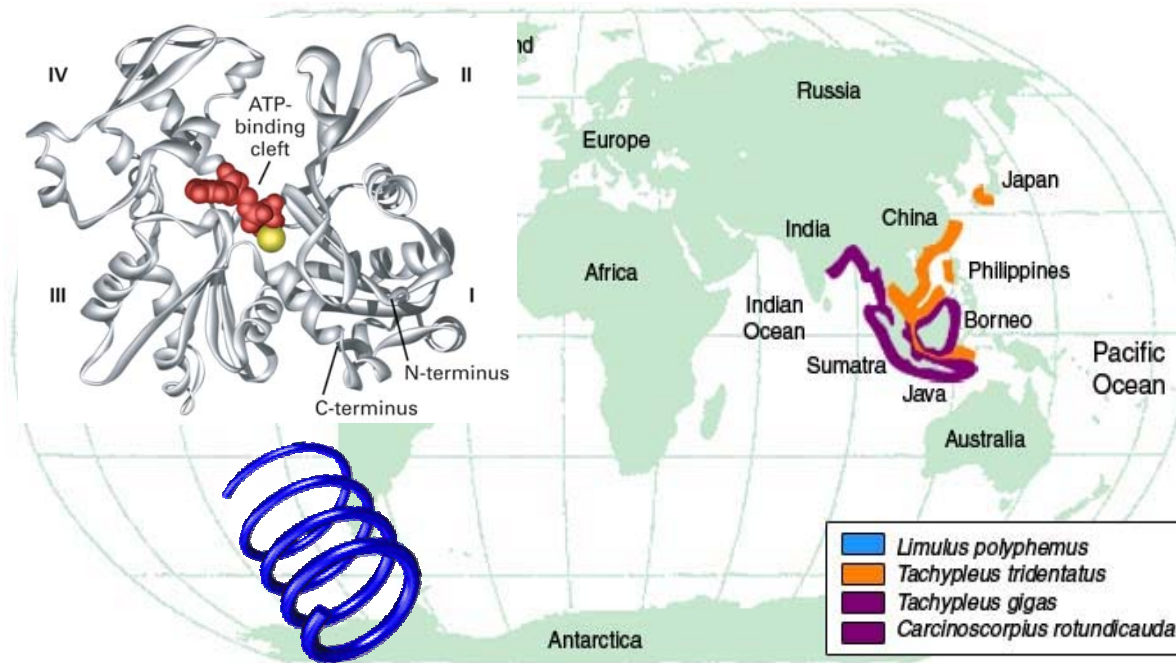


# Dynamics of an actin spring in horseshoe crab sperm



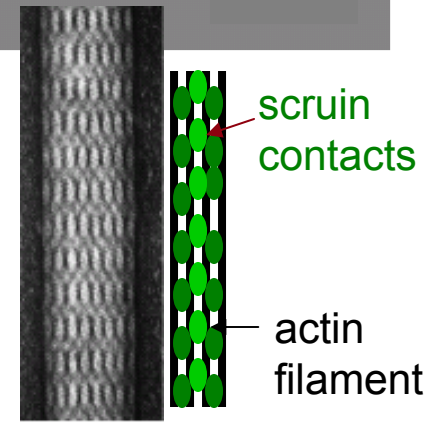
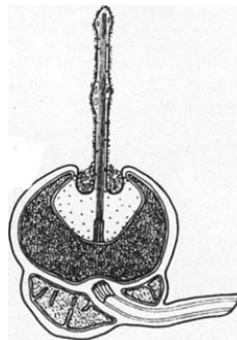
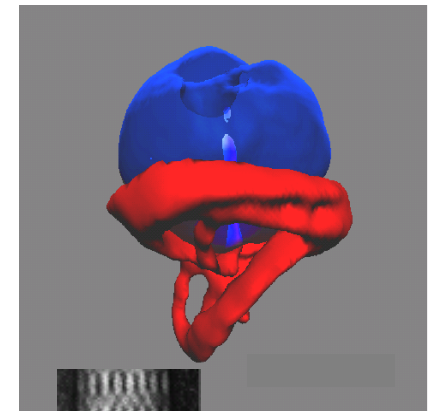
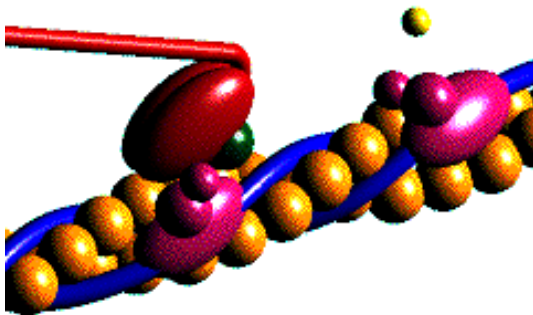
Jennifer H. Shin

Department of Mechanical Engineering,  
KAIST

April 3, 2006

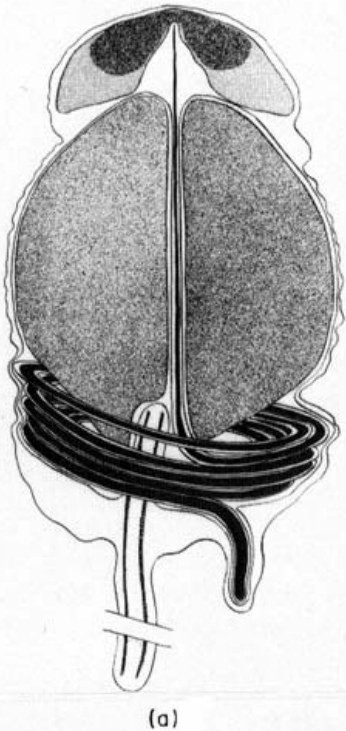
# Ubiquitous actin

- Actin based motility (ordered structure)
  - Railroad track for motors
  - Polymerization
  - Spring



# A preformed bundle uncoils & straightens

coil  
~6 loops



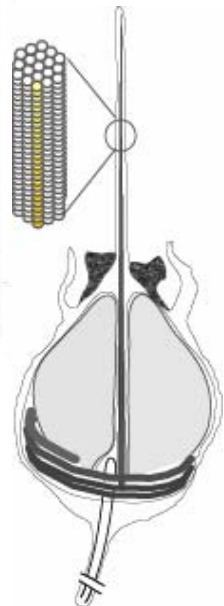
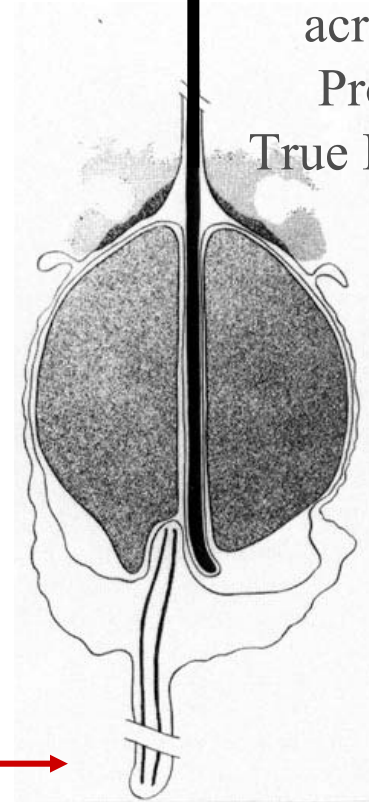
Ca<sup>2+</sup>  
or  
presence of an egg



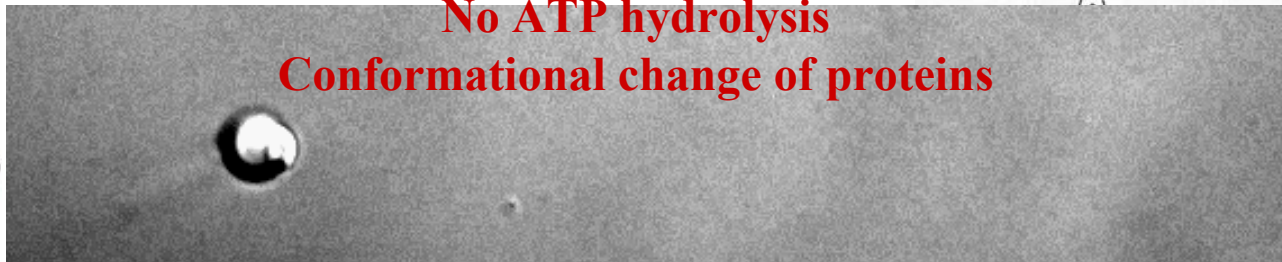
• Ca<sup>2+</sup>



60 μm  
acrosomal  
Process:  
True Discharge



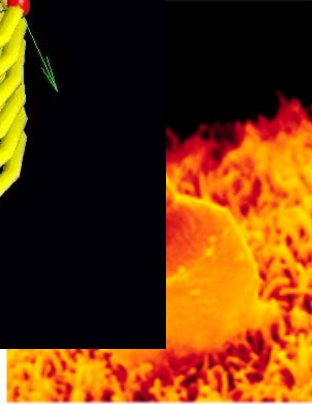
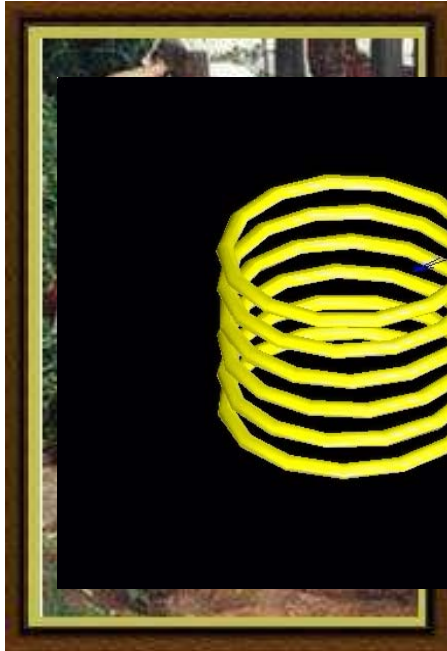
**No ATP hydrolysis**  
**Conformational change of proteins**



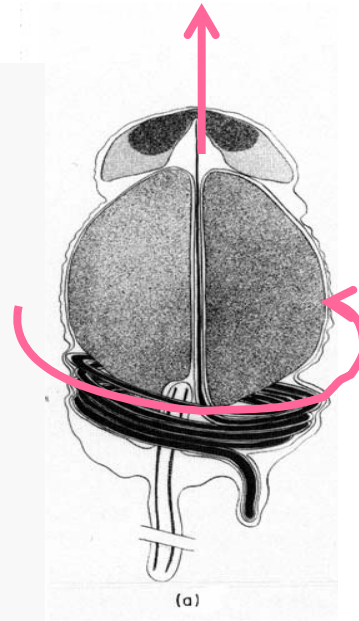
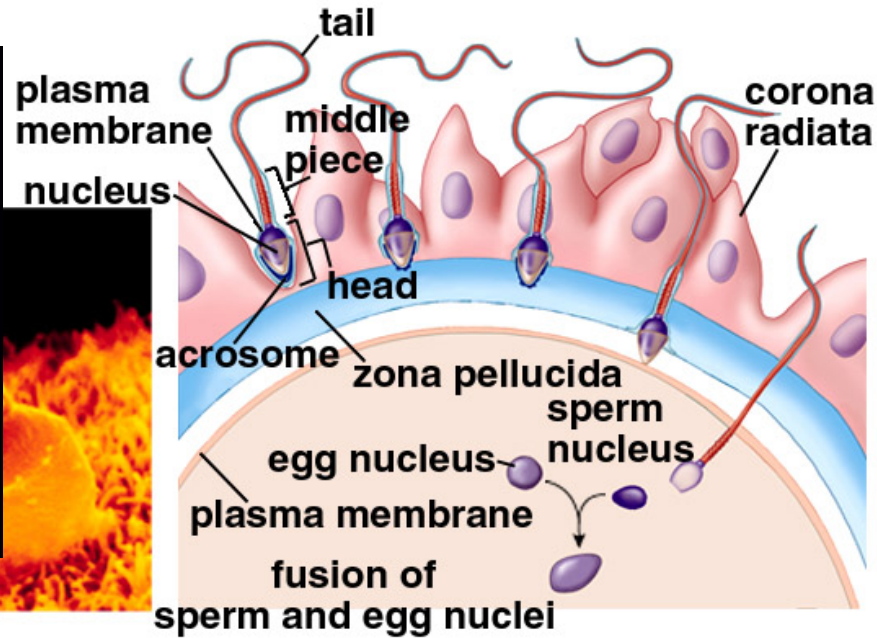


# Why is this process different ?

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## Fertilization



Thick & tough egg shell— screwing into the shell!

biological requirement for sperm to produce enough force/energy!

# Questions arise...



- **Structure:** The spring consists of 3 proteins.  
How is the structure related to its function?

- **Mechanism:** How does the transformation occur?



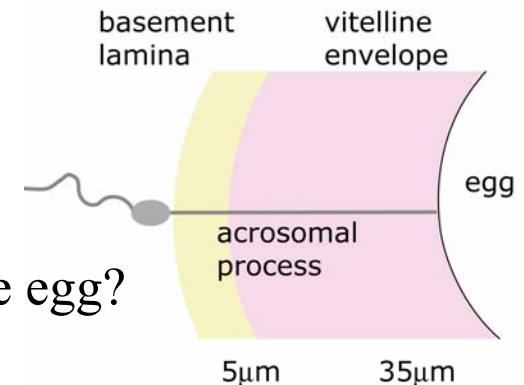
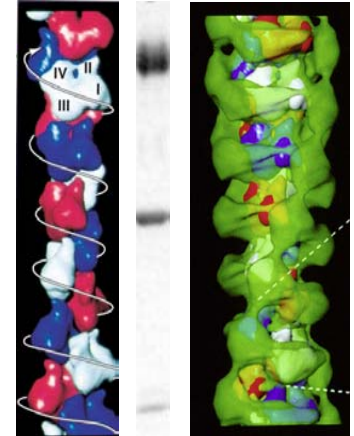
- Global unleashing
- Propagation of a localized untwist

- **Molecular mechanism:** What is going on in molecular level?

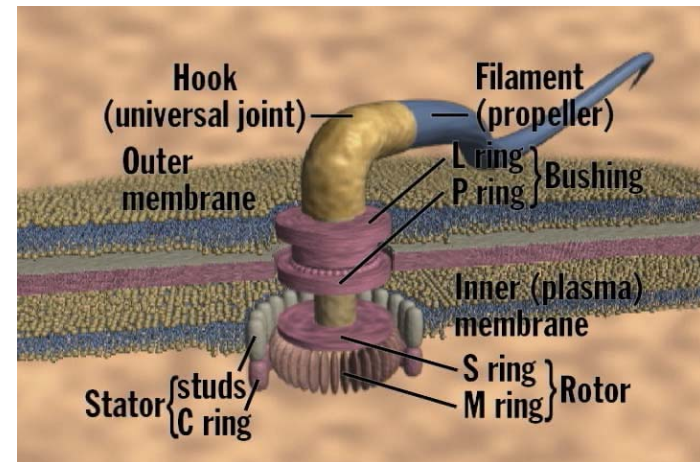
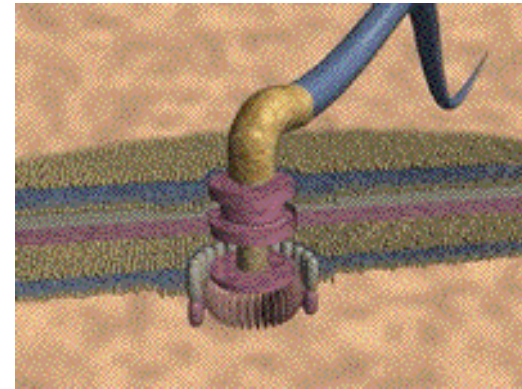
- **Energetics:** How is the energy stored to power the reaction?

- Elastic energy in the twist
- Ca<sup>2+</sup> binding energy
- ATP hydrolysis

- **Force:** Does it produce enough force to penetrate the egg?



# E. coli : efficient motility



# Acknowledgment

Dr. L. Mahadevan (Harvard University)

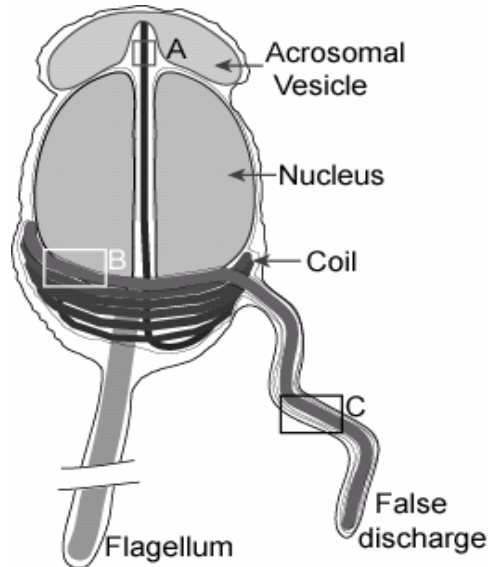
Dr. Paul Matsudaira (MIT)

Barney Tam

Guichy Waller

& all the members in Matsudaira lab

# Three states of actin spring



micrographs: Flicker et al., JMB

