Biology 427 Biomechanics

Lecture 13. From motors to muscle

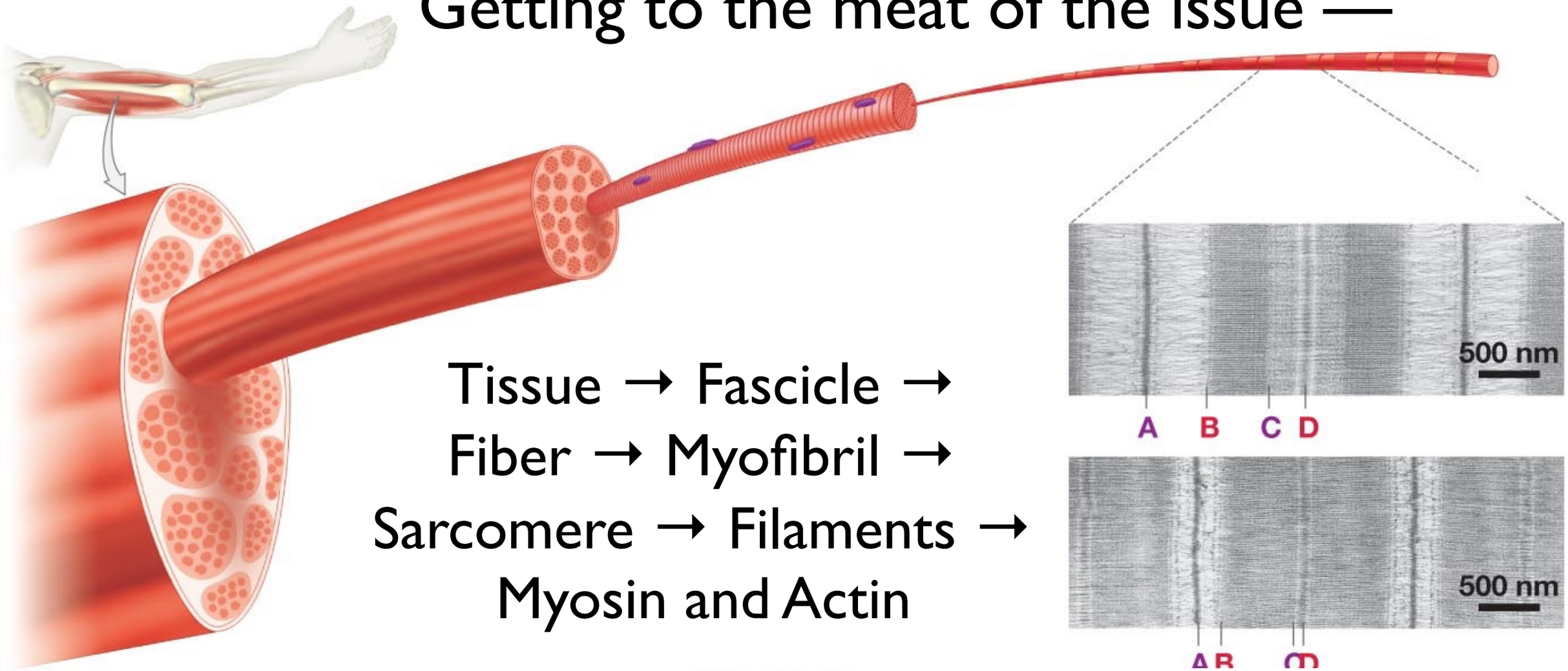
- Comments about projects
- Recap motor proteins
- Cellular and molecular structure of the sarcomere
- Force depends on the number of sarcomeres in parallel
- Length change depends on the number of sarcomeres in series
- Isometric versus isotonic experiments
- Force depends on: cross sectional area, time, sarcomere length, and contraction velocity

Biology 427 Biomechanics

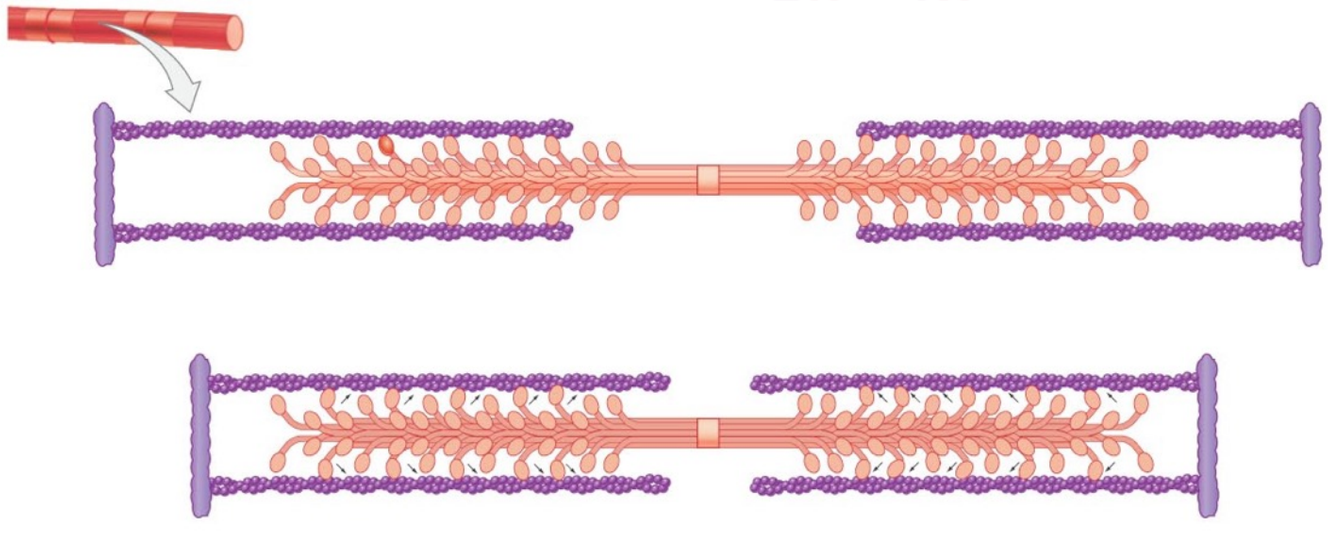
Course projects

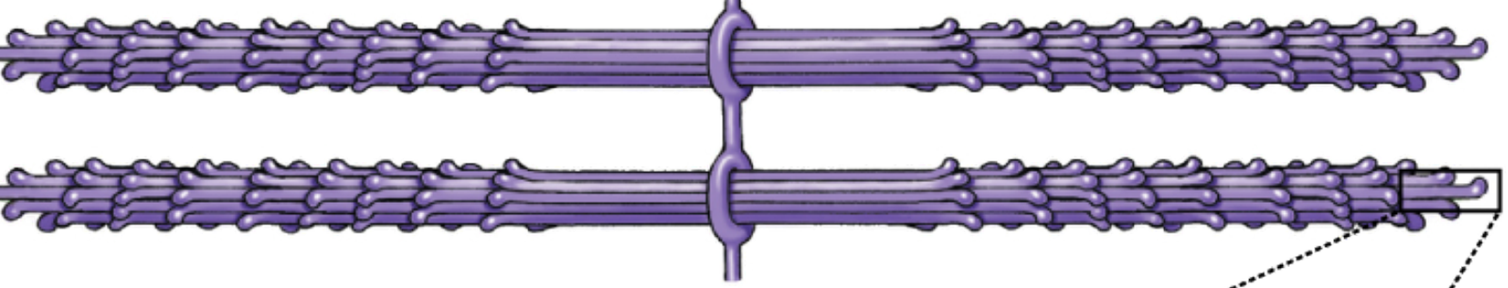
- 20 points
- Any topic that involves mechanics and biology
- It will be in the form of a poster that you will submit online (poster guidelines will be posted)
- Any pair within one lab
- Analytic/experimental work is excellent
- Will use lab during scheduled hours for projects
- Assistance with Mathematica (via TLD) can be had
- Poster template and guidelines Week of Nov 7
- Project proposals due in lab week of Nov 14
- Labs will be open Tues week of Nov 21 for joint work
- Week of Nov 28 is a half lab and half poster prep time.
- Week of Dec 5 poster presentations via power point slides.

Getting to the meat of the issue —

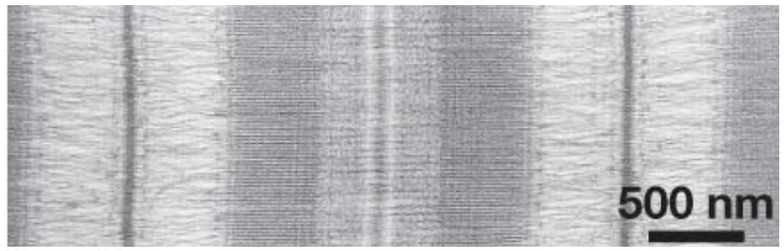


Tissue → Fascicle →
Fiber → Myofibril →
Sarcomere → Filaments →
Myosin and Actin

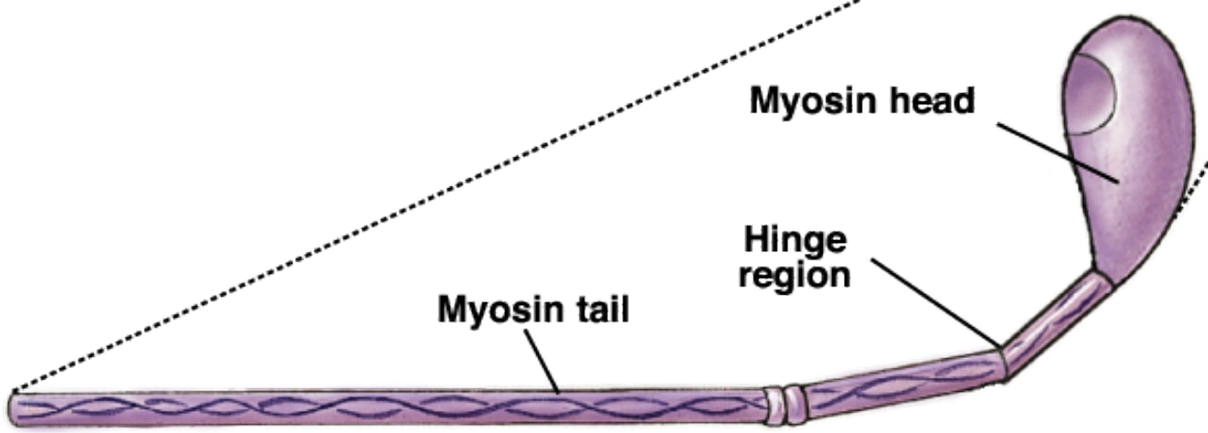




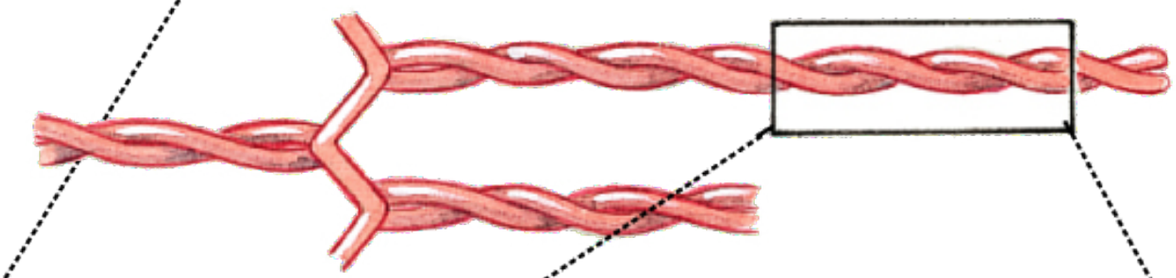
Thick filaments

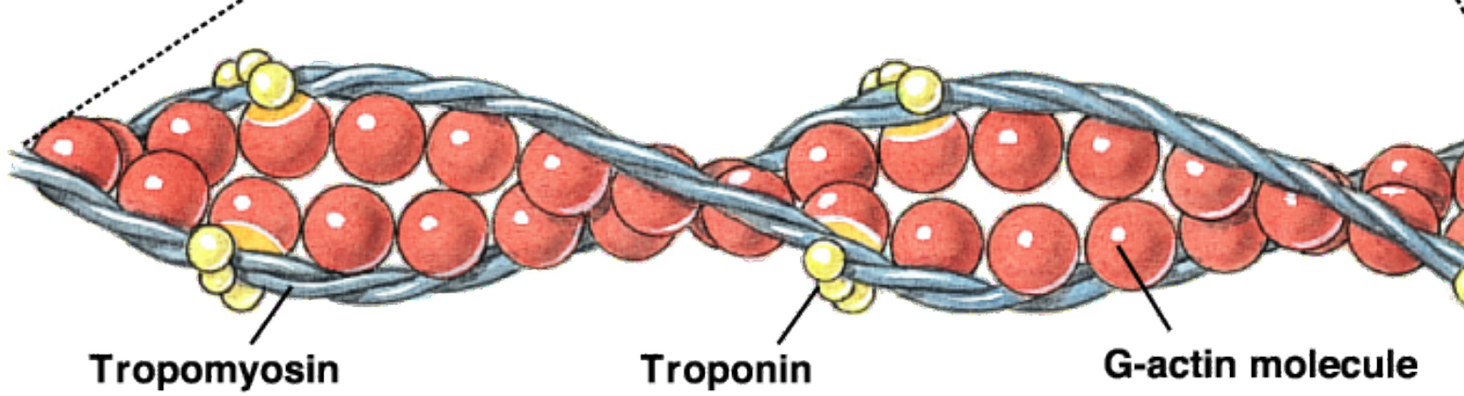


Thin filament



Myosin molecule

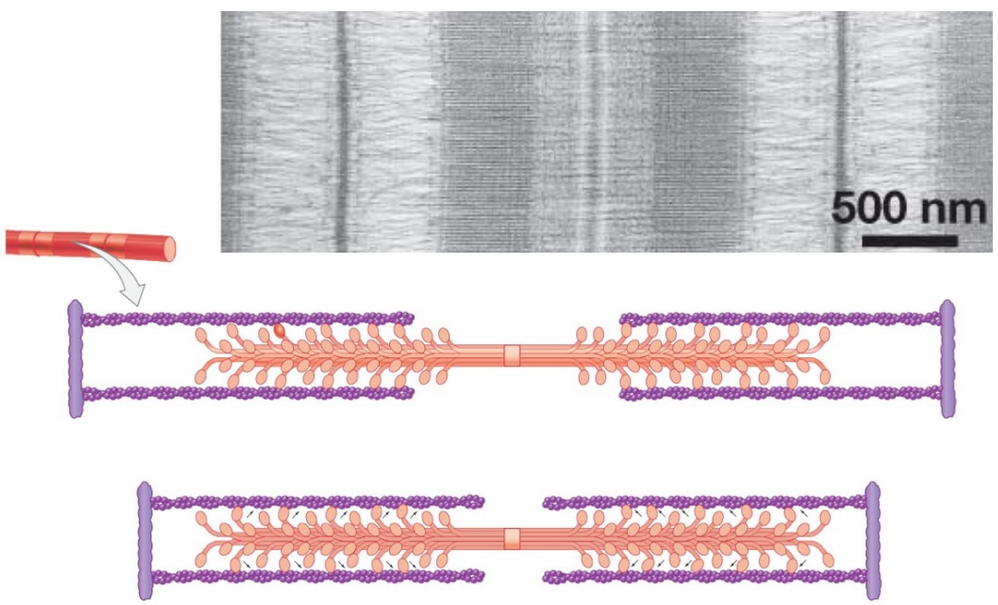


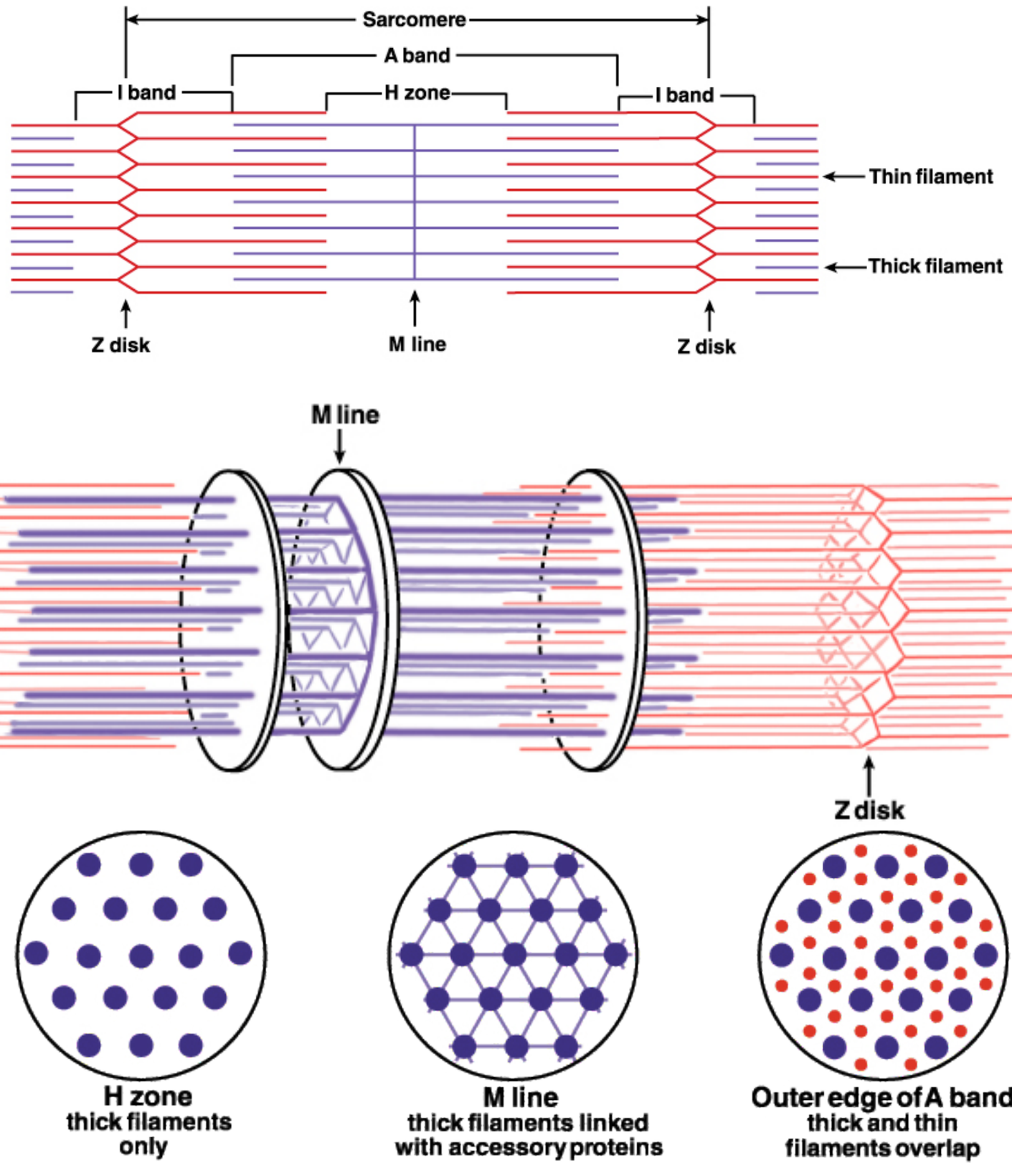


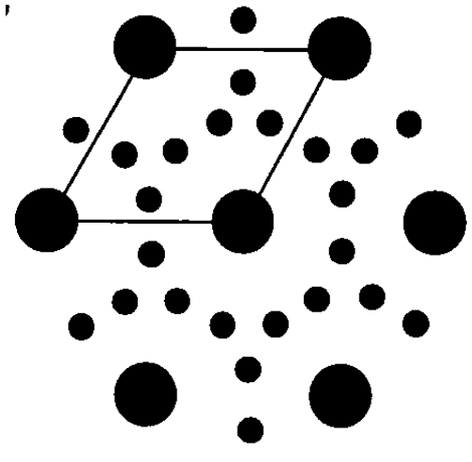
Actin chain

Silverthorn, Human Physiology, 2CE

The sarcomere is in 3D





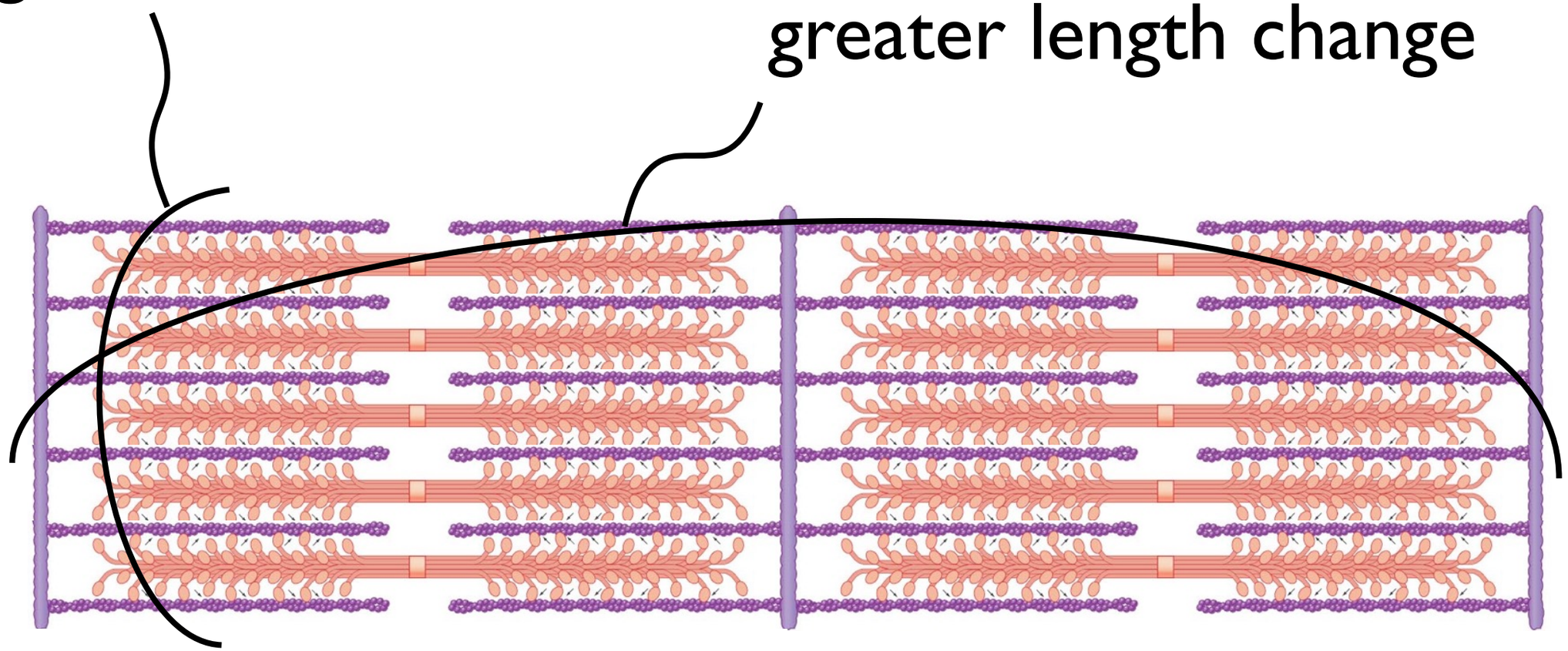


Scallop
Muscle

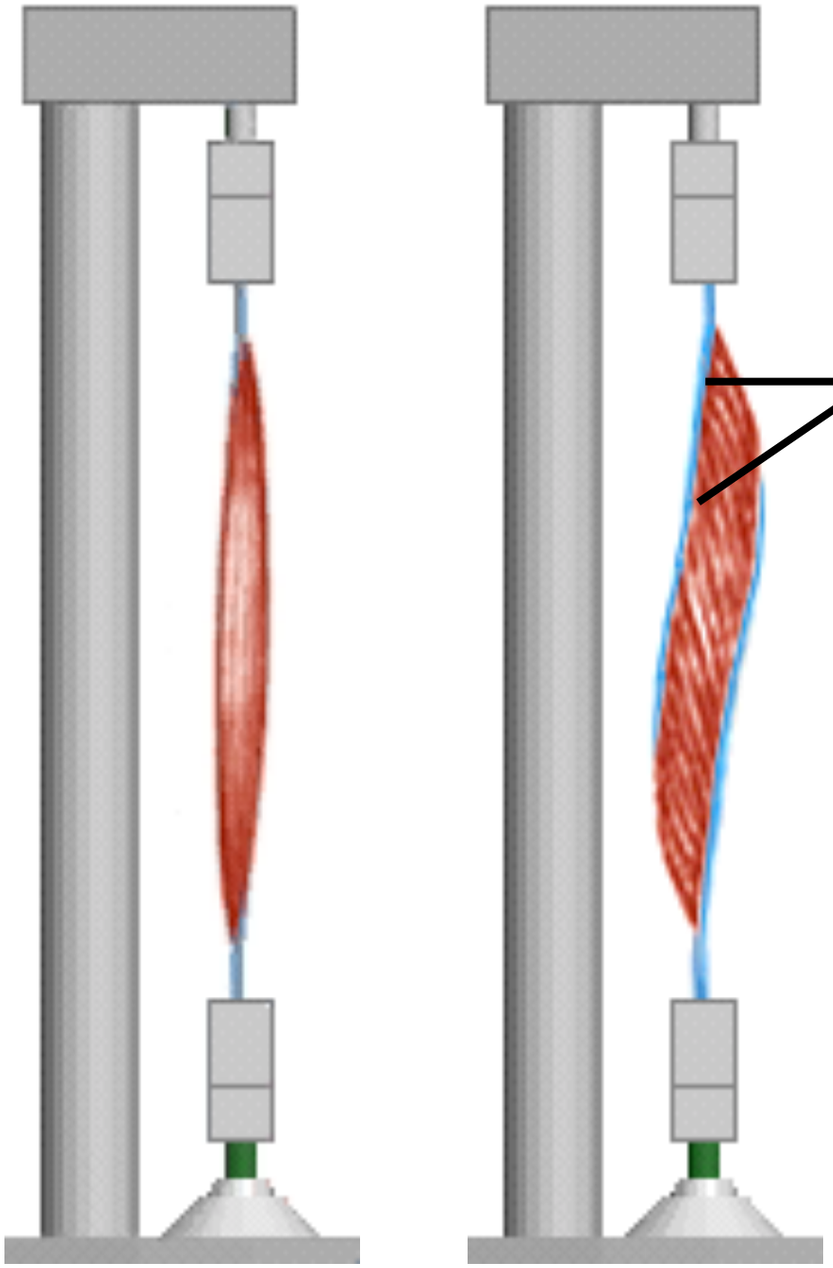
Force is proportional to the cross-sectional area

Pulling in parallel,
greater force

Pulling in series,
greater length change



Force is proportional to the cross-sectional area

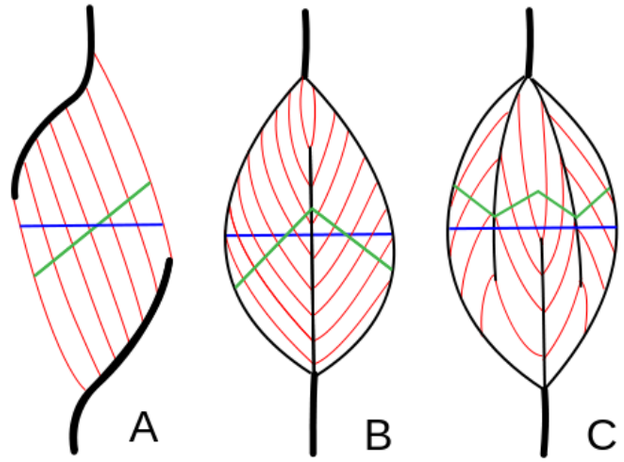


Parallel

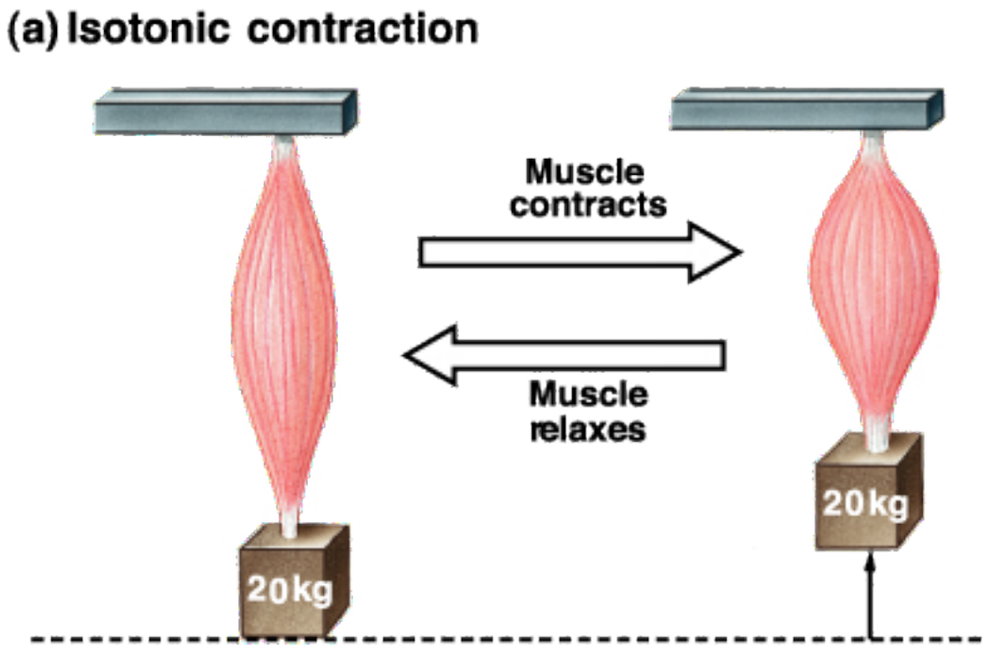
Pennate

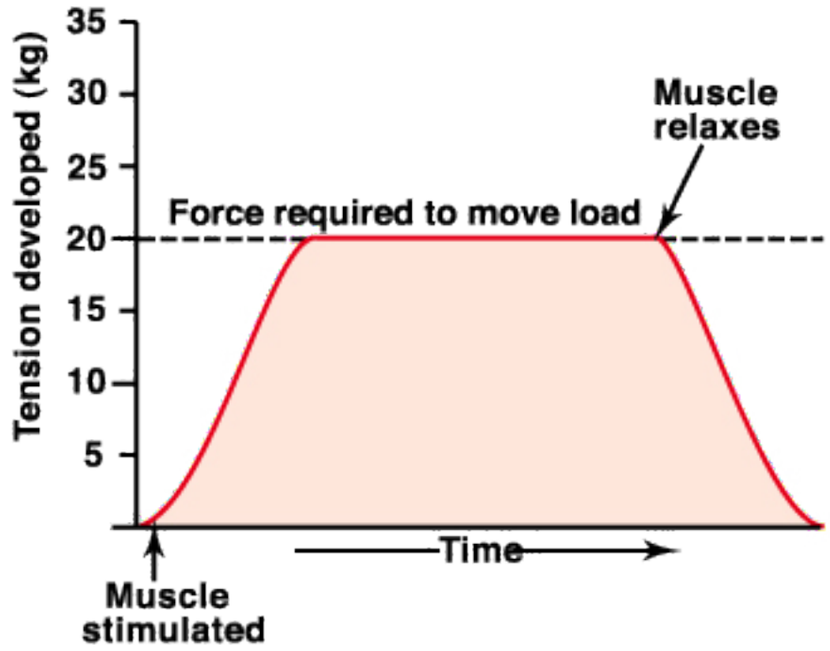
$$S_{Para} = \pi R^2$$

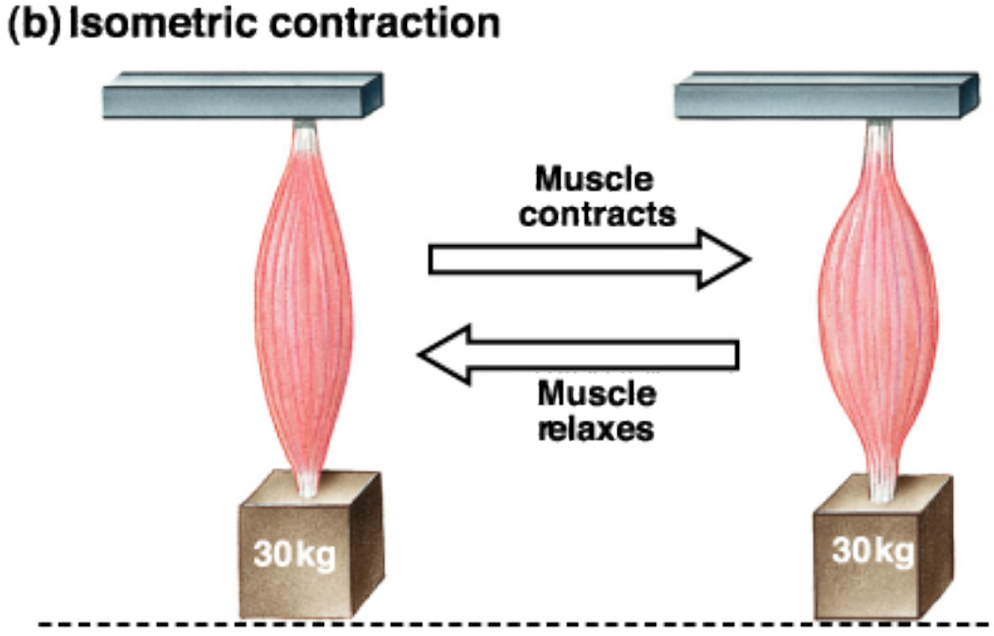
$$S_{Pen} = \pi R^2 \sec\theta$$

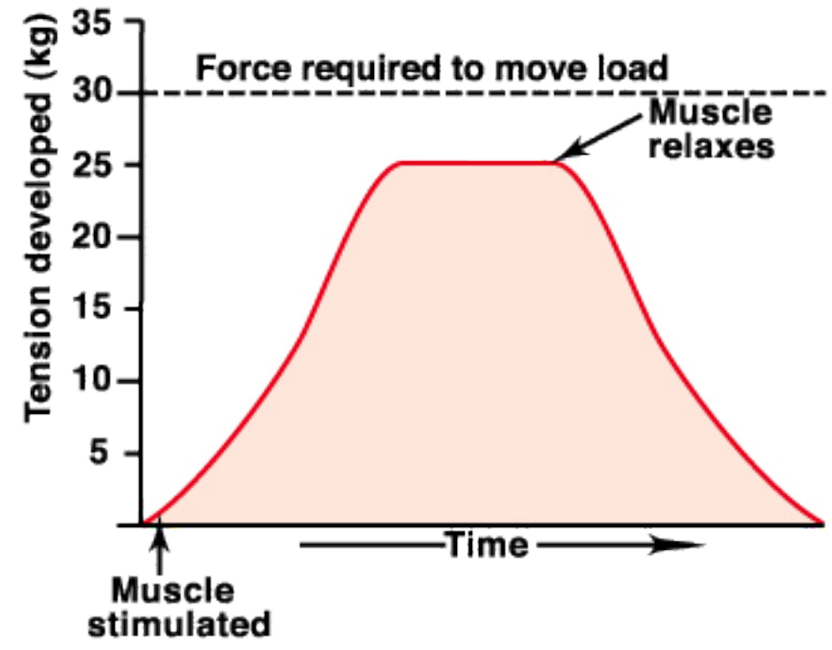


Isometric versus isotonic contractions



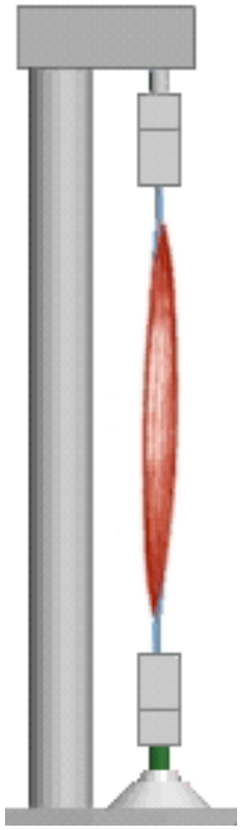


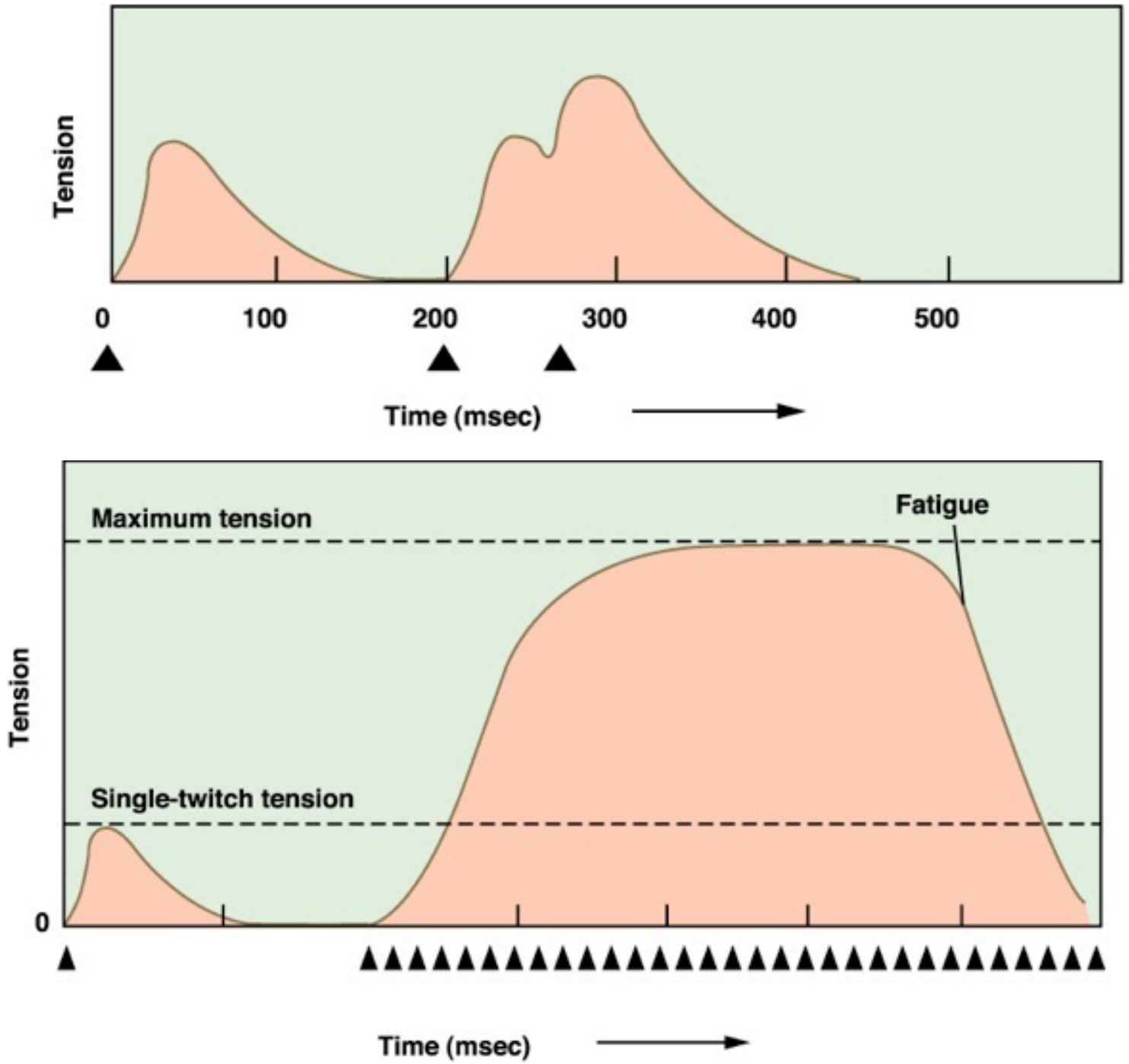




Silverthorn, Human Physiology, 2CE

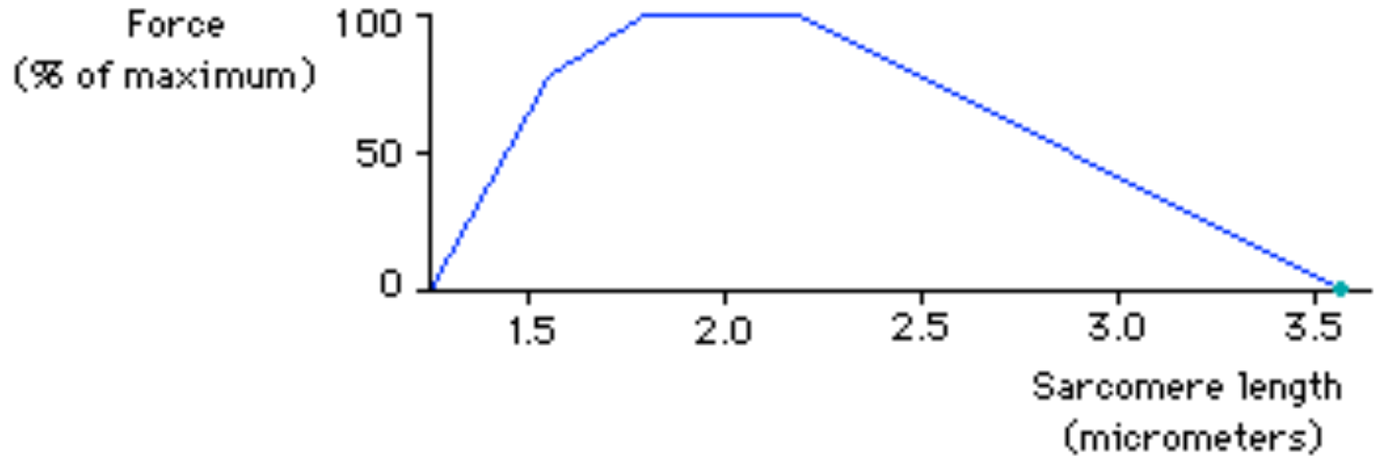
Force is proportional to the cross-sectional area and timing



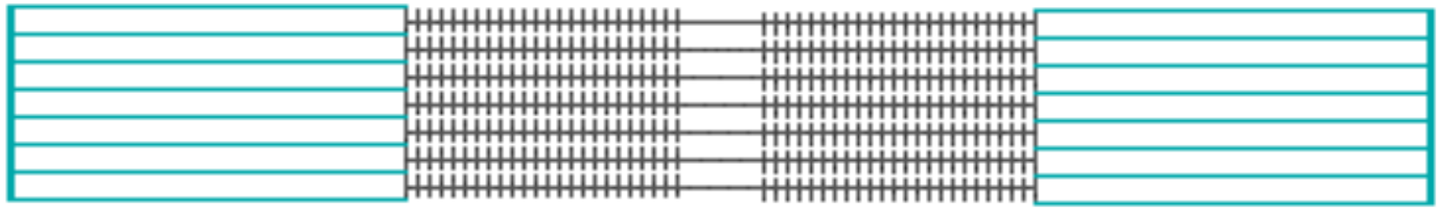


Silverthorn, Human Physiology, 2CE

Force is proportional to the cross-sectional area and timing and length



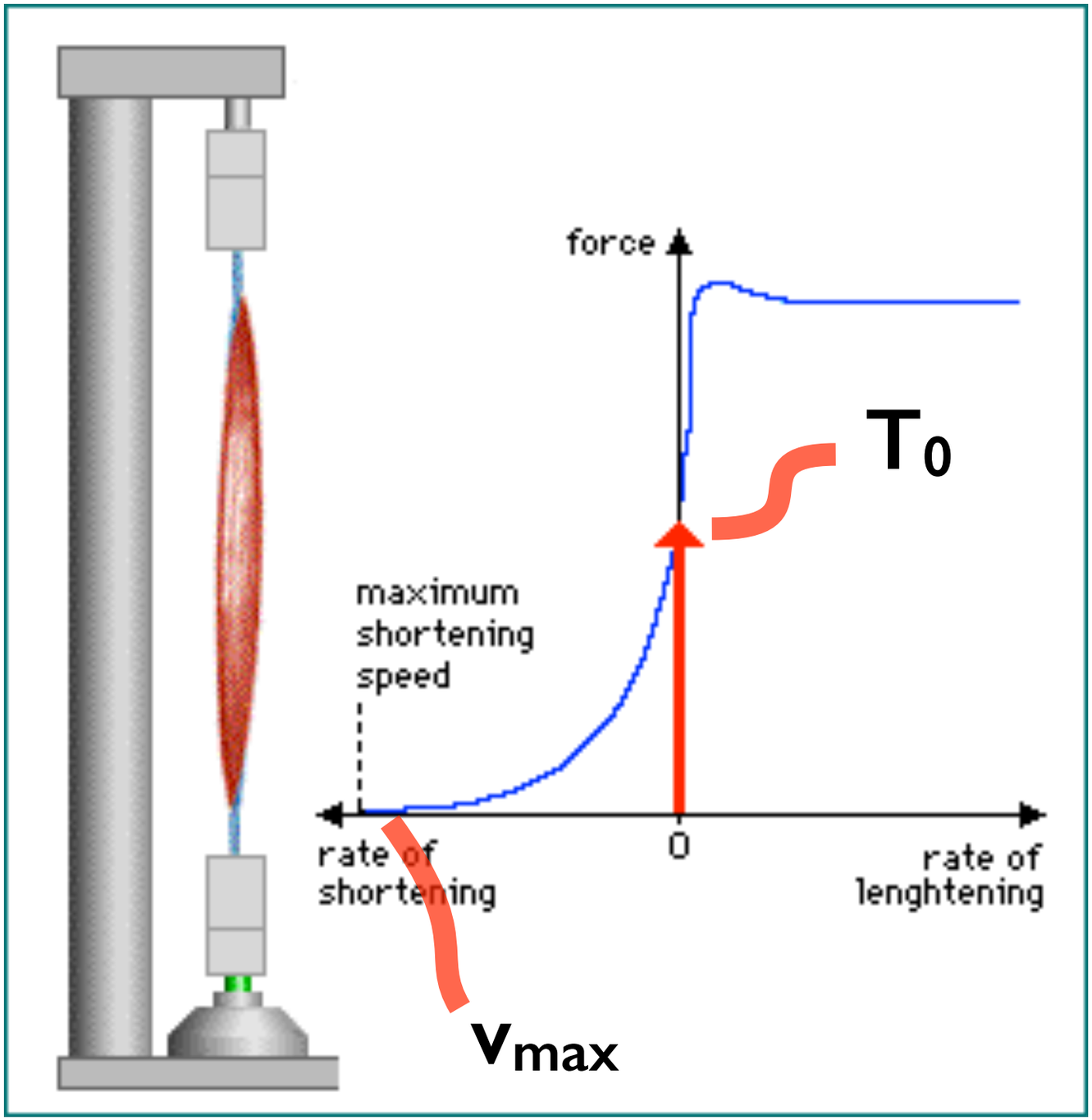
Where do animals normally operate?



Sliding filament theory

Gordon, Huxley and Julian 1966

Force is proportional to the cross-sectional area and timing and length and velocity



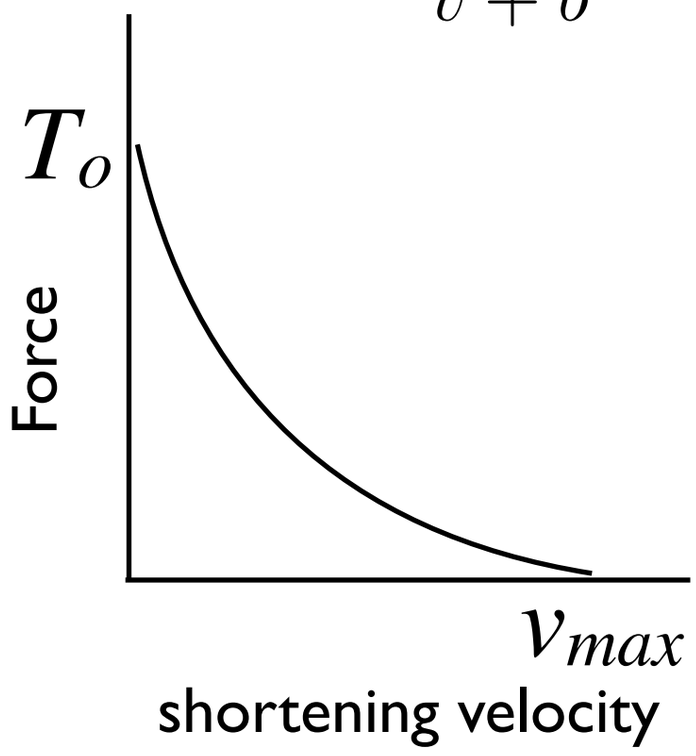
$$F = \frac{b\,T_0 - a\,v}{v + b}$$

$$\frac{b}{v_{max}} \approx \frac{a}{T_0} \approx \frac{1}{4}$$

$$\frac{F}{T_0} = \frac{v_{max} - v}{4v + v_{max}}$$

Force is proportional to the cross-sectional area and timing and length and velocity

$$F = \frac{b\,T_0 - a\,v}{v + b}$$



Power =force x velocity