

Bio-Inspired Design

Wb2436-05



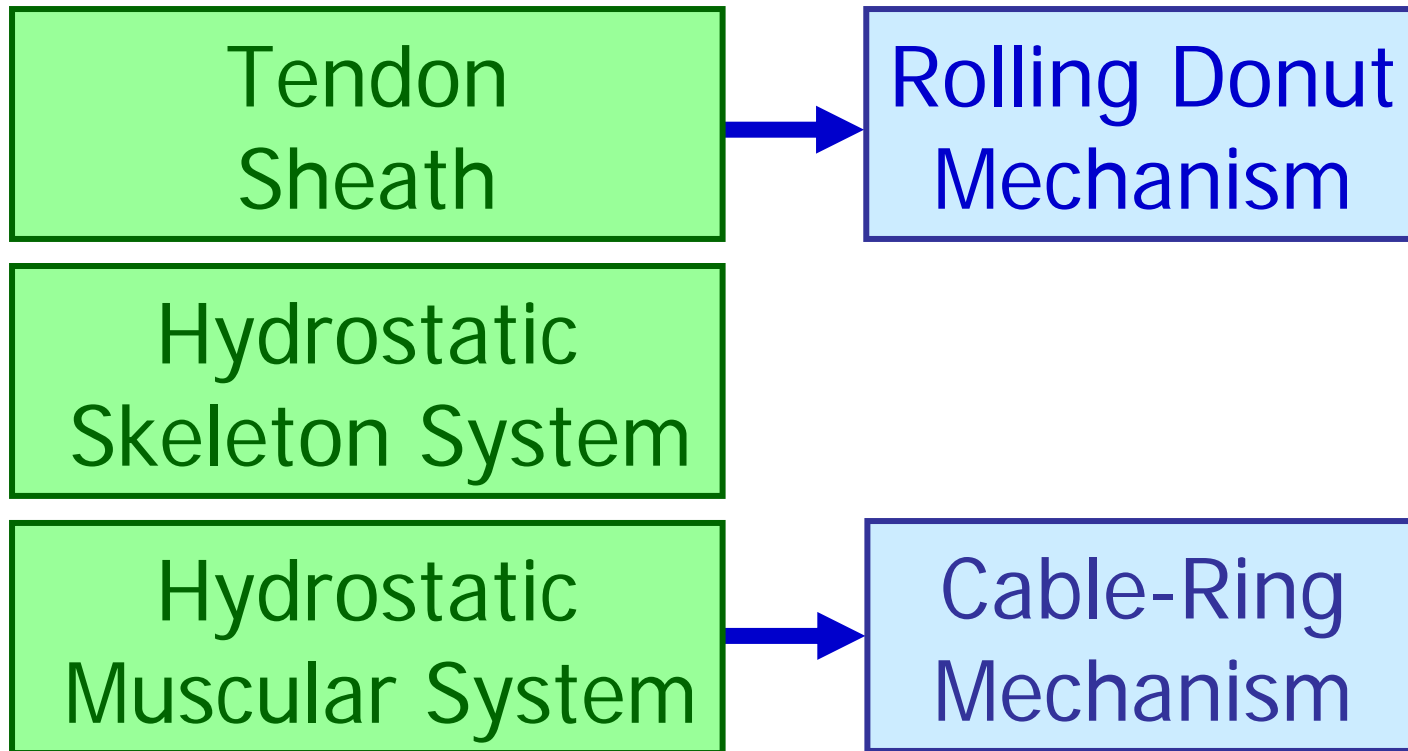
“Moving without Bones”

<http://monsterfinance.wordpress.com/2008/08/18/16/>

Overview

Biological
Mechanism

Resulting
Technology



Tendon Sheath

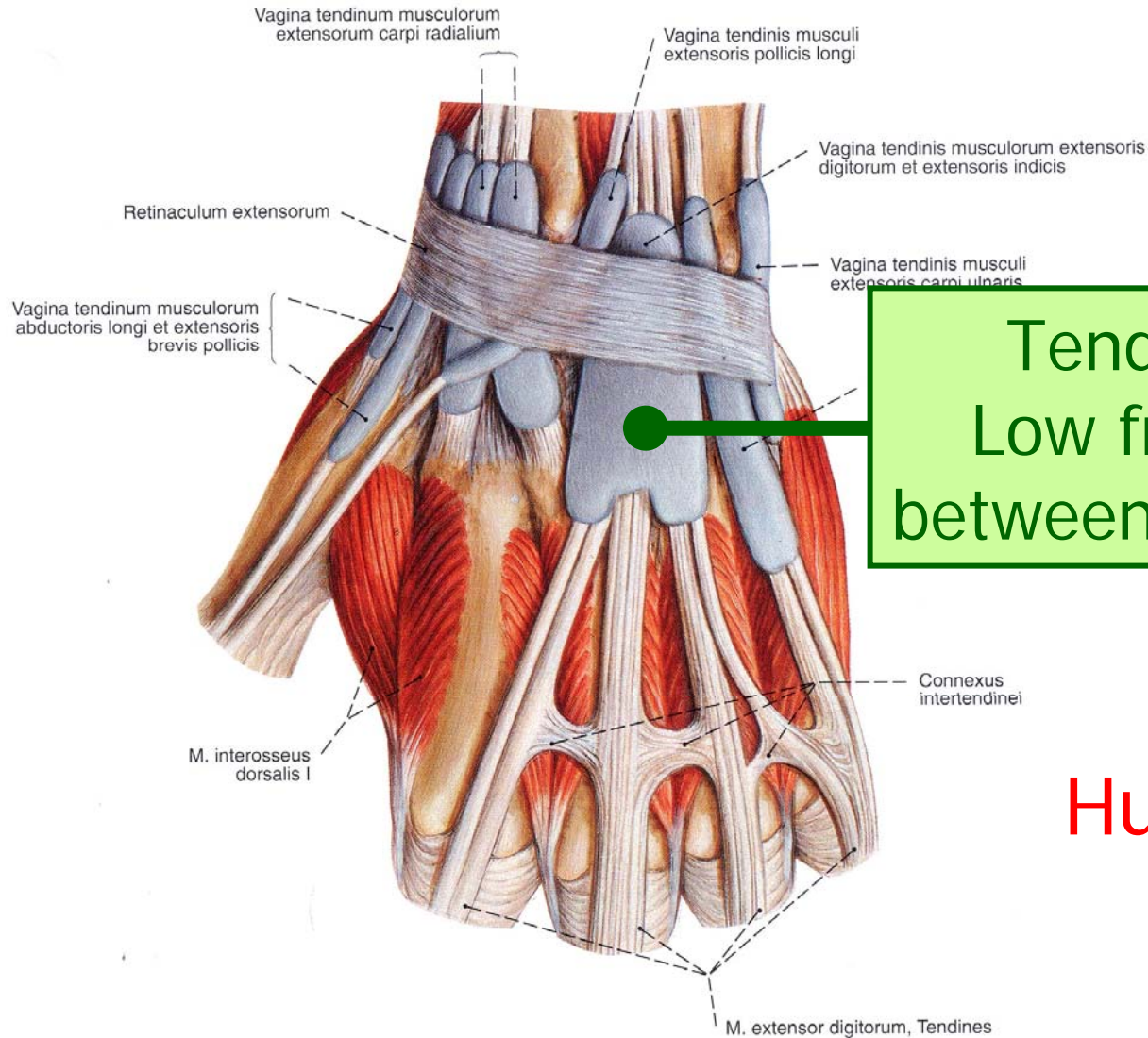
Hydro Skeleton

Hydro Muscular

Tendon Sheath

Hydro Skeleton

Hydro Muscular



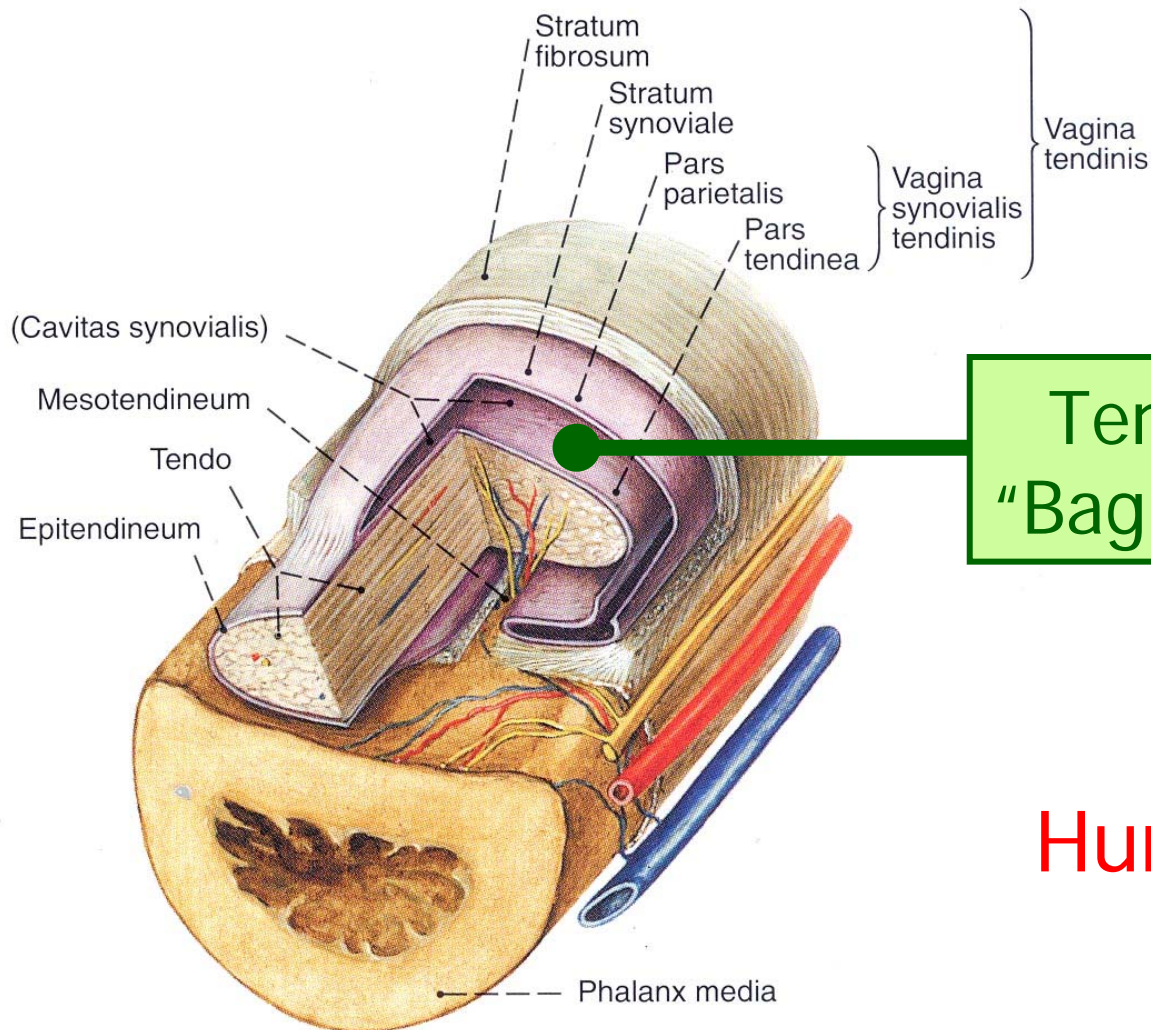
Tendon Sheath =
Low friction bearing
between tendon & tissue

Human Hand

Tendon Sheath

Hydro Skeleton

Hydro Muscular



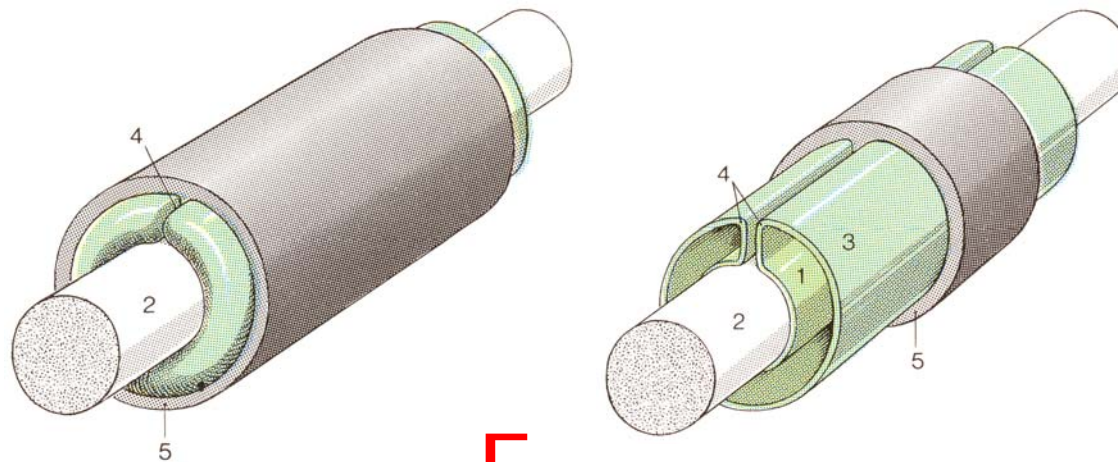
Tendon Sheath =
"Bag" filled with fluid

Human Finger

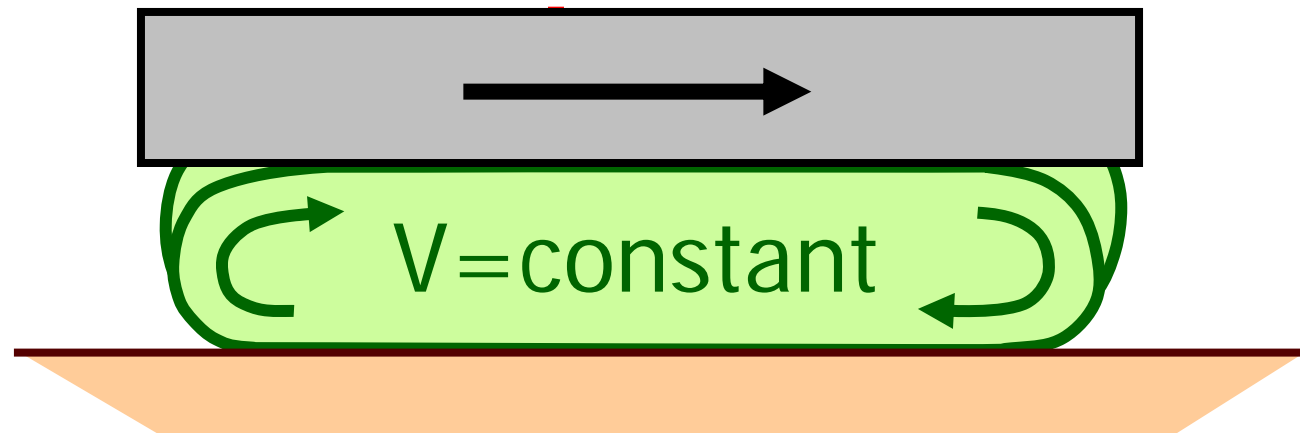
Tendon Sheath

Hydro Skeleton

Hydro Muscular



F



Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut

Pain!

Pain!

Stick

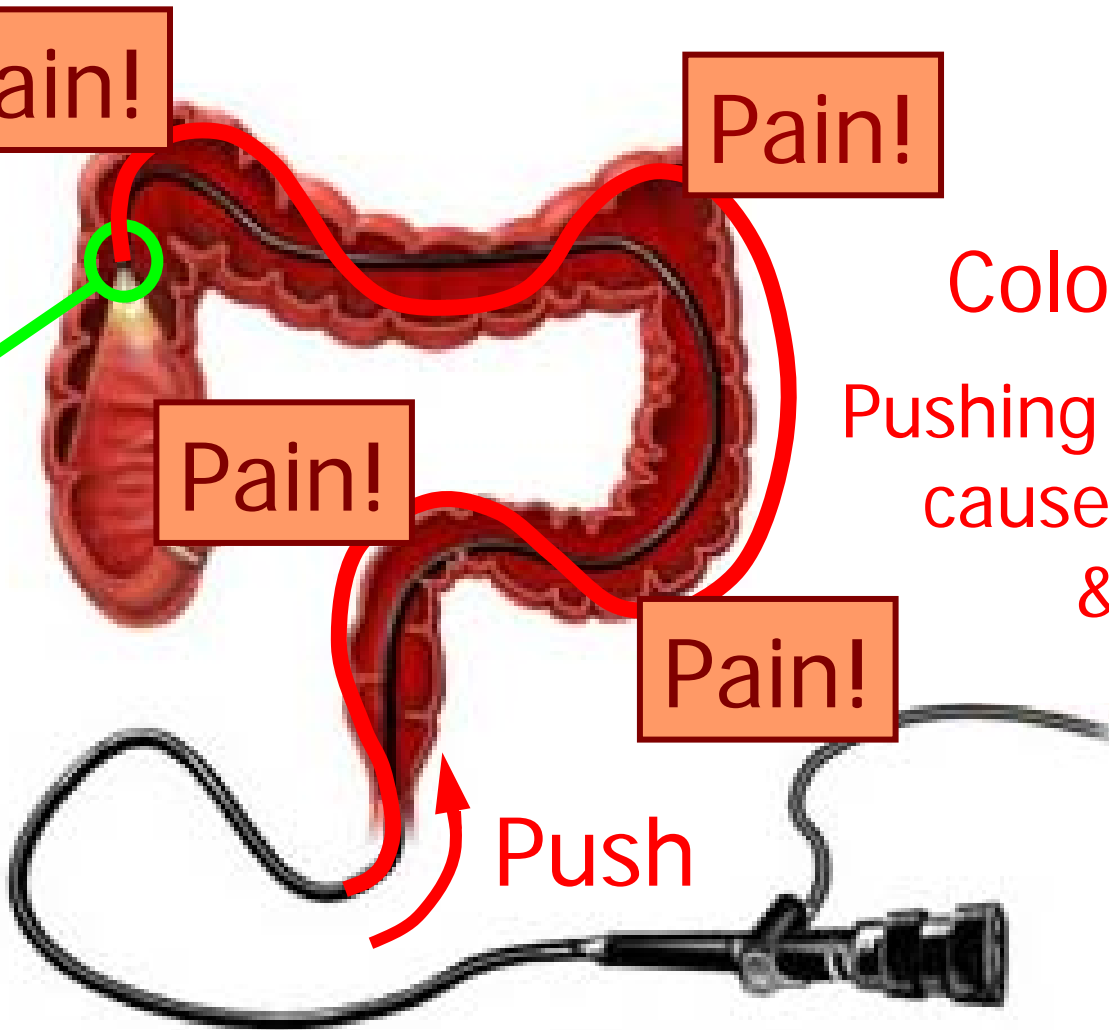
Pain!

Pain!

Colonoscopy

Pushing from behind
causes buckling
& pain

Push



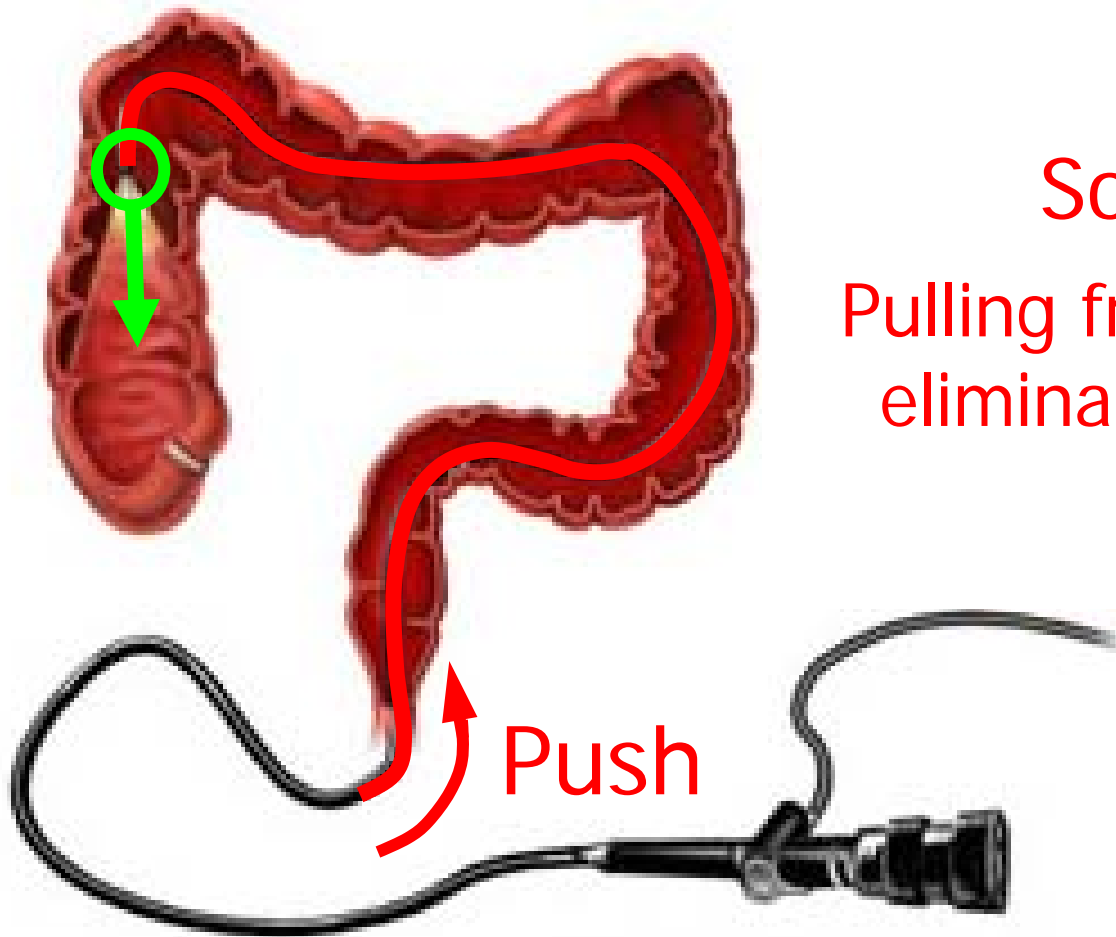
Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut

Pull



Solution

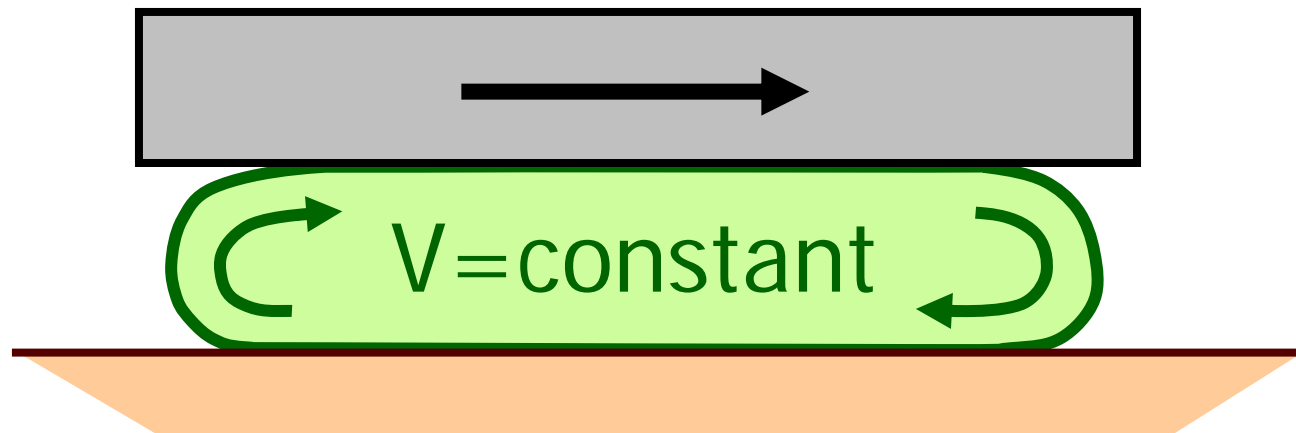
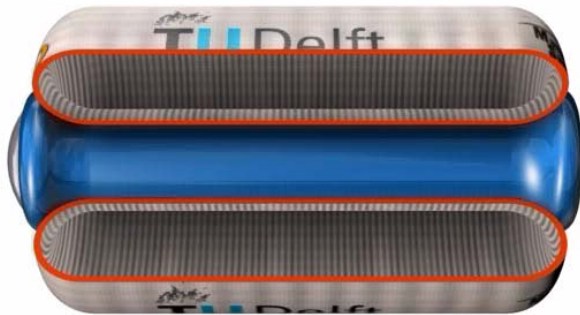
Pulling from the front eliminates buckling

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut

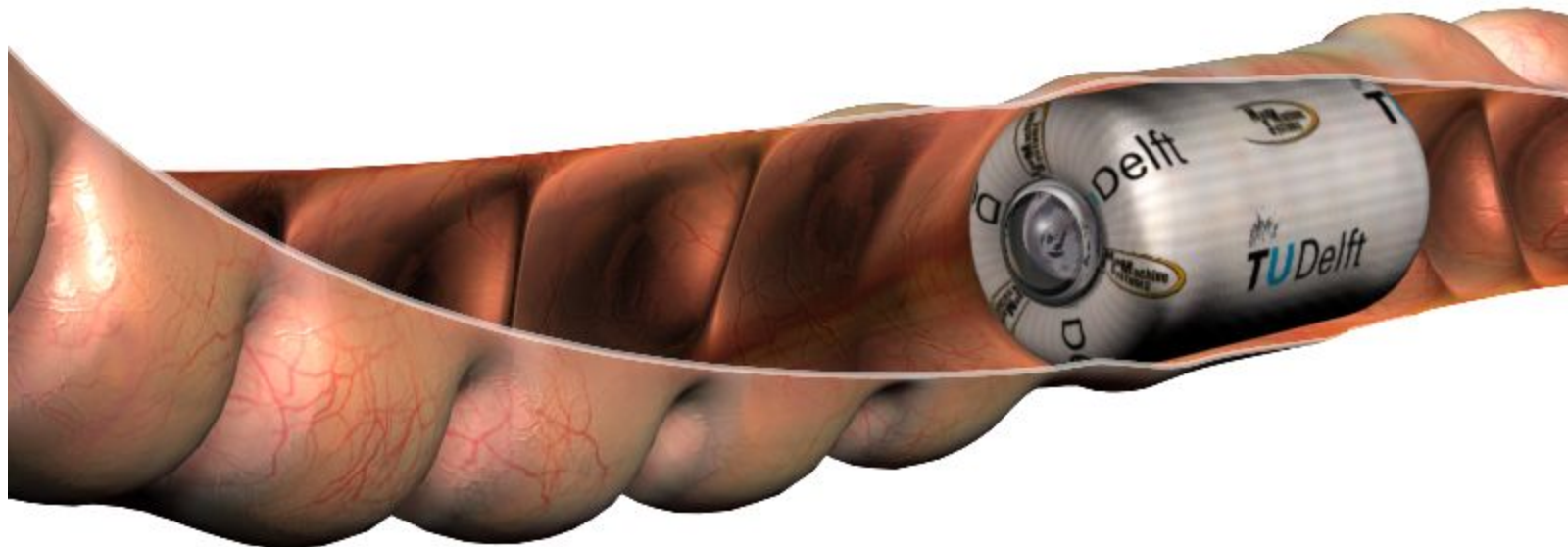


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut

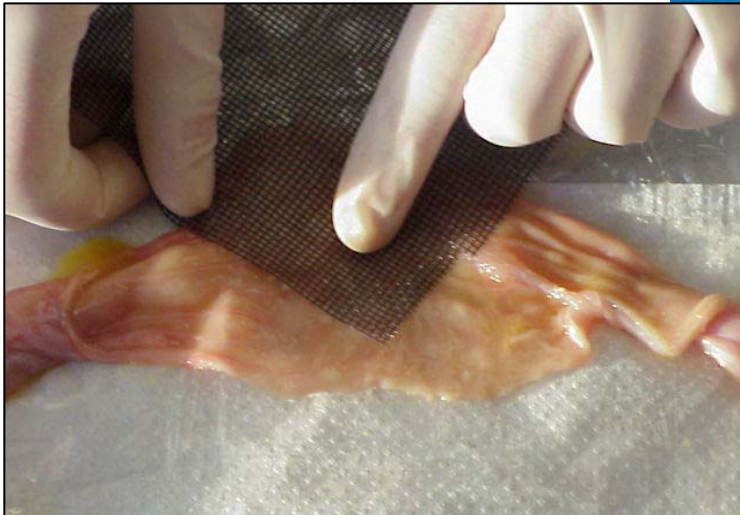


Tendon Sheath

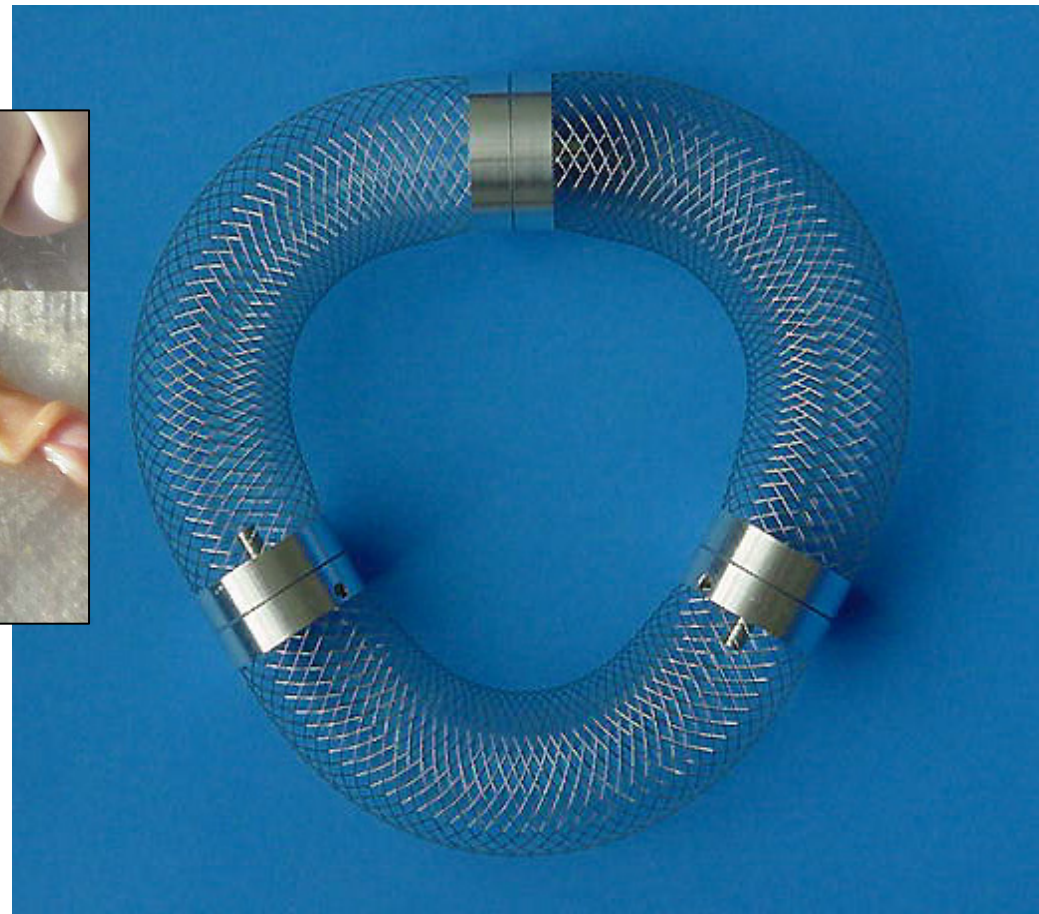
Hydro Skeleton

Hydro Muscular

Rolling Donut



Mesh gives
high Friction

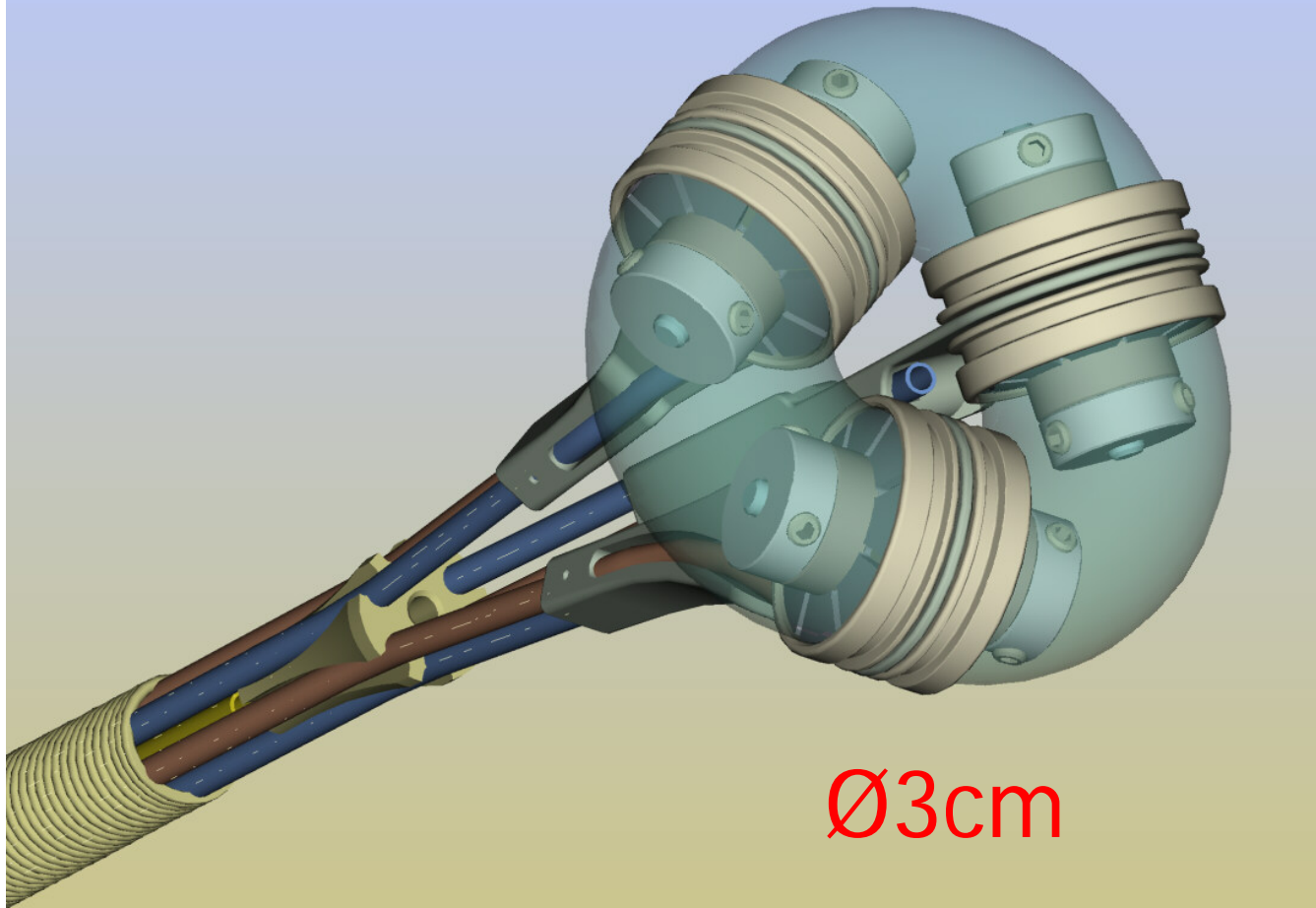


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut

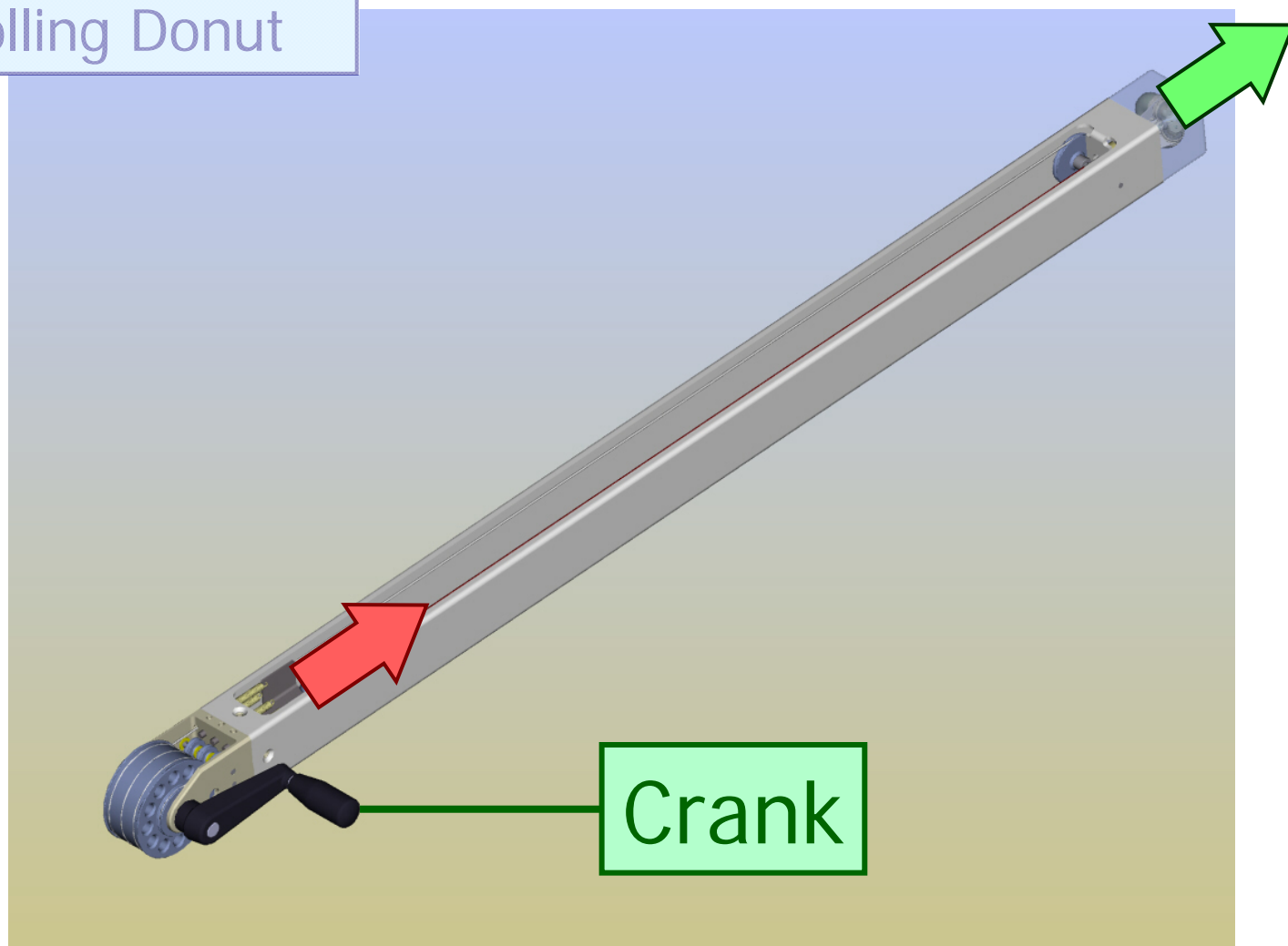


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut



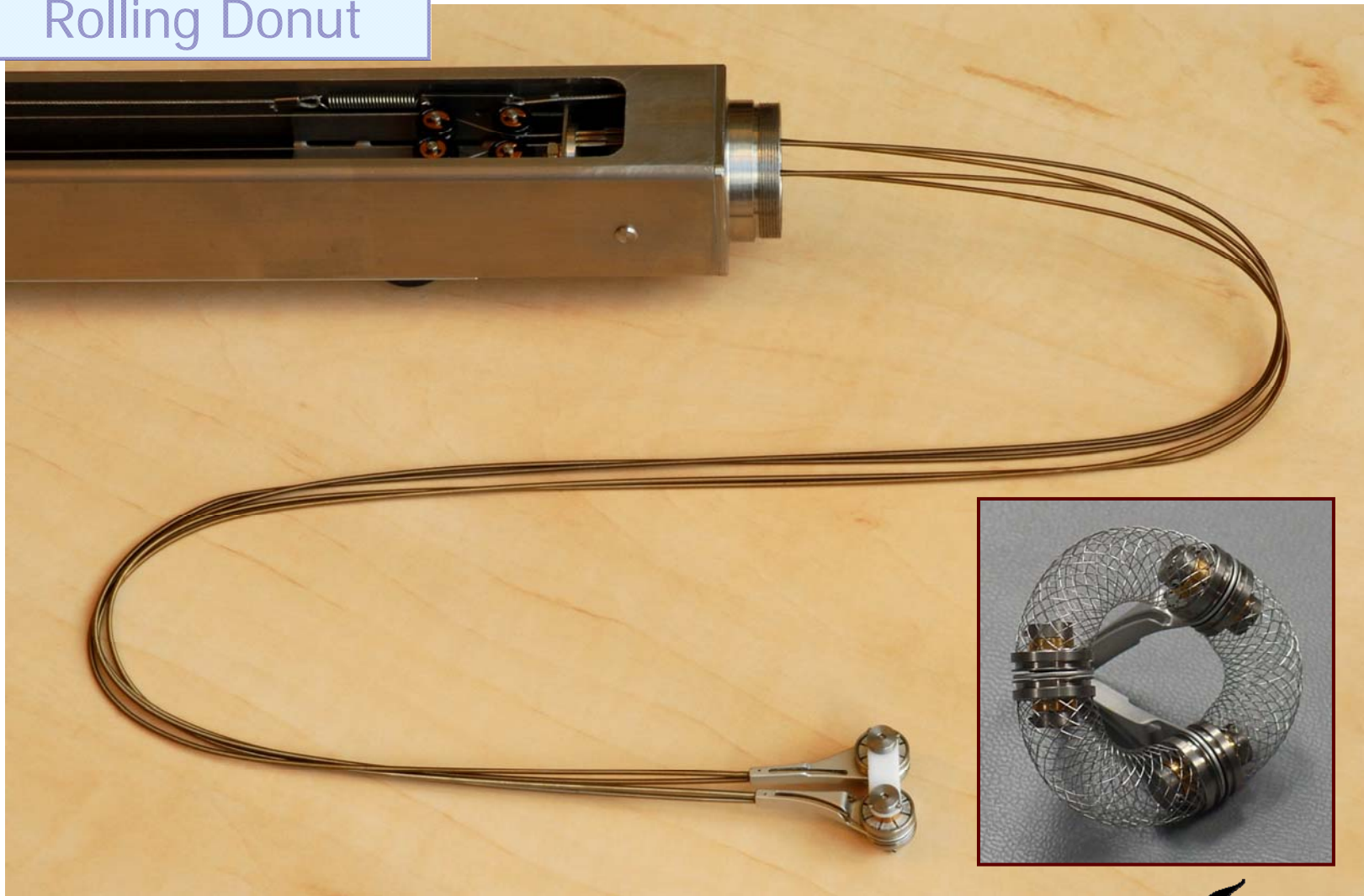
Crank

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Rolling Donut



Tendon Sheath

Hydro Skeleton

Hydro Muscular



Hydrostatic Skeleton System =
Skeleton consisting of
segments filled with fluid &
surrounded by muscles

“How to Push when you can only Pull?”

Tendon Sheath

Hydro Skeleton

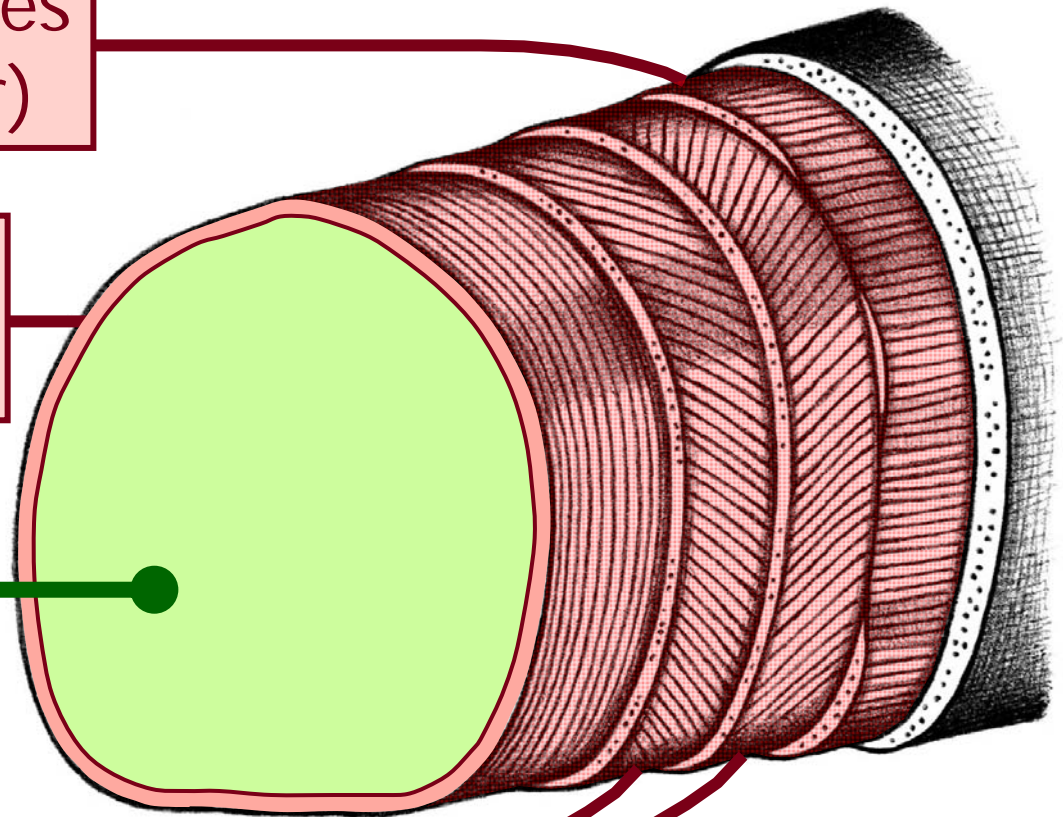
Hydro Muscular

Longitudinal Muscles
(shorter & thicker)

Circular Muscles
(longer & thinner)

Fluid
($V = \text{constant}$)

Helical Muscles
(axial rotation)



Tendon Sheath

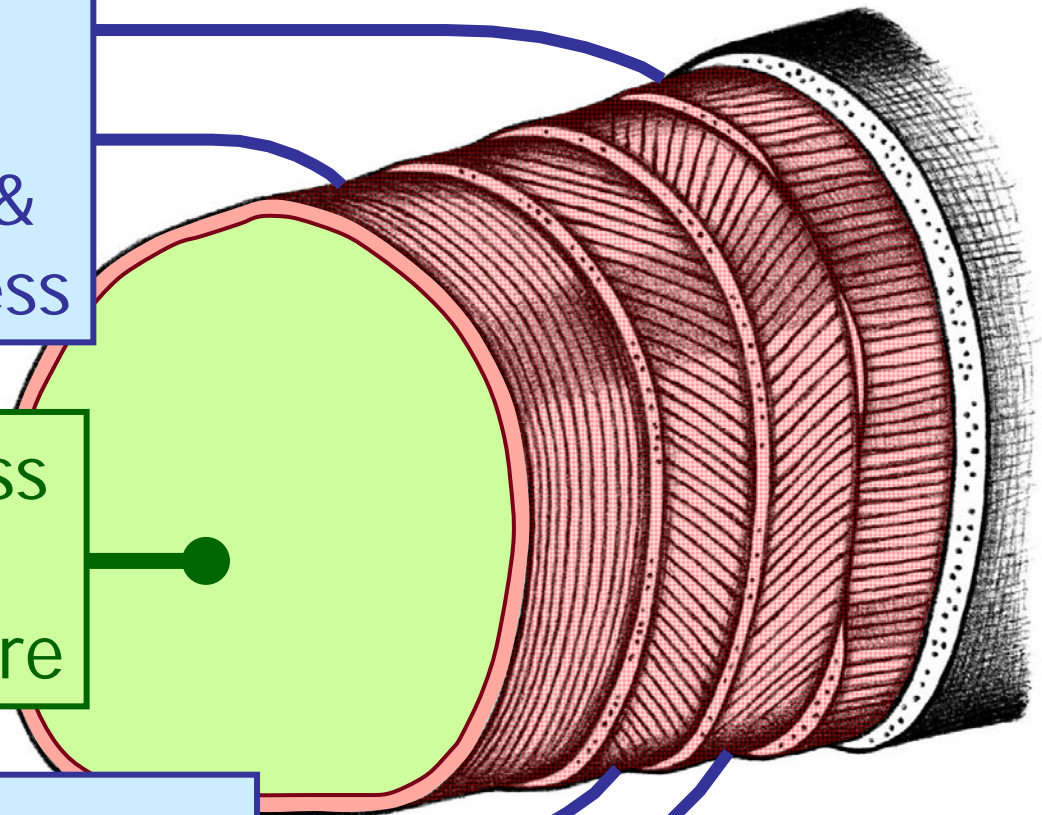
Hydro Skeleton

Hydro Muscular

Antagonists:
Control of
bending stiffness &
longitudinal stiffness

Increasing stiffness
leads to higher
hydrostatic pressure

Antagonists:
Control of torsion stiffness

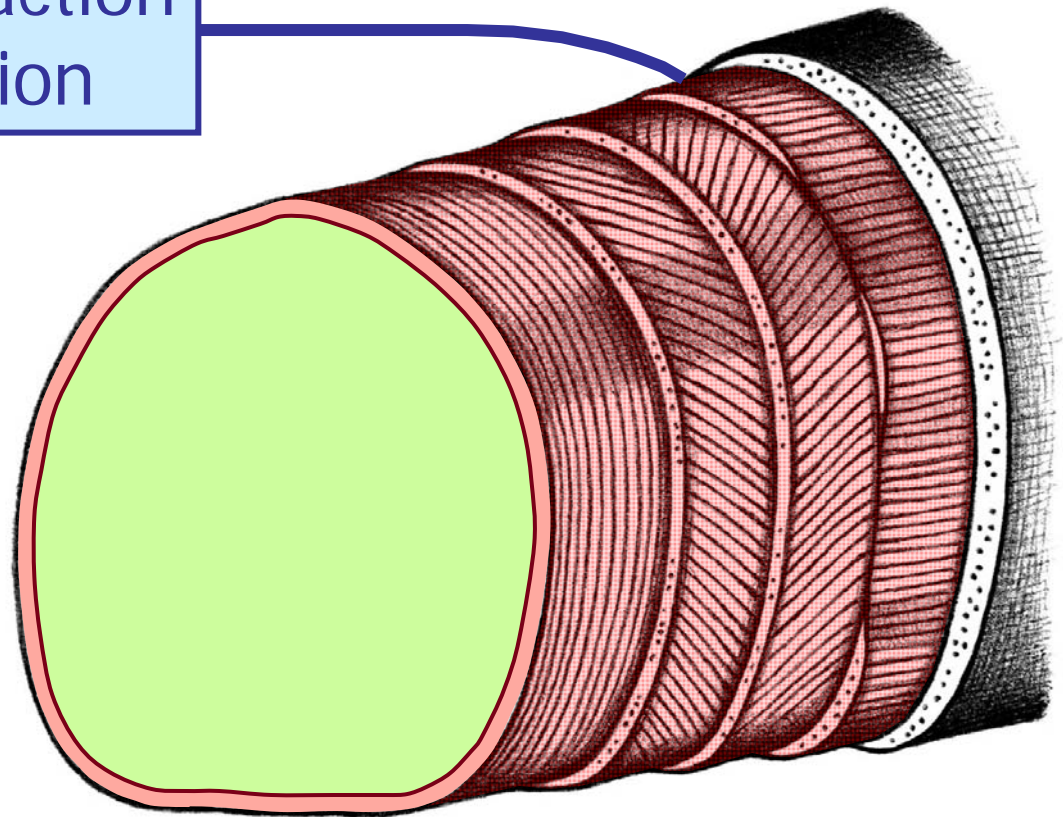
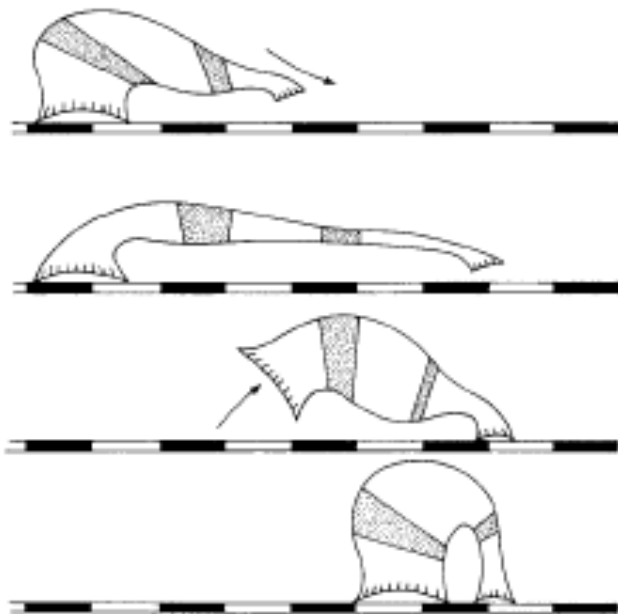


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Asymmetric contraction
→ Bending motion



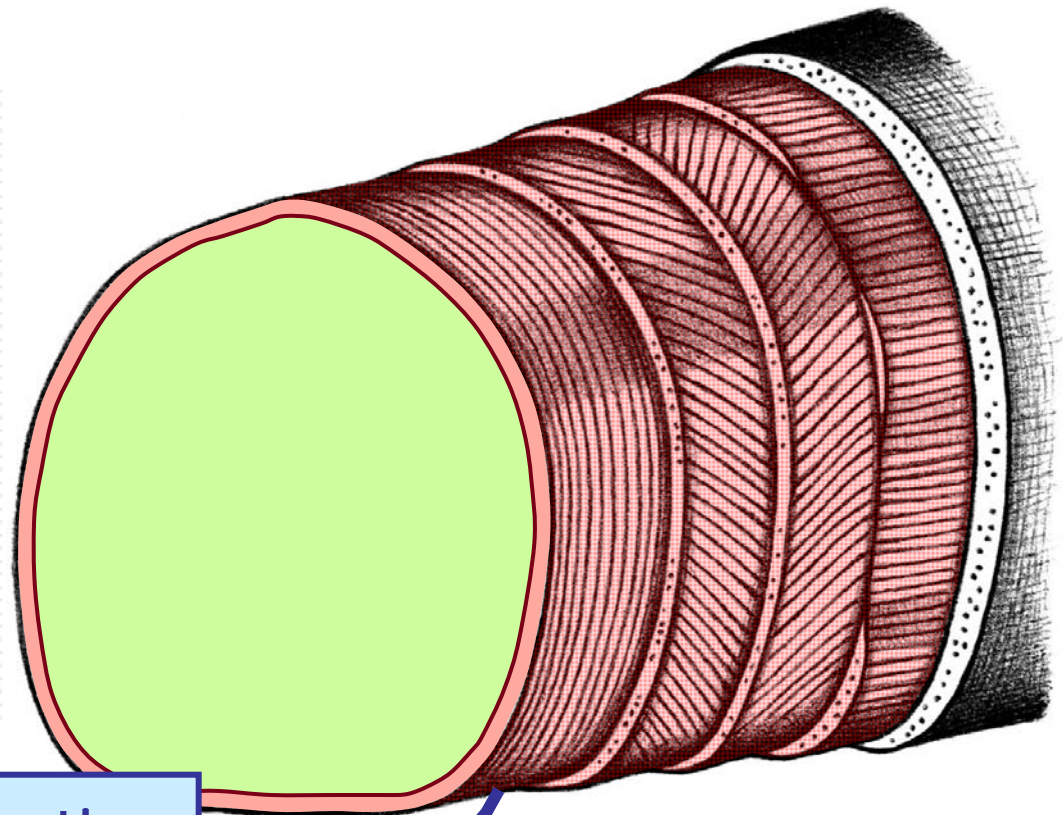
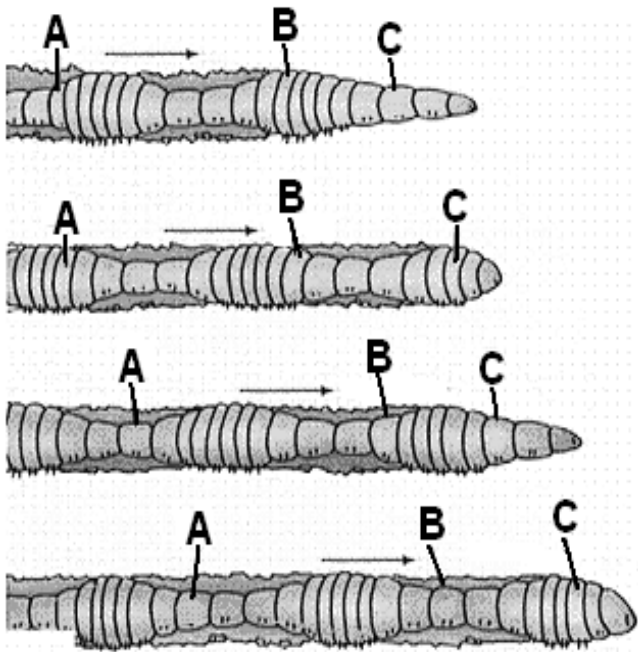
Leech

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Earthworm

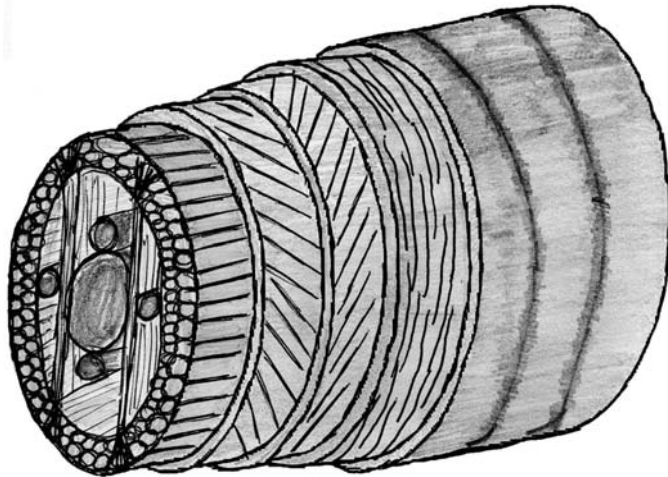


Asymmetric contraction
→ Peristaltic motion

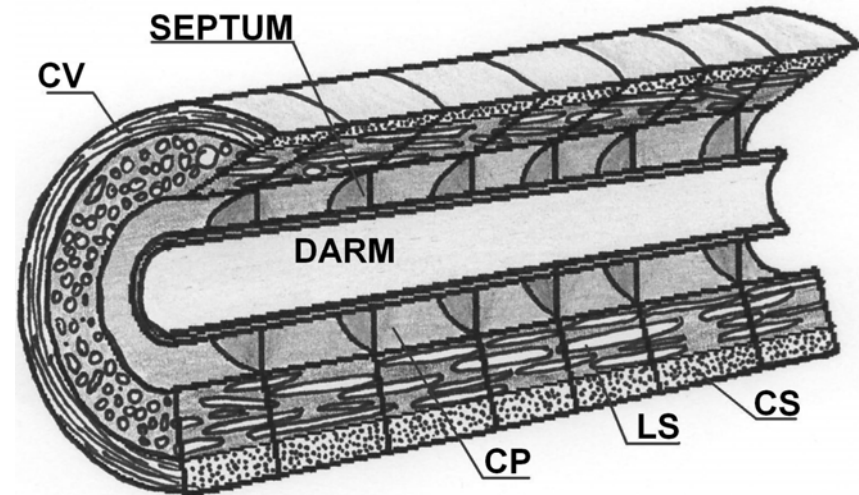
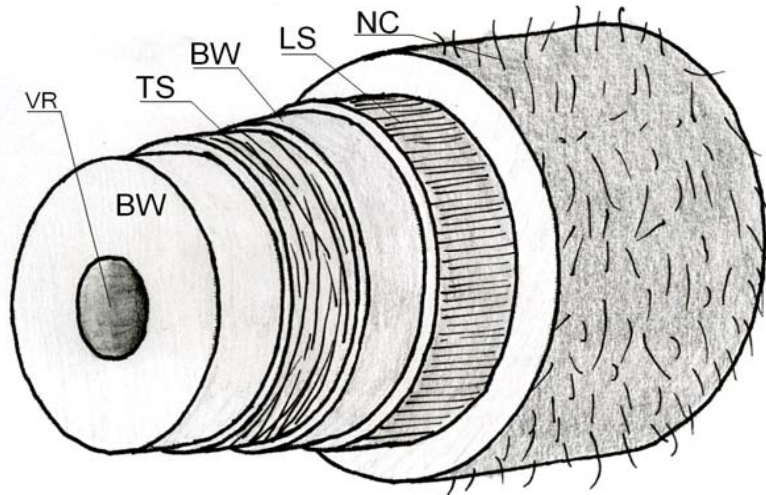
Tendon Sheath

Hydro Skeleton

Hydro Muscular



Leech



Earthworm:
No helical muscles

Anemone:
Lot of connective tissue
Not stretchable

Tendon Sheath

Hydro Skeleton

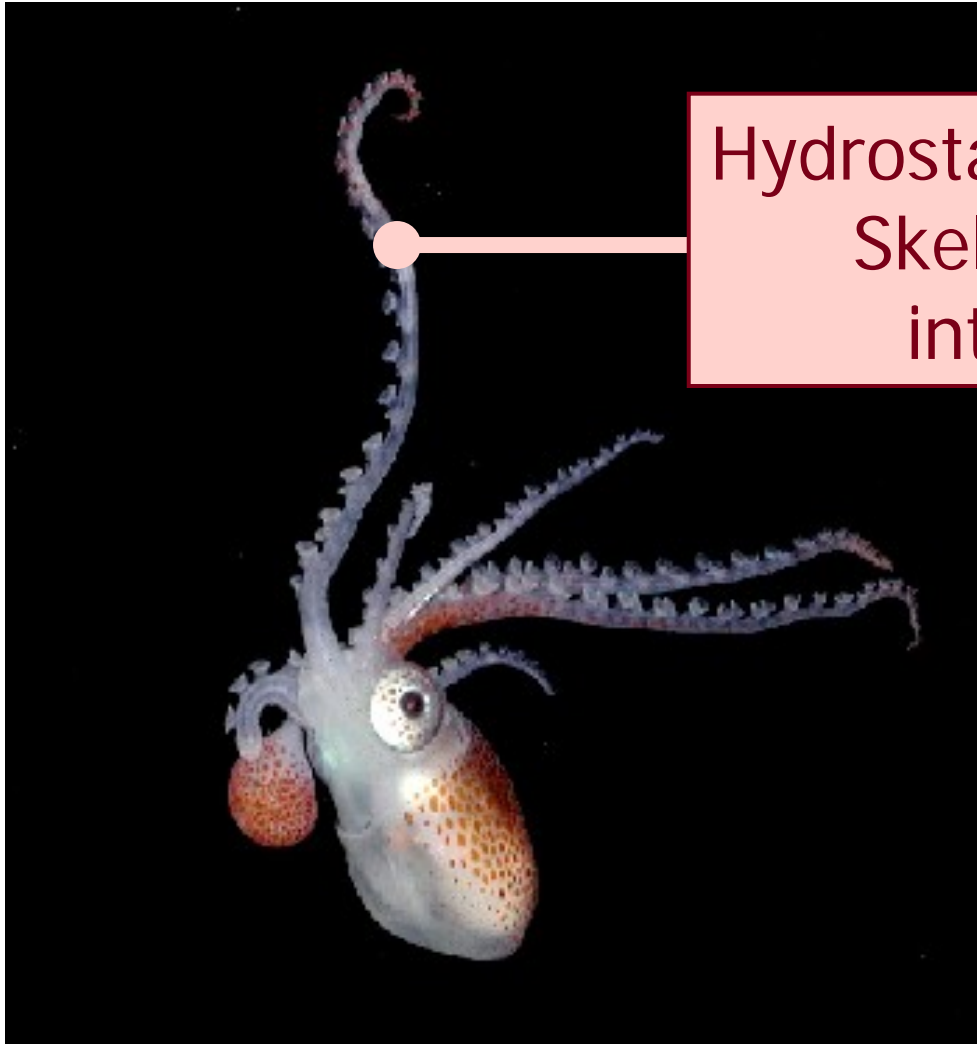
Hydro Muscular



Tendon Sheath

Hydro Skeleton

Hydro Muscular



Hydrostatic Muscular System =
Skeleton consisting of
interacting muscles

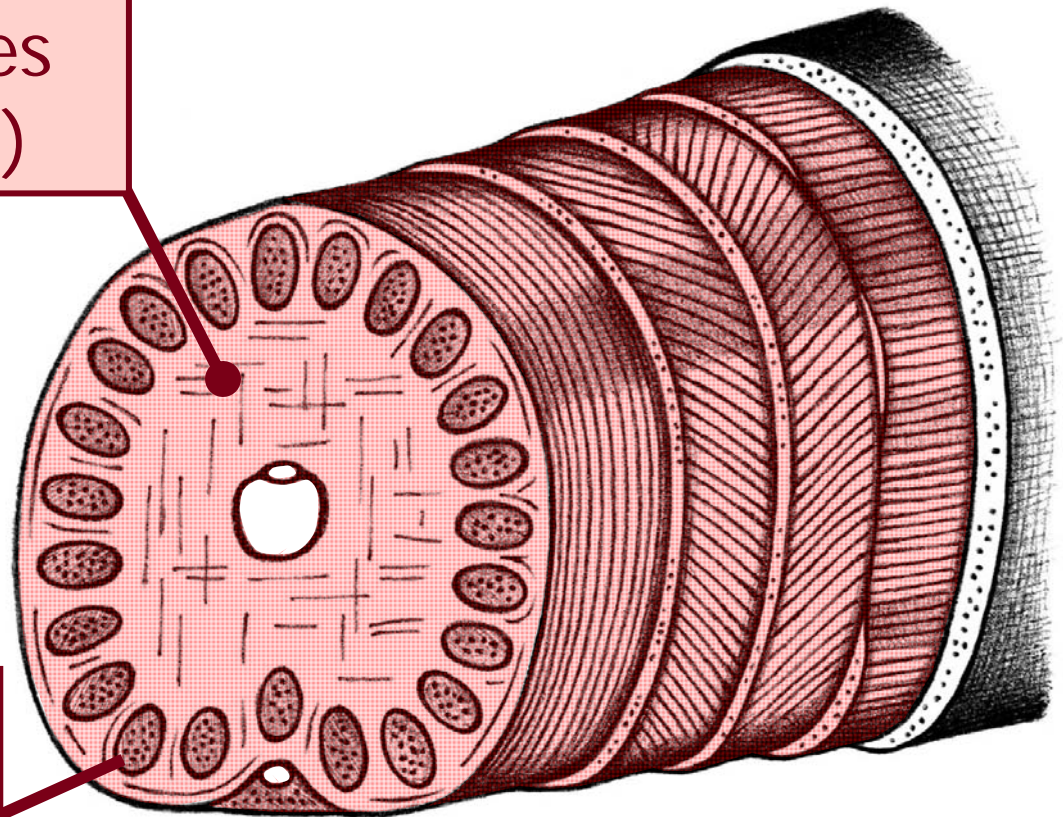
Tendon Sheath

Hydro Skeleton

Hydro Muscular

Transverse Muscles
(longer & thinner)

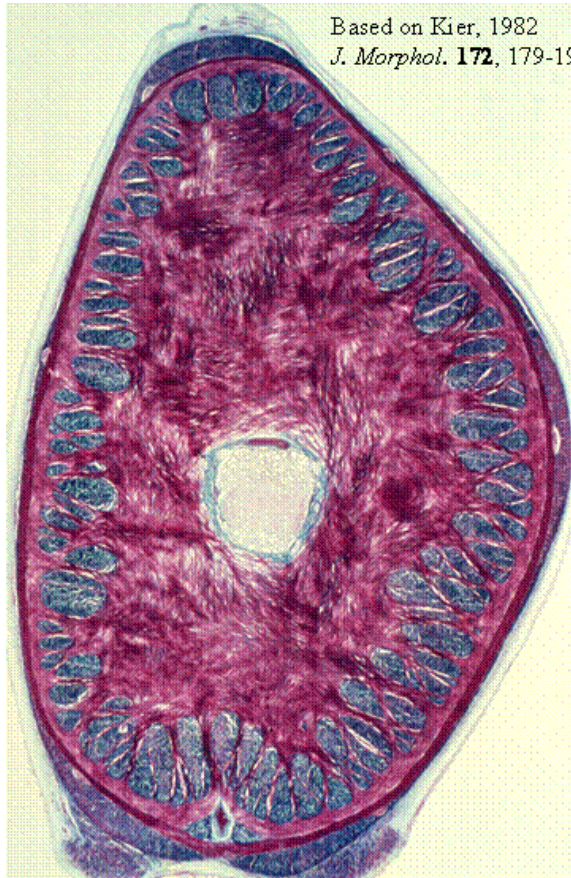
Longitudinal
Muscle Bundles
(shorter & thicker)



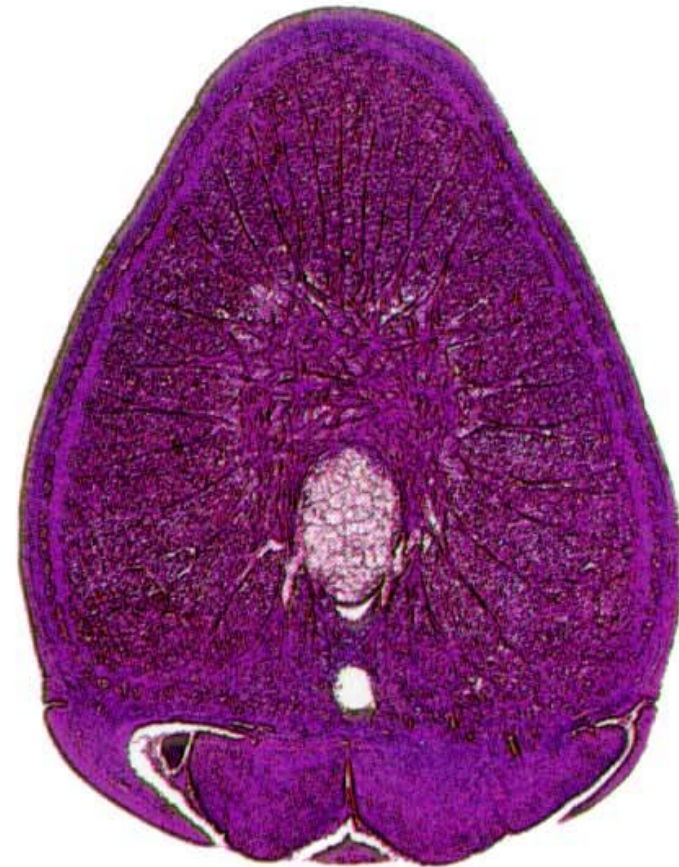
Tendon Sheath

Hydro Skeleton

Hydro Muscular



Squid Tentacle

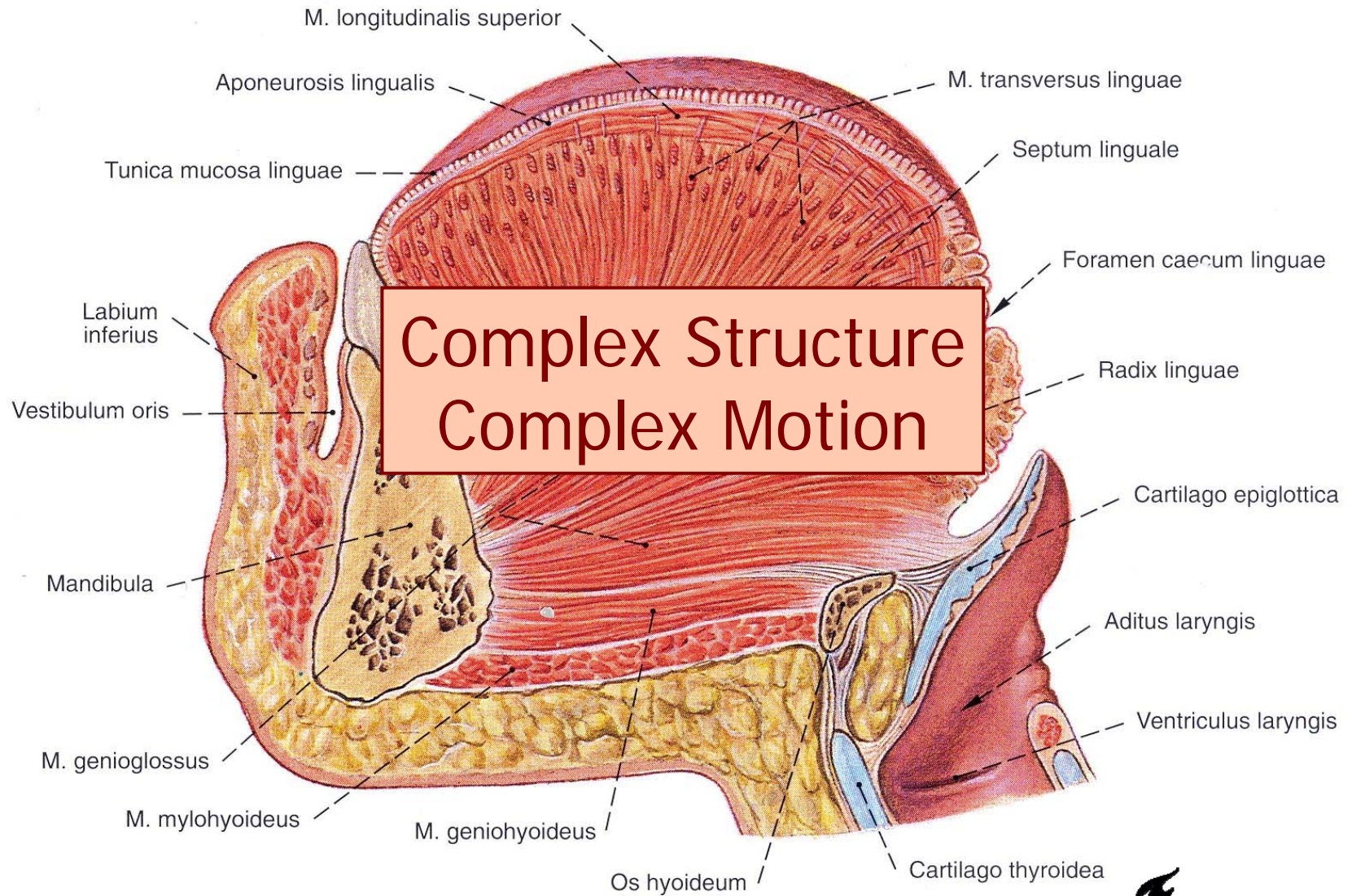


Sea Slug

Tendon Sheath

Hydro Skeleton

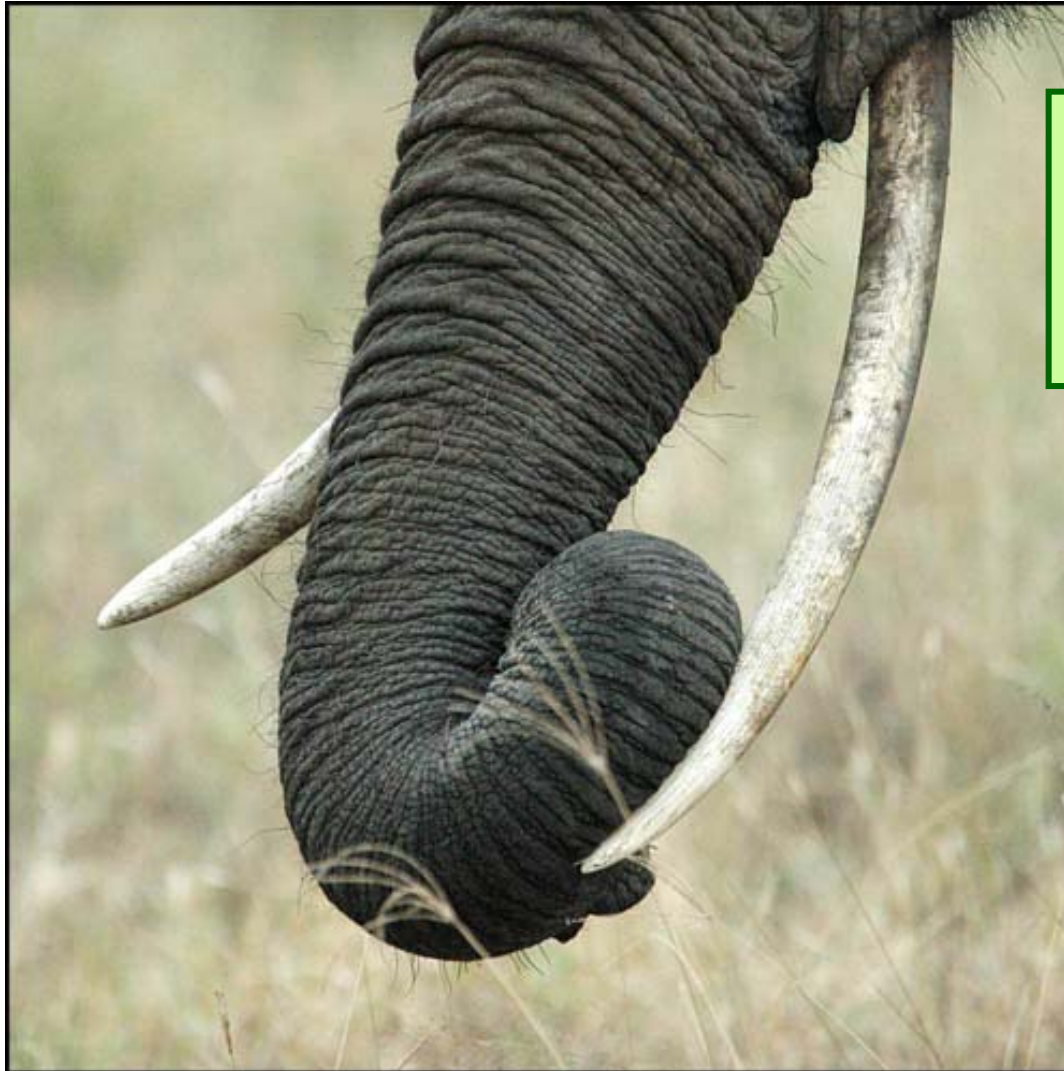
Hydro Muscular



Tendon Sheath

Hydro Skeleton

Hydro Muscular



Increasing stiffness
leads to higher
hydrostatic pressure

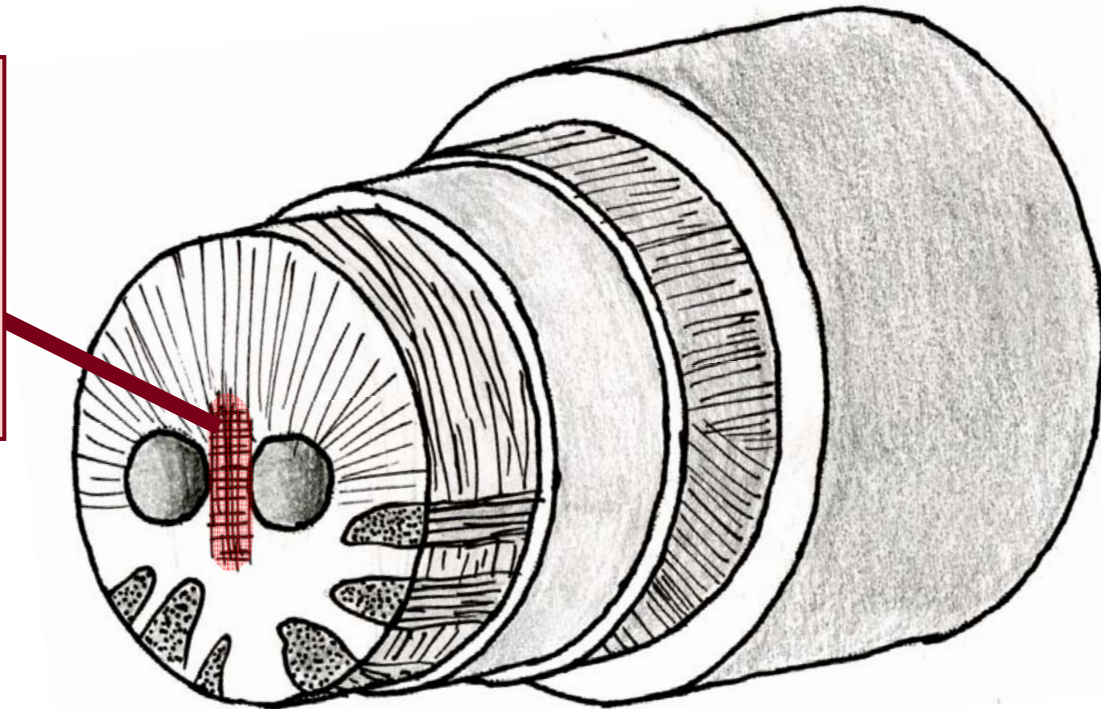
“How do
elephants
keep their
nose open?”

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Muscular spine:
Flexible link
around which
trunc can bend



Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring



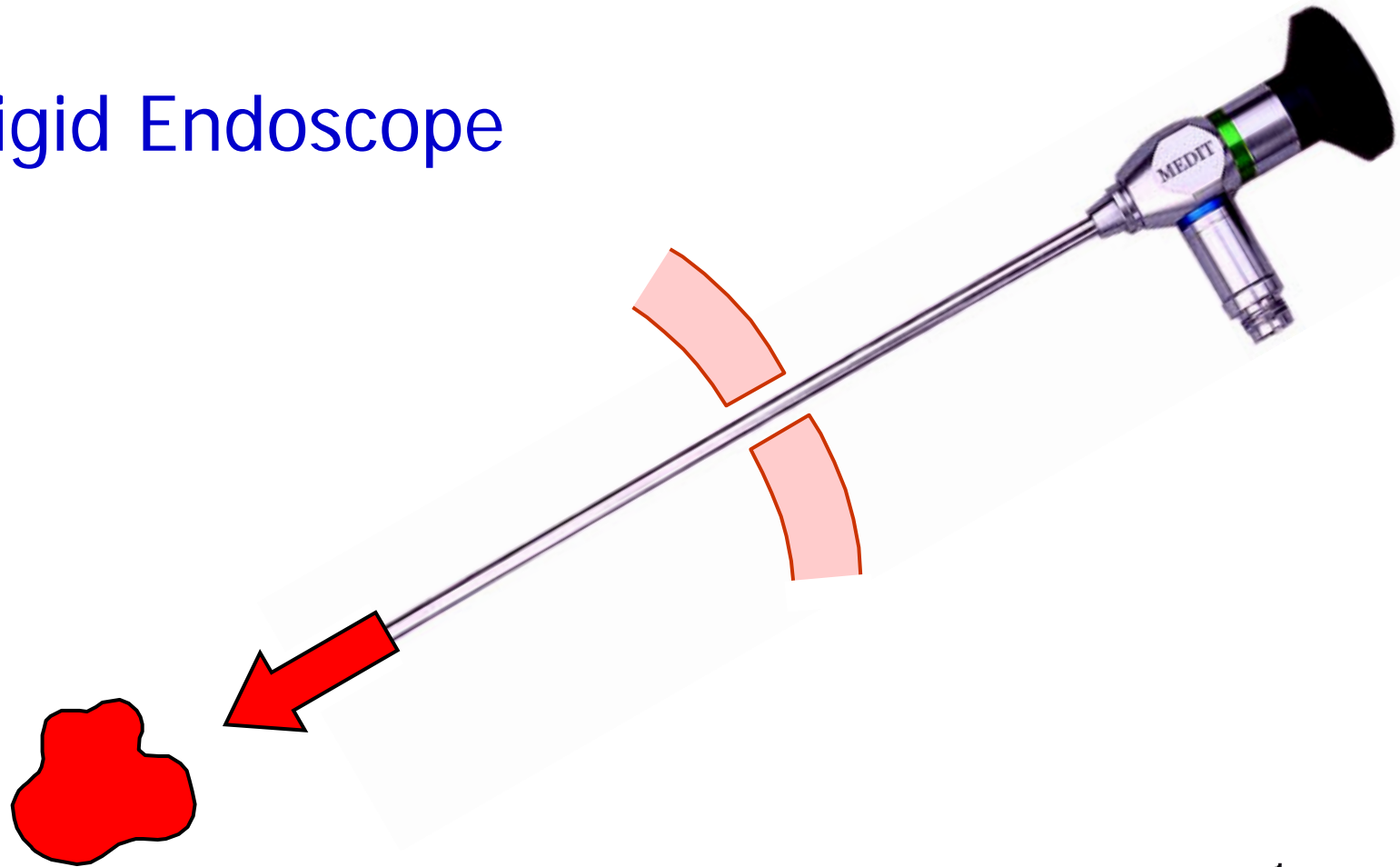
Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring

Rigid Endoscope



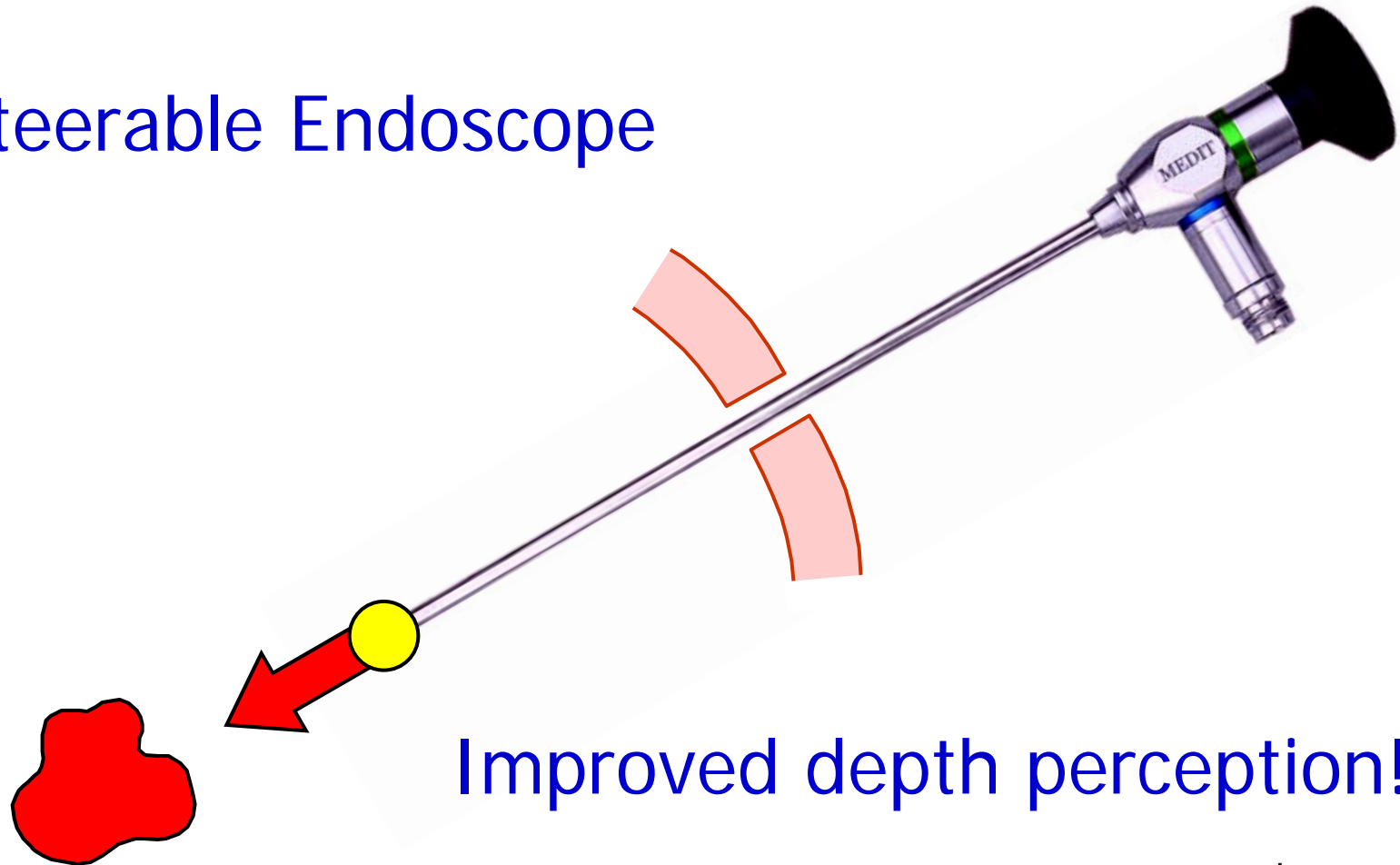
Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring

Steerable Endoscope



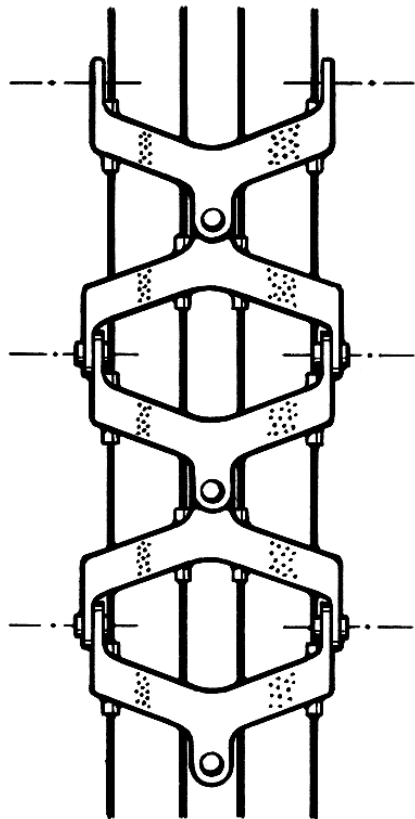
Improved depth perception!

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring



Gastrosopes & Colonoscopes

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring



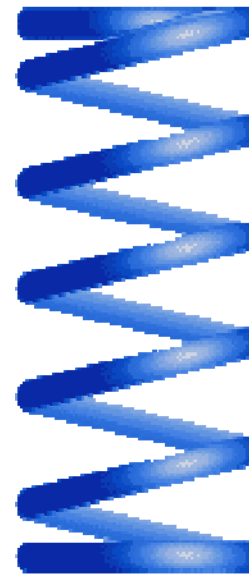
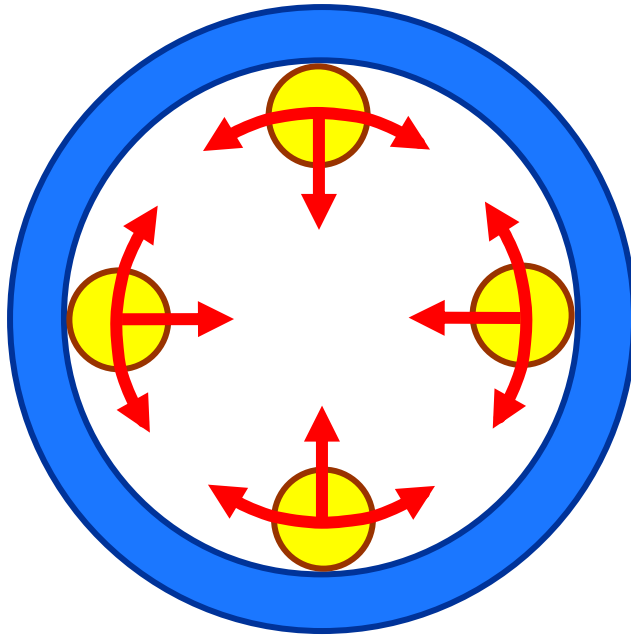
Steerable Laparoscopic Instruments

Tendon Sheath

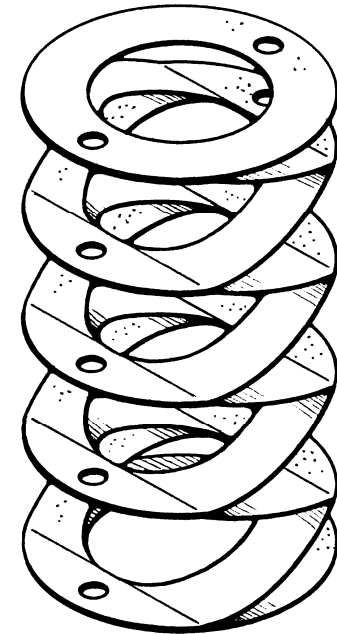
Hydro Skeleton

Hydro Muscular

Cable Ring



Coil
Spring



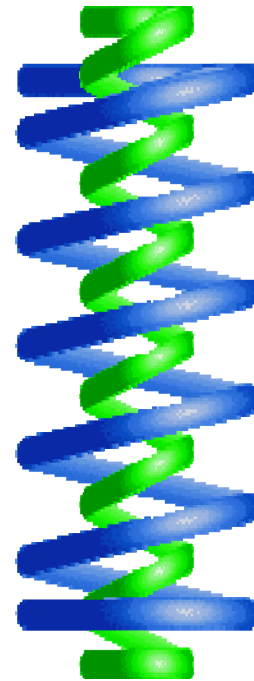
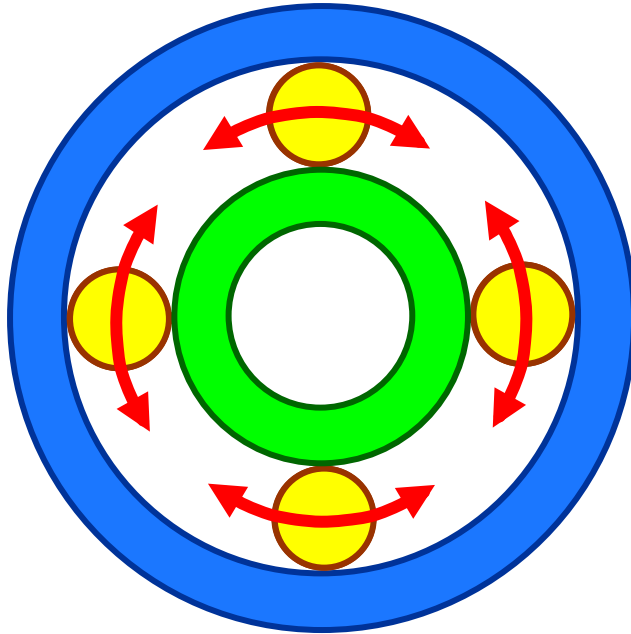
Ring
Spring

Tendon Sheath

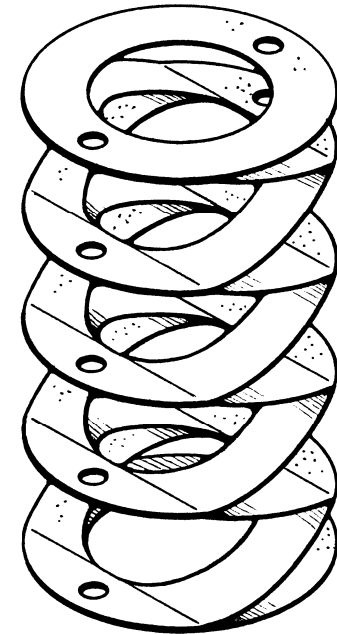
Hydro Skeleton

Hydro Muscular

Cable Ring



Coil
Spring



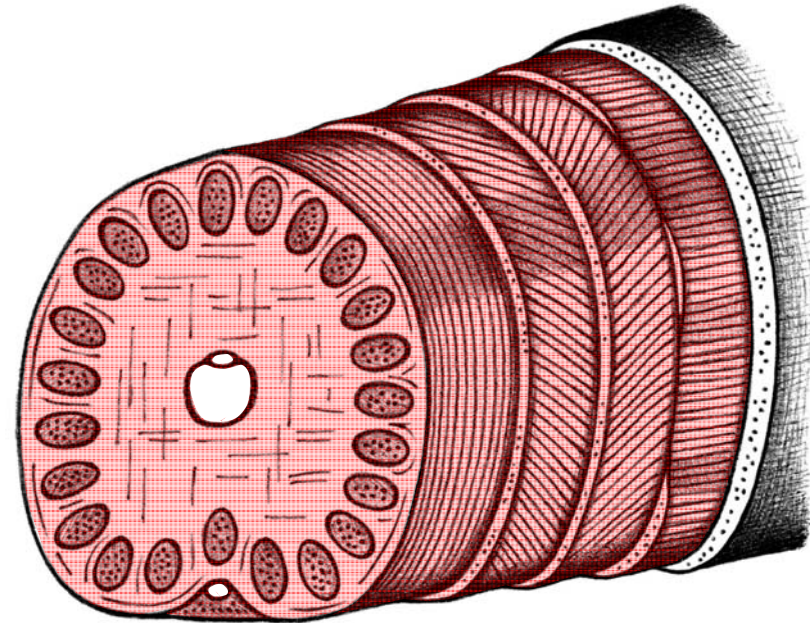
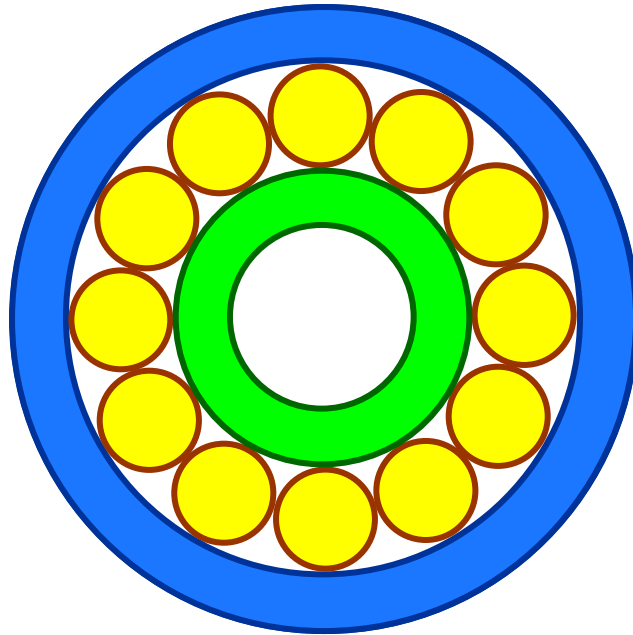
Ring
Spring

Tendon Sheath

Hydro Skeleton

Hydro Muscular

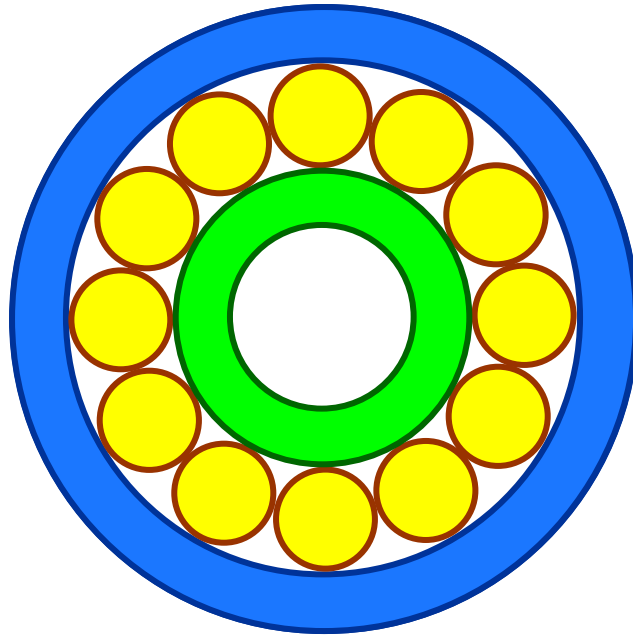
Cable Ring



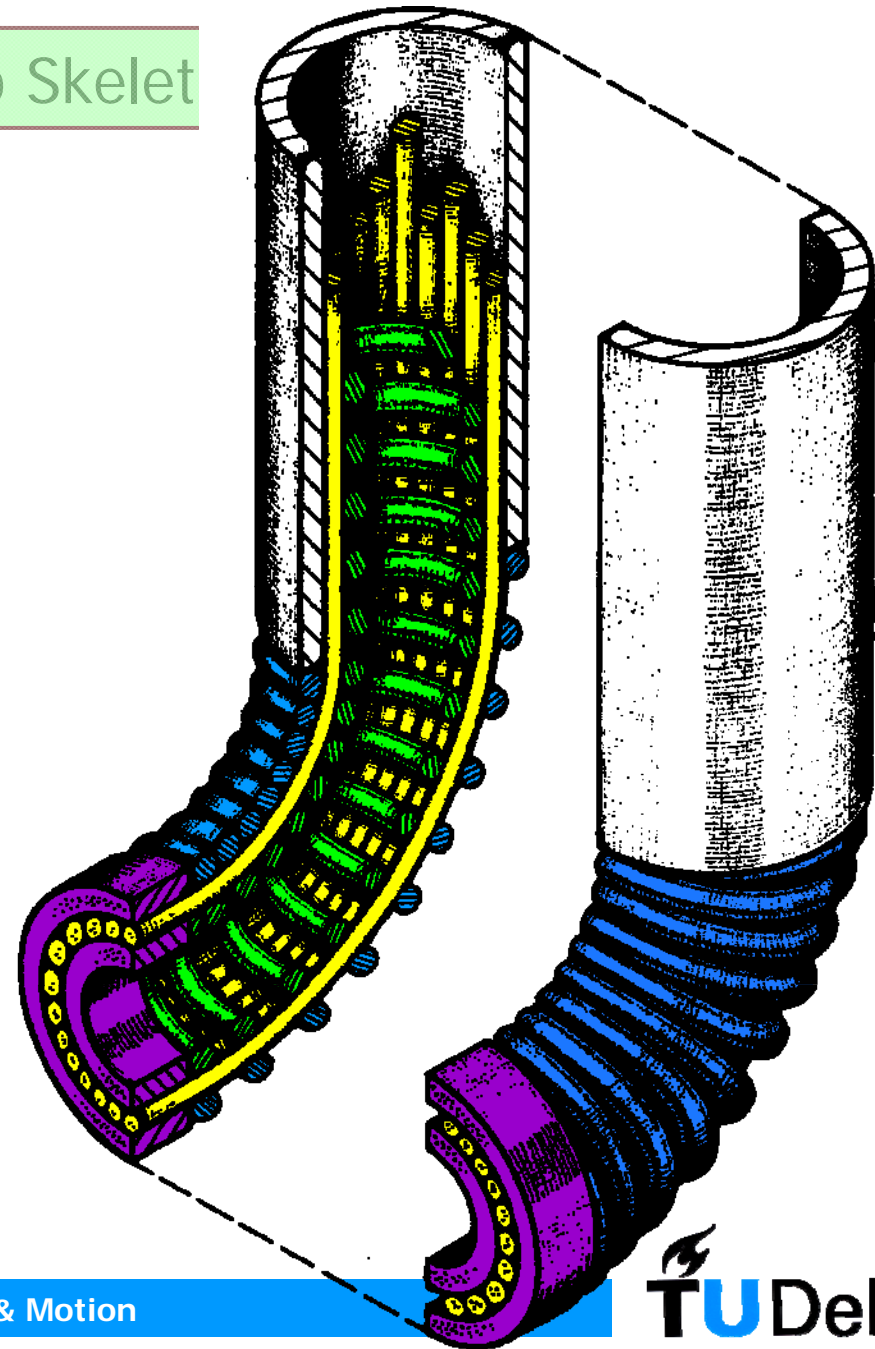
Cable Ring Mechanism

Tendon Sheath

Hydro Skelet



Cable Ring Mechanism

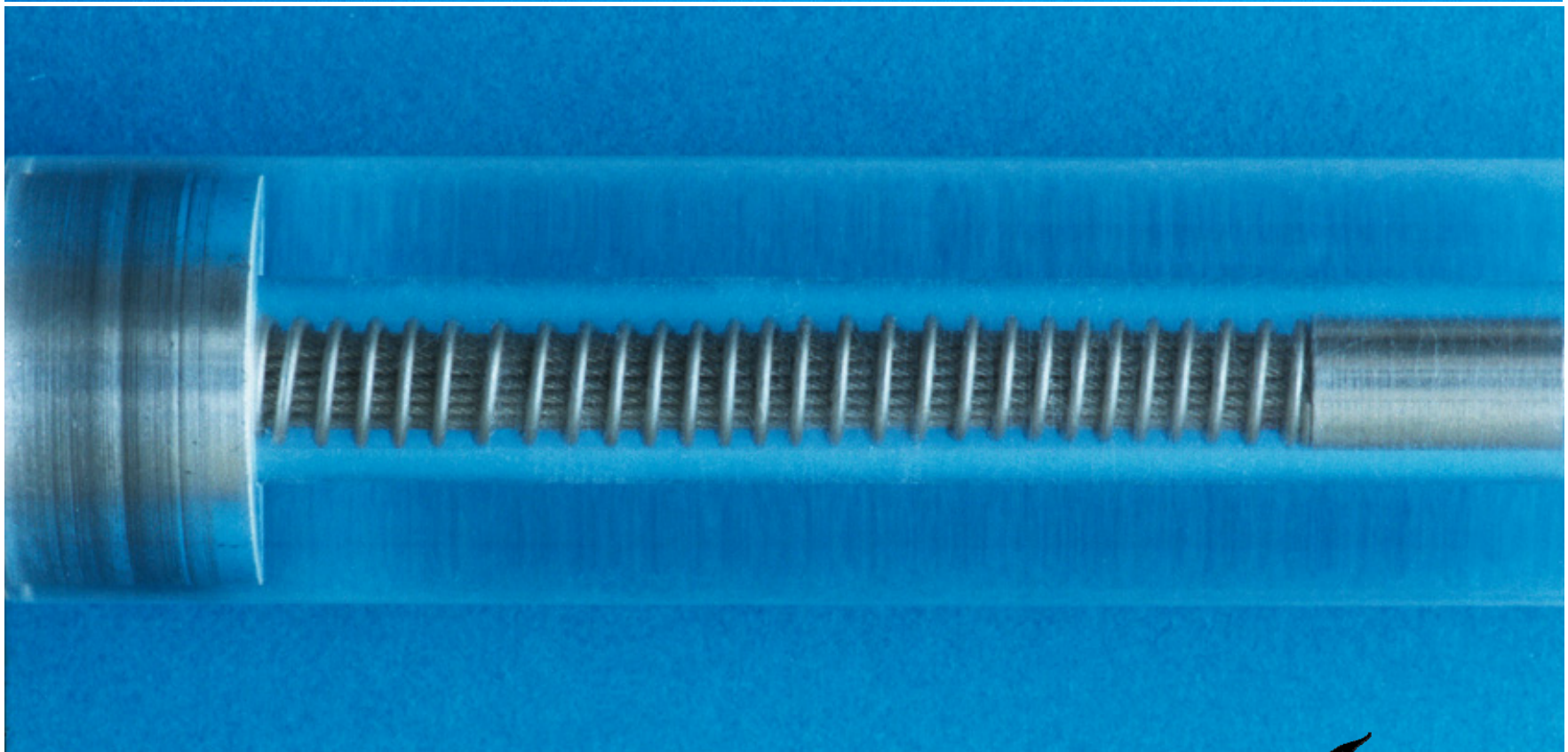


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring

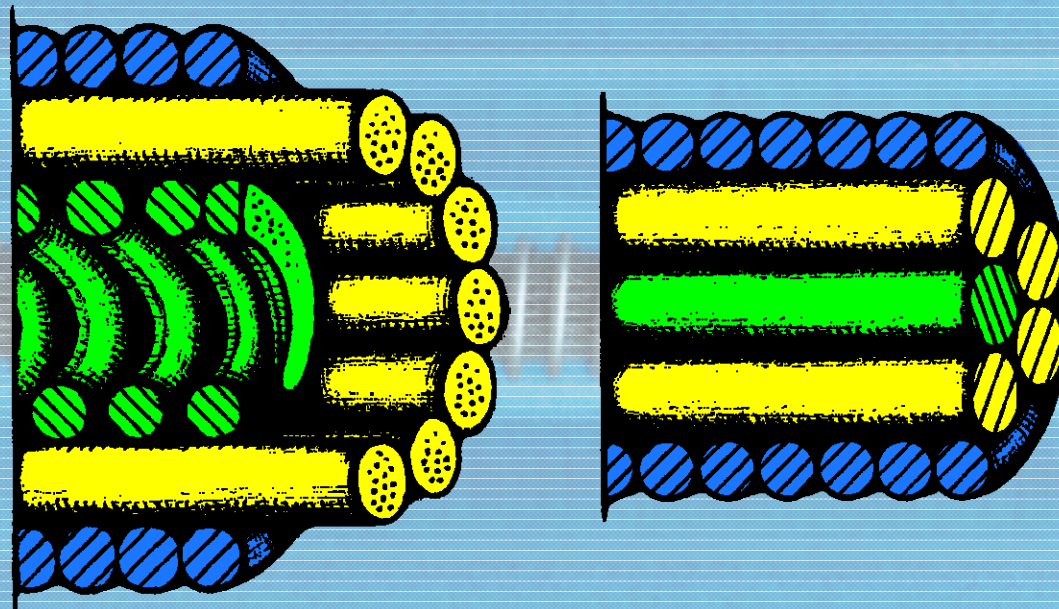


Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring



Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring

- New steerable mechanism with great possibilities
- Very simple, very cheap
- Extreme miniaturisation possible
- World-wide patent application

Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring



Tendon Sheath

Hydro Skeleton

Hydro Muscular

Cable Ring

Biology gives creativity!

No imitation but *inspiration!*

Still a wealth of
unused ideas..

