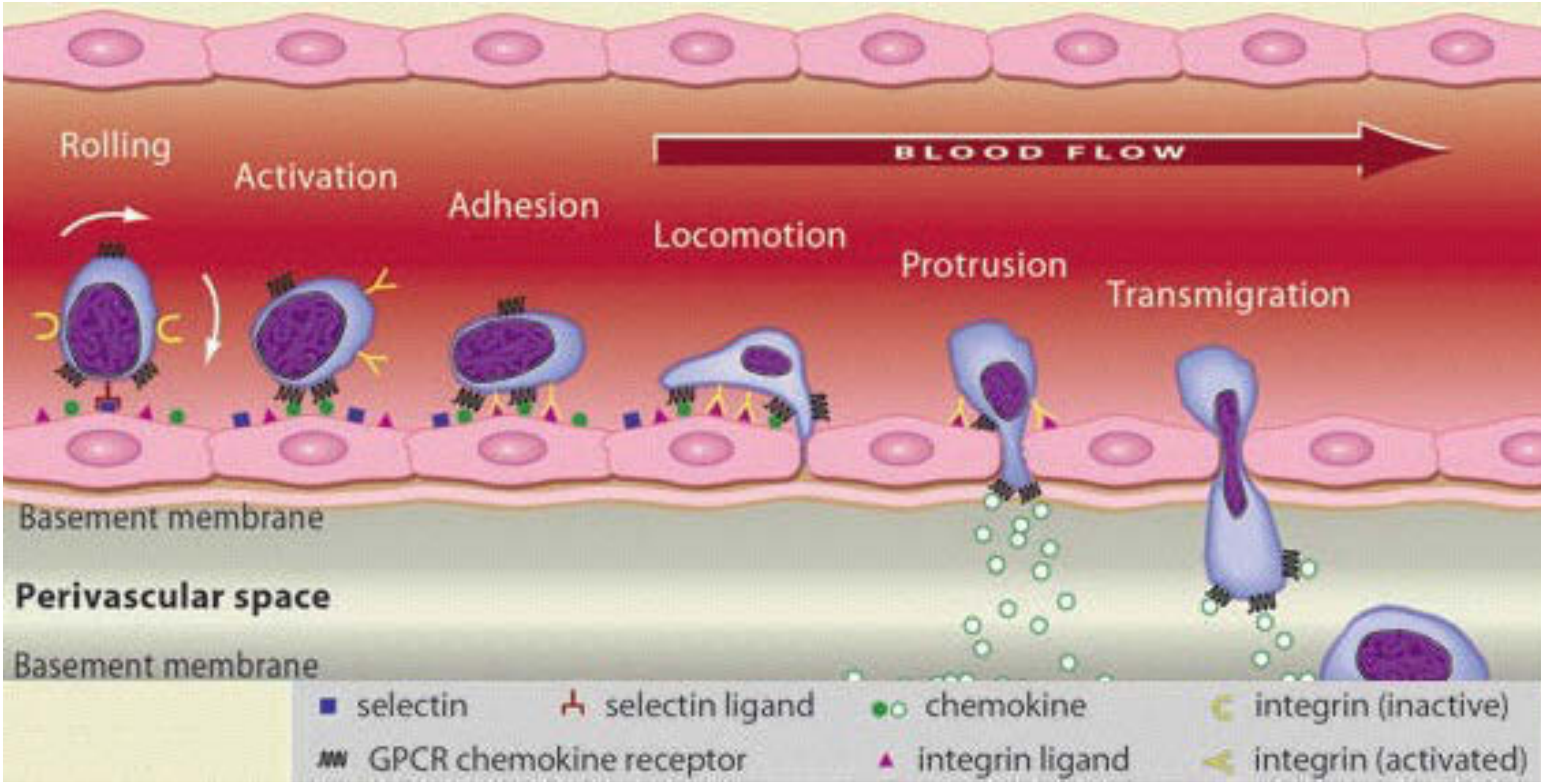
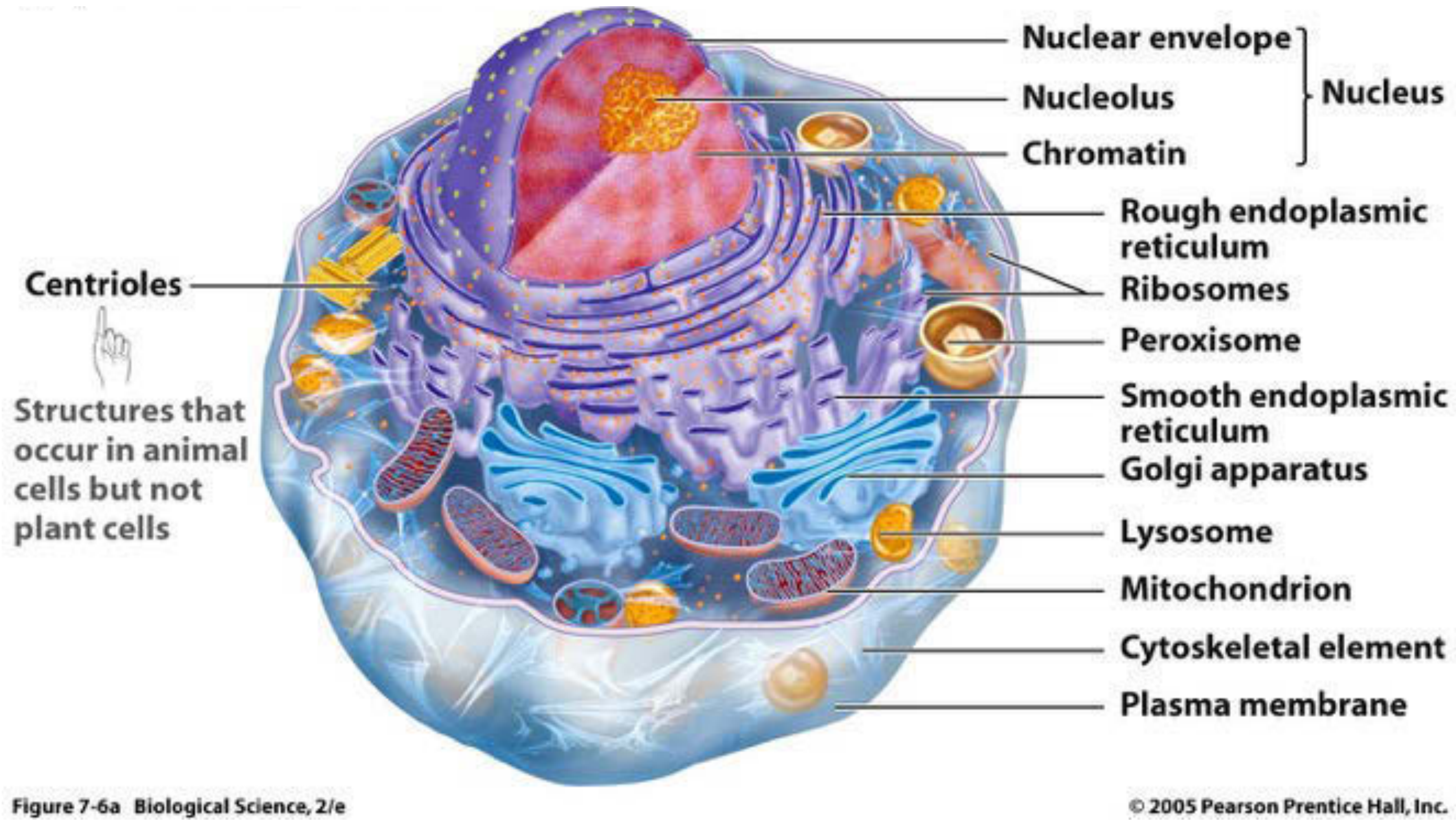
White blood cell (e.g., neutrophil) scavenging: rolling, adhesion, and extravasation



Source: Man, Shumei, Eroboghene E. Ubogu, and Richard M. Ransohoff. "Inflammatory cell migration into the central nervous system: a few new twists on an old tale." Brain Pathology 17, no. 2 (2007): 243-250.

http://www.dnatube.com/video/4140/Leukocyte-Rolling-Adhesion

Cellular mechanical response to applied force



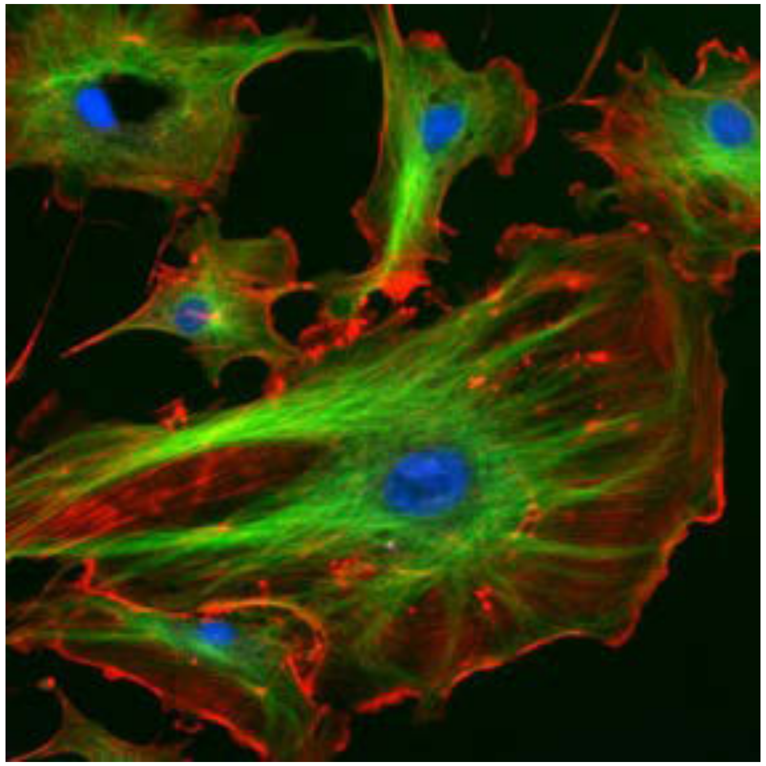
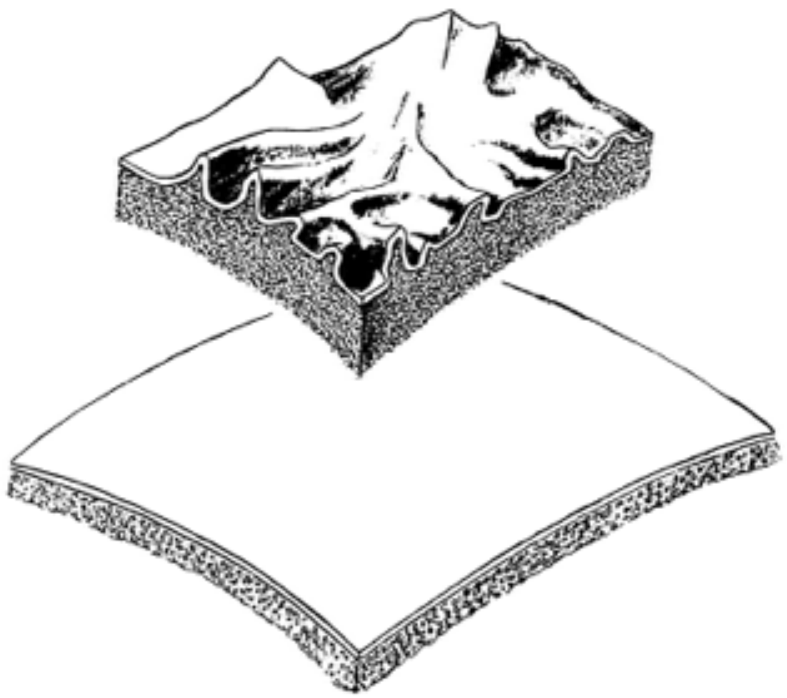


Image in the public domain.

Neutrophils behave like Newtonian fluids!



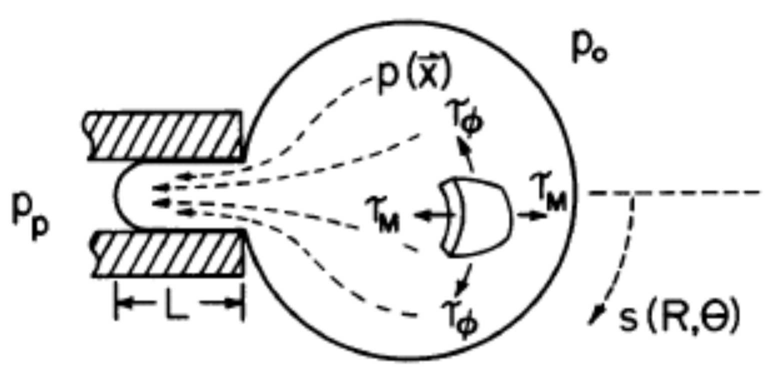
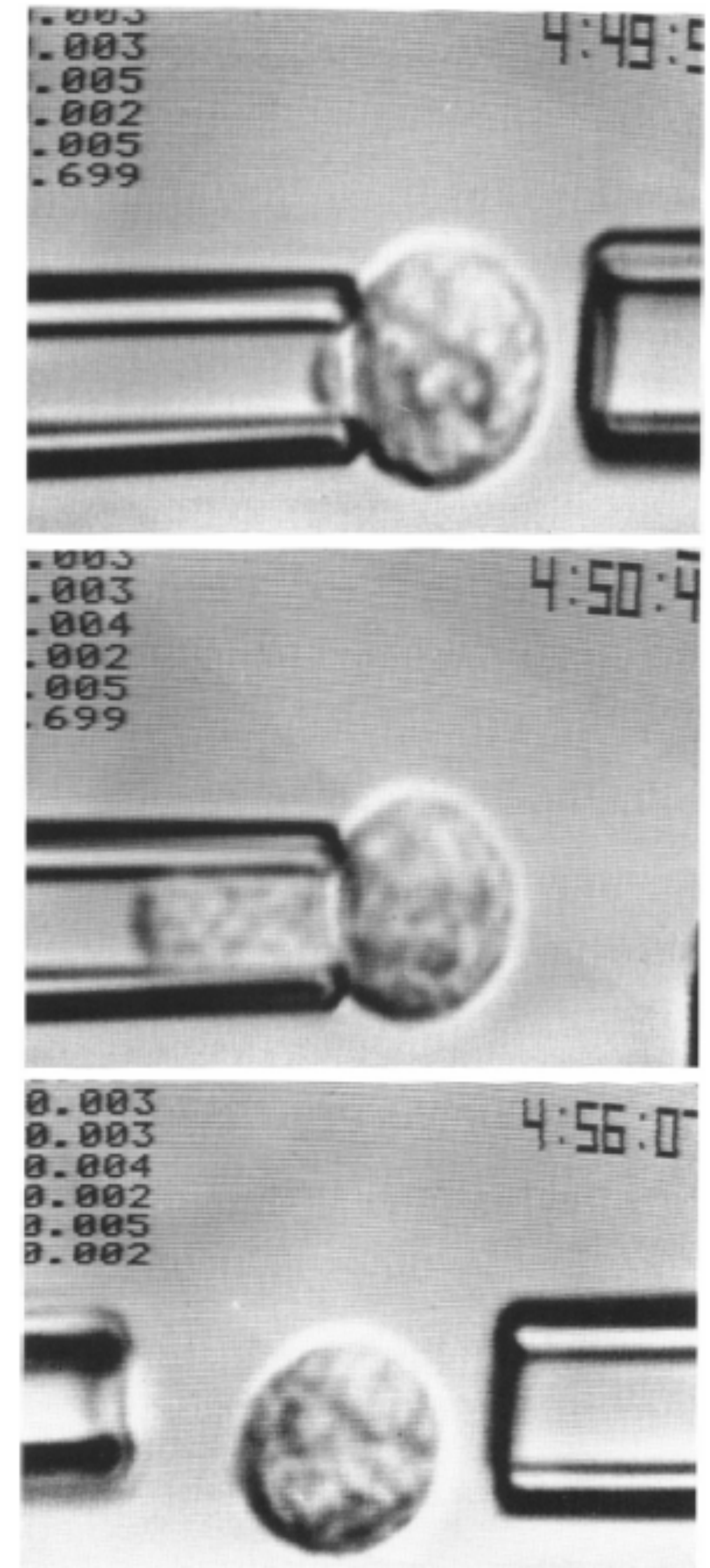
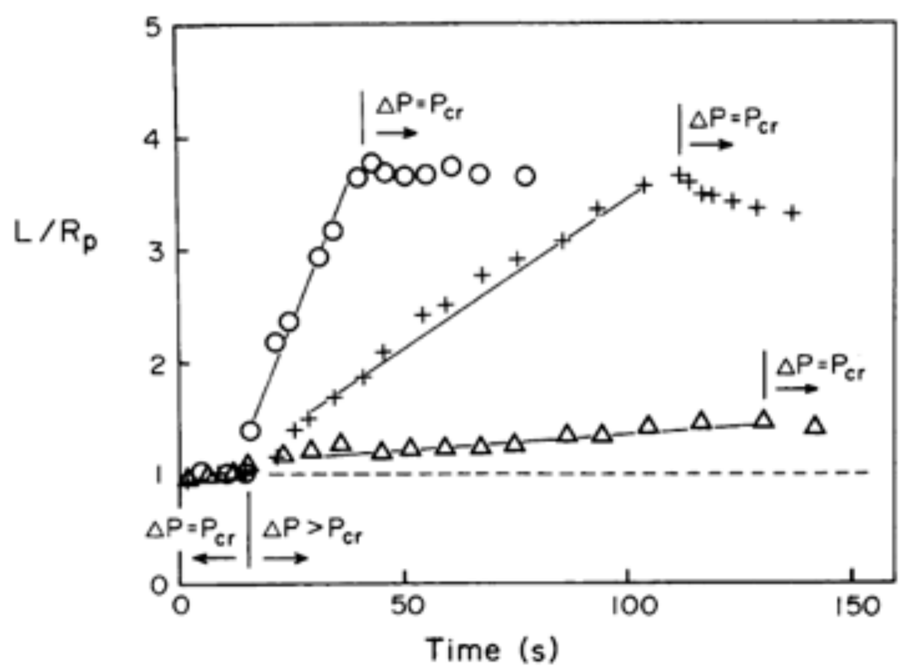
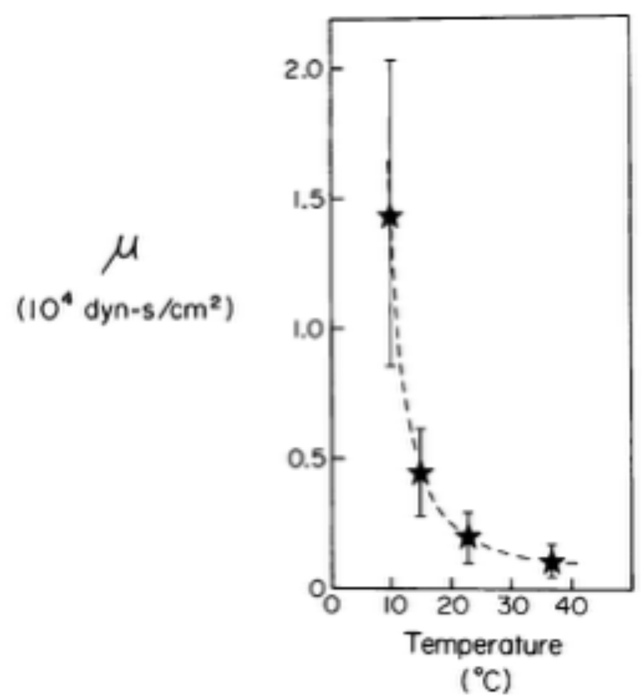


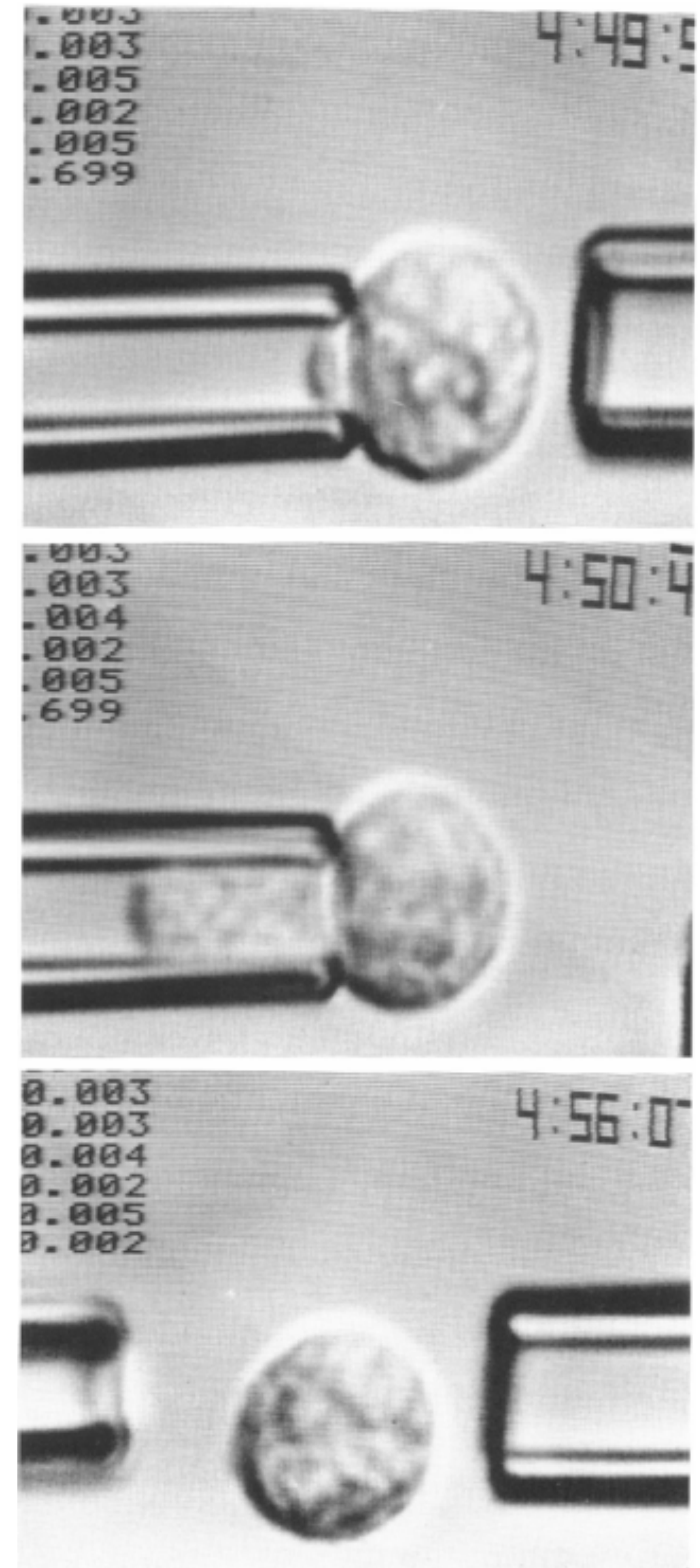
FIGURE 3 Schematic of the convergent flow into the pipet and the in-plane stress resultants supported by the cortical shell.



Courtesy of Elsevier, Inc., http://www.sciencedirect.com. Used with permission.
Source: Yeung, A. and E. Evans. "Cortical shell-liquid core model for passive flow of liquid-like spherical cells into micropipets." Biophysical Journal 56, no. 1 (1989): 139-149.


L / R_p
Time (s)
0
50
100
150
1
2
3
4
5
ΔP = P_cr
ΔP > P_cr


μ
(10^4 dyn-s/cm^2)
Temperature
(°C)
0
10
20
30
40
0.5
1.0
1.5
2.0


.003
.005
.002
.005
.699
.003
.004
.002
.005
.699
0.003
0.003
0.004
0.002
0.005
0.002

Chondrocytes are more like elastic spheres

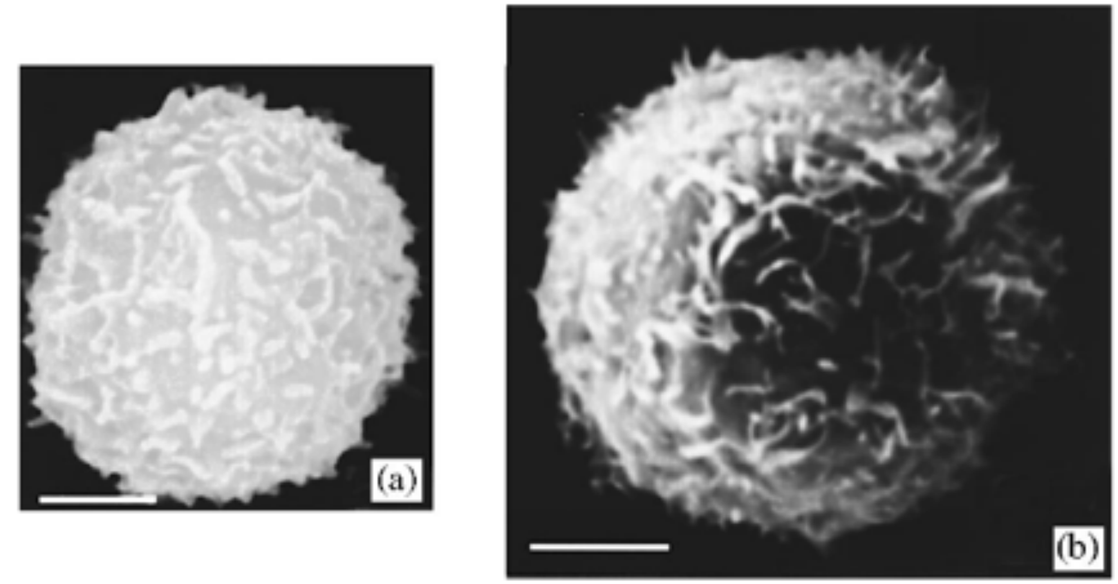


Fig. 3. Comparison of a human neutrophil (a) to a chondrocyte (b). The neutrophil has a diameter of about 8 μm while the majority of chondrocytes have diameters between about 12 and 16 μm. The scale bars indicate 2 μm, but note that the significant shrinkage of the cell has occurred during the preparation of the cells for scanning electron microscopy.

Table 1
"Natural" SI units at the level of the cell

	"Micro SI"	Application
Distance (m)	1 μm (10^{-6} m)	All
Force	1 pN(10^{-12} N)	Molecular bonds "soft" cells
(N)	1 nN(10^{-9} N)	Stiff cells
Pressure, stress	1 pN/μm^2(1 Pa)	Soft cells (blood cells)
(Pa)	1 nN/μm^2(1 kPa)	Stiff cells
Tension	1 pN/μm (10^{-3} mN/m)	Cortical elasticity of soft cells
(mN/m)	1 nN/μm(1 mN/m)	Elasticity of lipid bilayer

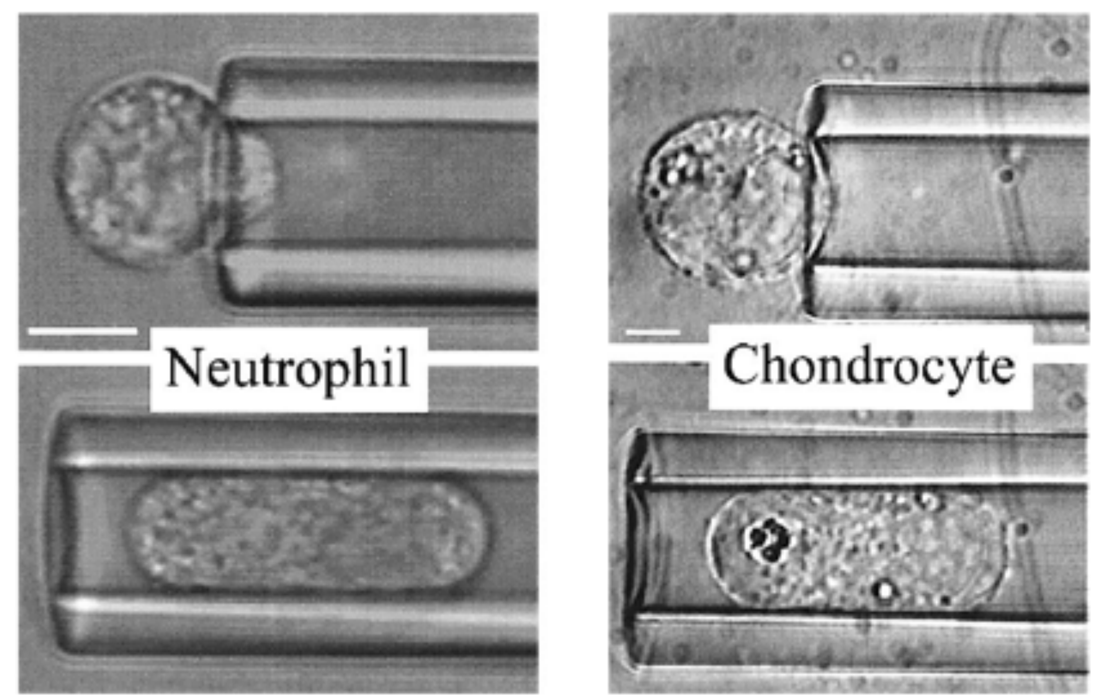


Fig. 4. A neutrophil and a chondrocyte each being aspirated into a micropipette. The photomicrographs of the chondrocyte are adapted from Jones et al. (1999). The scale bars indicate 5 μm.

Hochmuth 2000

Source: Hochmuth, Robert M. "Micropipette aspiration of living cells." Journal of Biomechanics 33, no. 1 (2000): 15-22.

Complex fluids: Silly Putty

Text about Silly Putty removed due to copyright restrictions.

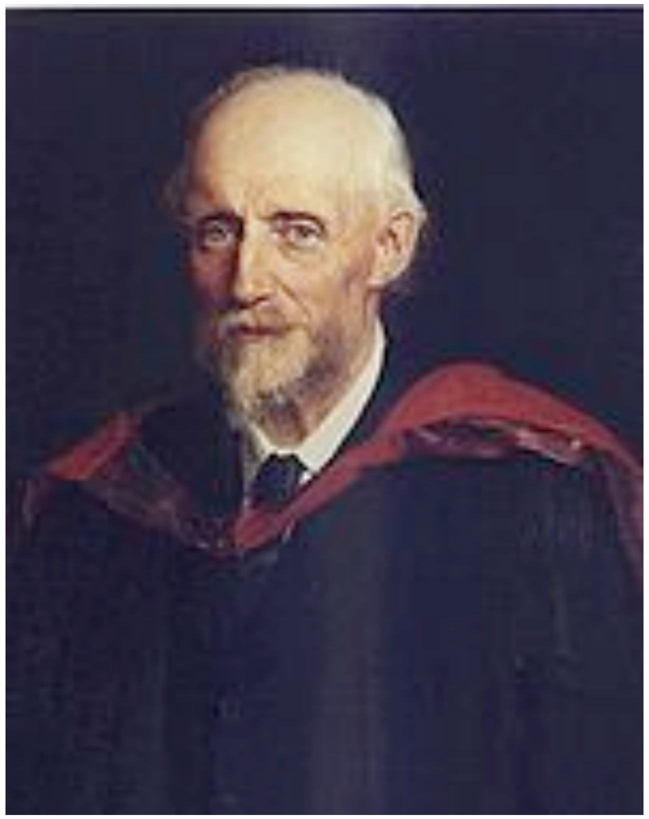
Silly Putty
t = 0 min

Silly Putty
t = 30 min

Silly Putty
t = 24 hours

Low Reynolds Number Flows

Text from "Osborne Reynolds" article on wikipedia removed due to copyright restrictions.



Painting by John Collier; in the public domain.

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Low Reynolds Number Flows

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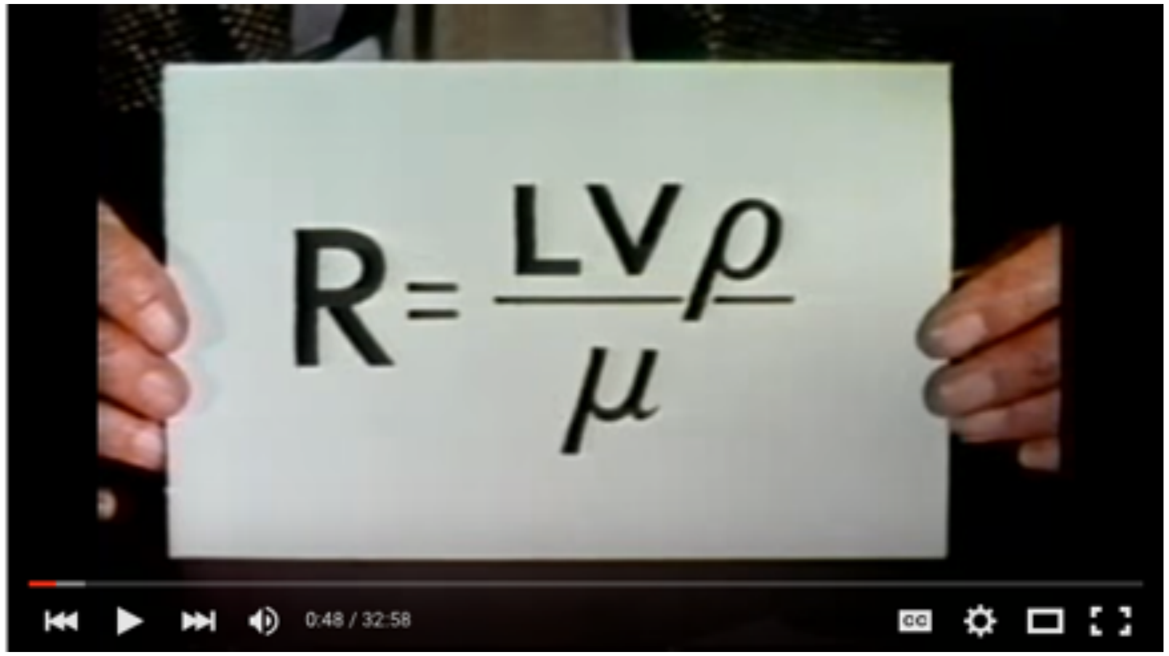
Introduction to low Reynold's number flows (0−5:35)



Kinematic reversibility at low Reynold's number (13:17-17:33)

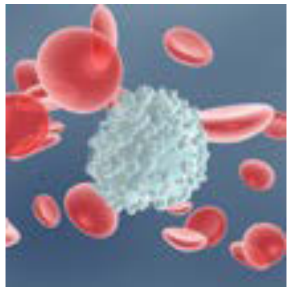
Falling spheres at low Reynolds number

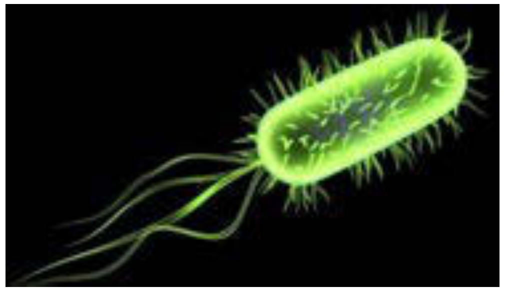
Class exercise:

1. Does a larger ball fall faster or slower than the smaller one?
2. How much faster, with a 2:1 diameter ratio?
3. Does a wall slow down the sphere, or not?

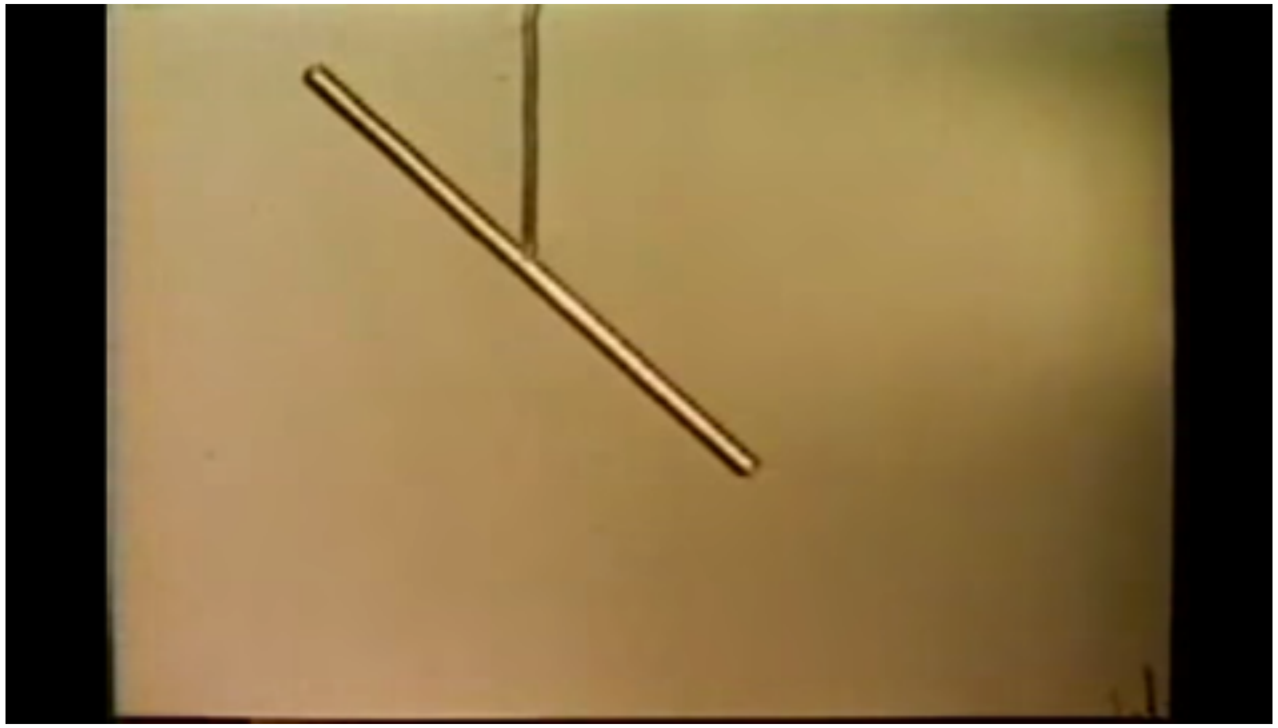
17:36-19:45

Drag on spherical versus slender bodies





Drag on rodlike bacteria versus spherical cells (21:11-25:00)
Falling rods at low Re—difference in drag in two directions



Does the rod fall vertically, or not?

Why or why not?

Self-propelling bodies, flapping versus rotating

25:07-28:55