SHOW BROWNIAN MOTION SLIDE.

$\langle r \rangle = \sqrt{\frac{\gamma t}{r_H}}$ ← STOKES · EINSTEIN.

$\langle r \rangle$: HOW FAR IT GOES, ON AVERAGE.

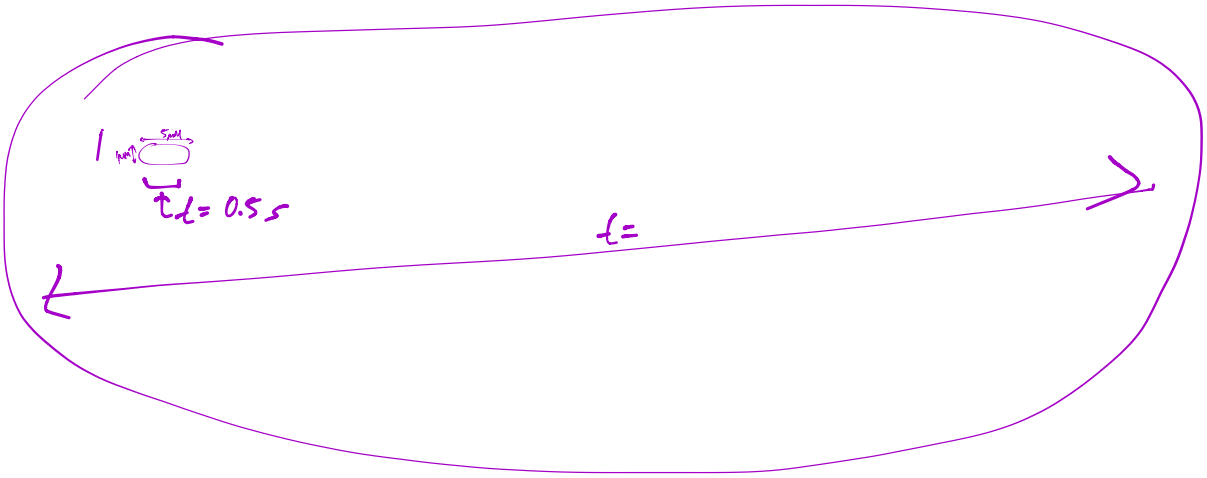
r_H: SIZE PARTICLE

$t = \frac{\langle r \rangle^2 \cdot r_H}{\gamma}$ ← 2 MEANS LONG DISTANCES ARE HARD!

HOW DO CELLS DEAL WITH SLOW DIFFUSION?

- SUBDIVIDE
  - ORGANELLES
  - ALSO ALLOWS SPECIALIZATION.
- MOVE STUFF
  - BOXES
  - ROADS
  - RATCHETING MOTORS.

RAILWAYS.



SHOW PICTURE EUKARYOTIC CELL.

SOMETIMES, CELLS JUST HAVE TO MOVE STUFF

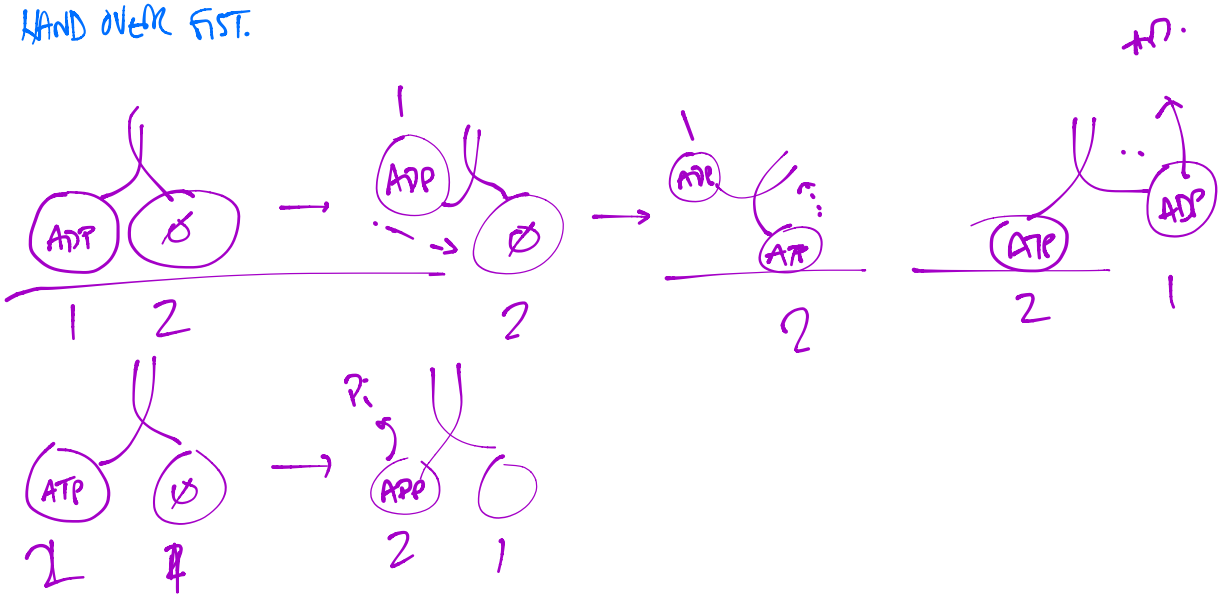
SHOW NEURON. 1m ← X YEARS!

USE RAILROADS.

SHOW VIDEO OF WALKING.

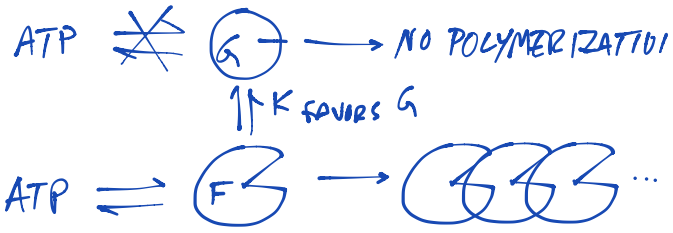
TUBULIN POLYMER ASSEMBLY.

HAND OVER FIST.



- KINASIN BREAKDOWN
- WHICH
- ATTACHMENT

CAN BE R.G. LIKE... NEED NOT BE.


ATP
G
NO POLYMERIZATION
K favors G
ATP
F