

Welcome!

Scientific project design in cell and developmental biology (BIO-464)

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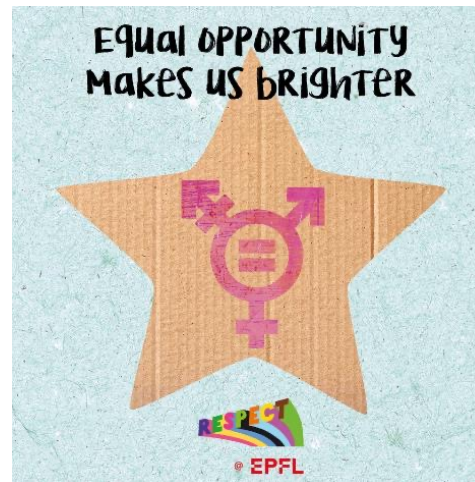
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- **Have fun** in doing all of the above!

● Typical weekly cycle

- Wed, 8:15am-9:30am: **discussion of paper** that has been provided the week before (only main text + figures discussed, but the Supplemental material can help)
- Wed, 9:45am-10am: **introduction** to topic of the following week (> Moodle by Monday night)
- Wed, 10am: **one paper** provided for the following week (> on Moodle after class)
- Wed 10:15am-noon and/or rest of the week, at your own pace: **read and analyze** paper for following week
- **Questions? Suggestions?** Pierre.Gonczy@epfl.ch or Andrew.Oates@epfl.ch

● Reading and analyzing papers

- Everyone reads paper in depth
- Consider **discussing among yourselves**
- On Wednesday: **discussions and questions**, figure by figure, randomly calling on people



● Analyzing paper figures: some basics

- What **question** is being addressed?
- Which **experimental approaches** are utilized?
- Have appropriate **controls** been conducted?
- Which **conclusions** can be drawn?
- Which experiments could be performed **next**?

● Schedule and topics

- Sep 10: Course overview, introduction spindle assembly
- Sep 17: Paper 1, spindle assembly (PG)
- Sep 24: Paper 2, kinesin (PG)
- Oct 1: Paper 3, centriole assembly (PG)
- Oct 8: Paper 4, biomolecular condensates (PG)
- Oct 15: Paper 5, organoids as model systems (PG)
- *(fall break)*
- Oct 29: Paper 6, cell adhesion and sorting (AO)
- Oct 29: (10:15am): continuous control

● Project

- Nov 5: Paper 7, organizer function/signaling (AO)
+ introduction to project research topics (PG/AO)
- Nov 12: Paper 8, somitogenesis (AO)
+ discussion of proposed projects (PG/AO)
- Nov 19: Paper 9, mechano-chemical coupling (AO)
+ refine/start project (PG/AO)
- Nov 26: Project week 2
- Dec 3: Project week 3
- Dec 10: Project week 4 (career presentations: 12:15pm)
- Dec 17: Oral presentation and final discussions

● Evaluation

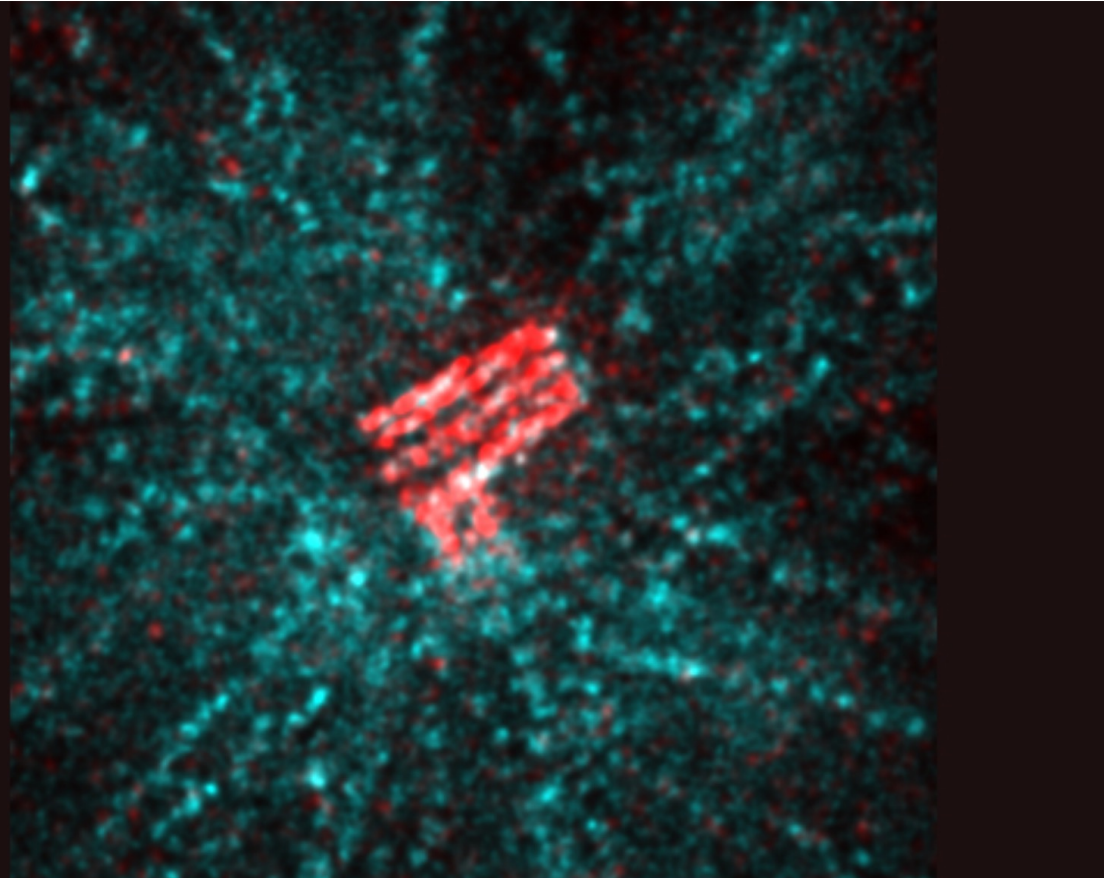
- 1/3 grade: **class participation**
- 1/3 grade: **written continuous control** (2 hours on Oct 29th, 10:15am-12:15pm); questions on a paper provided the week before
- 1/3 grade: **project design, execution and presentation**

● Who are we?

● Geneva > New York City > Heidelberg >

Lausanne

**Gönczy Lab
Cell and
Developmental
Biology**



<https://www.epfl.ch/labs/gonczy-lab/>

● Adelaide > Melbourne > Princeton > Chicago

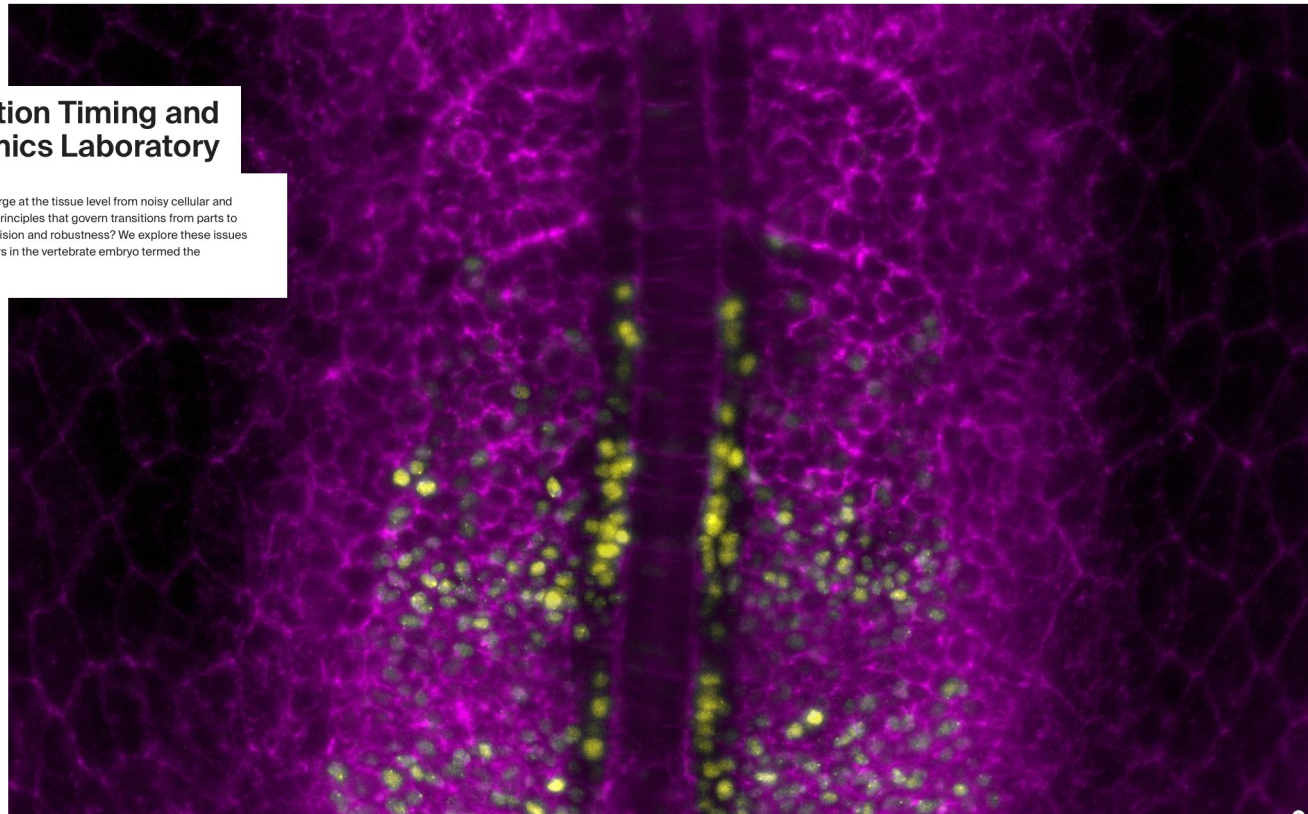
Dresden > London > Lausanne

OATES LAB



Segmentation Timing and Dynamics Laboratory

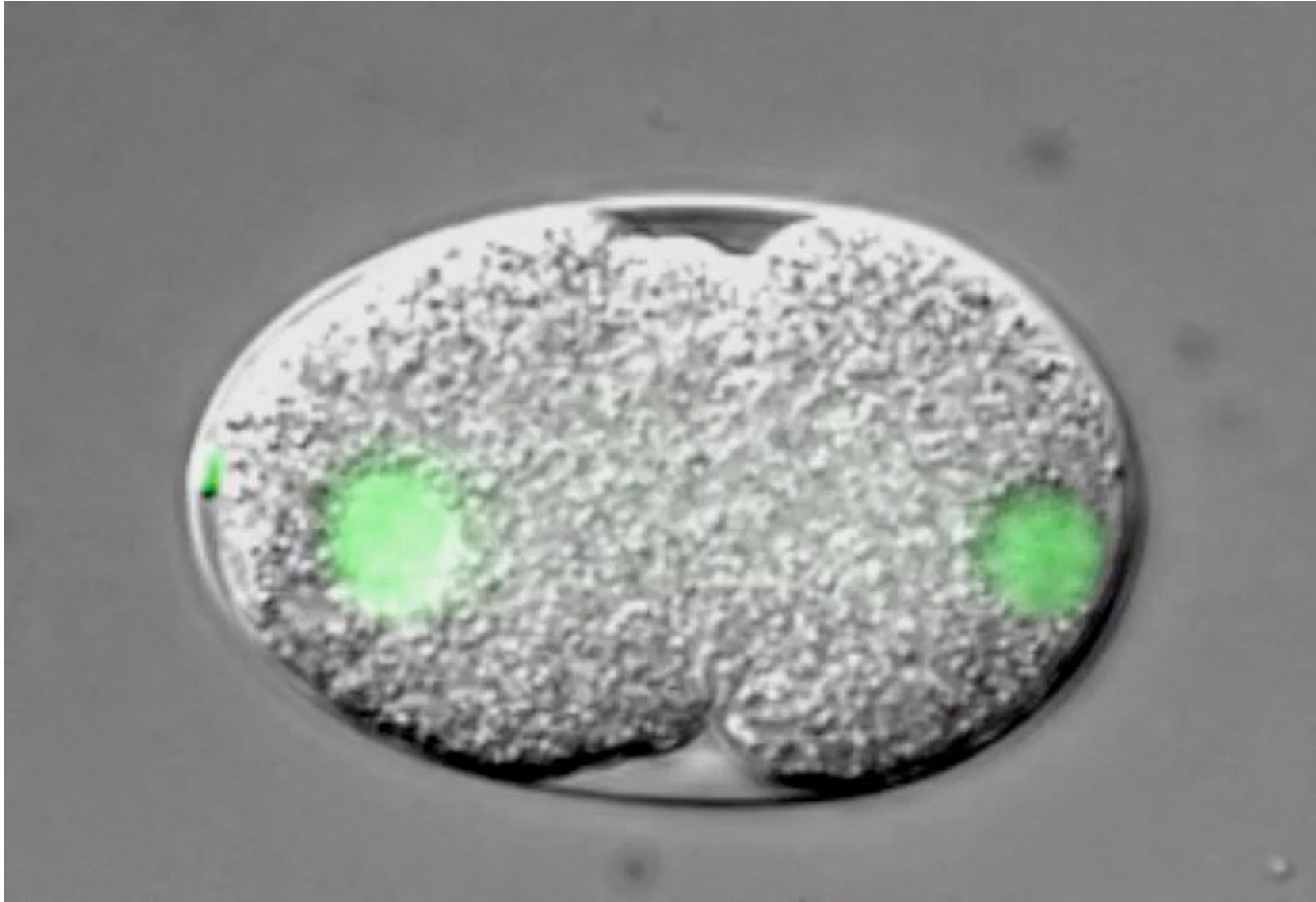
How do spatio-temporal patterns emerge at the tissue level from noisy cellular and molecular interactions? What are the principles that govern transitions from parts to wholes, and those that determine precision and robustness? We explore these issues using a population of genetic oscillators in the vertebrate embryo termed the segmentation clock.



<https://www.epfl.ch/labs/oates-lab/>

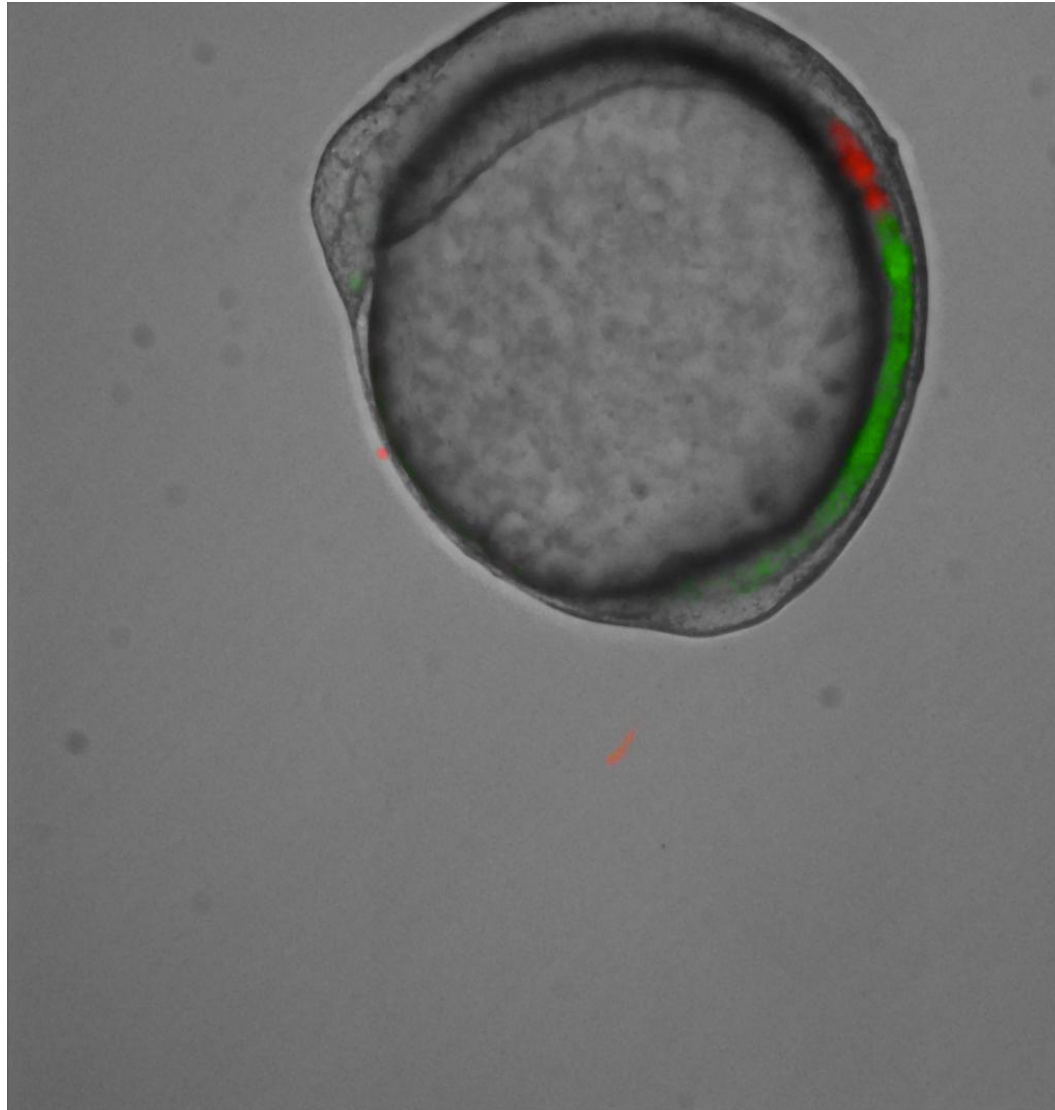
- **Awesome cell and developmental biology**

- The beauty of the early *C. elegans* embryo



C. elegans zygote

- **The beauty of the zebrafish embryo**



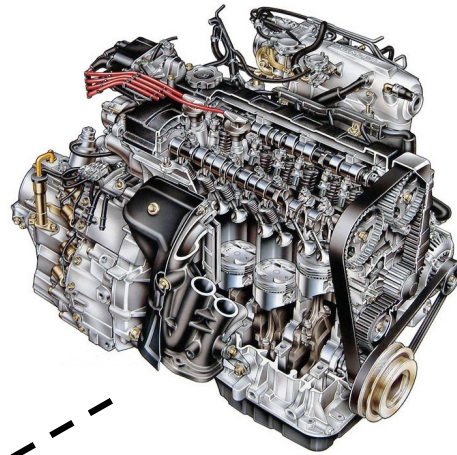
zebrafish embryo

● Questions?

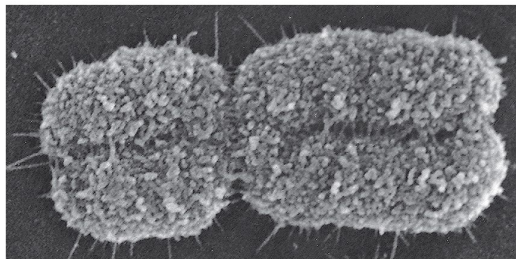
● Introduction to Paper 1

- **Biological question: spindle assembly**

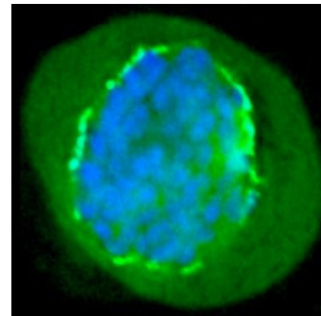
● Mitosis: beautiful moment of the cell cycle



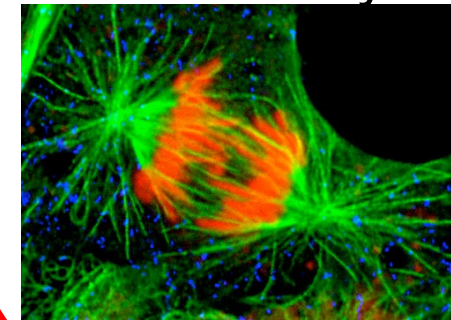
chromosome
condensation



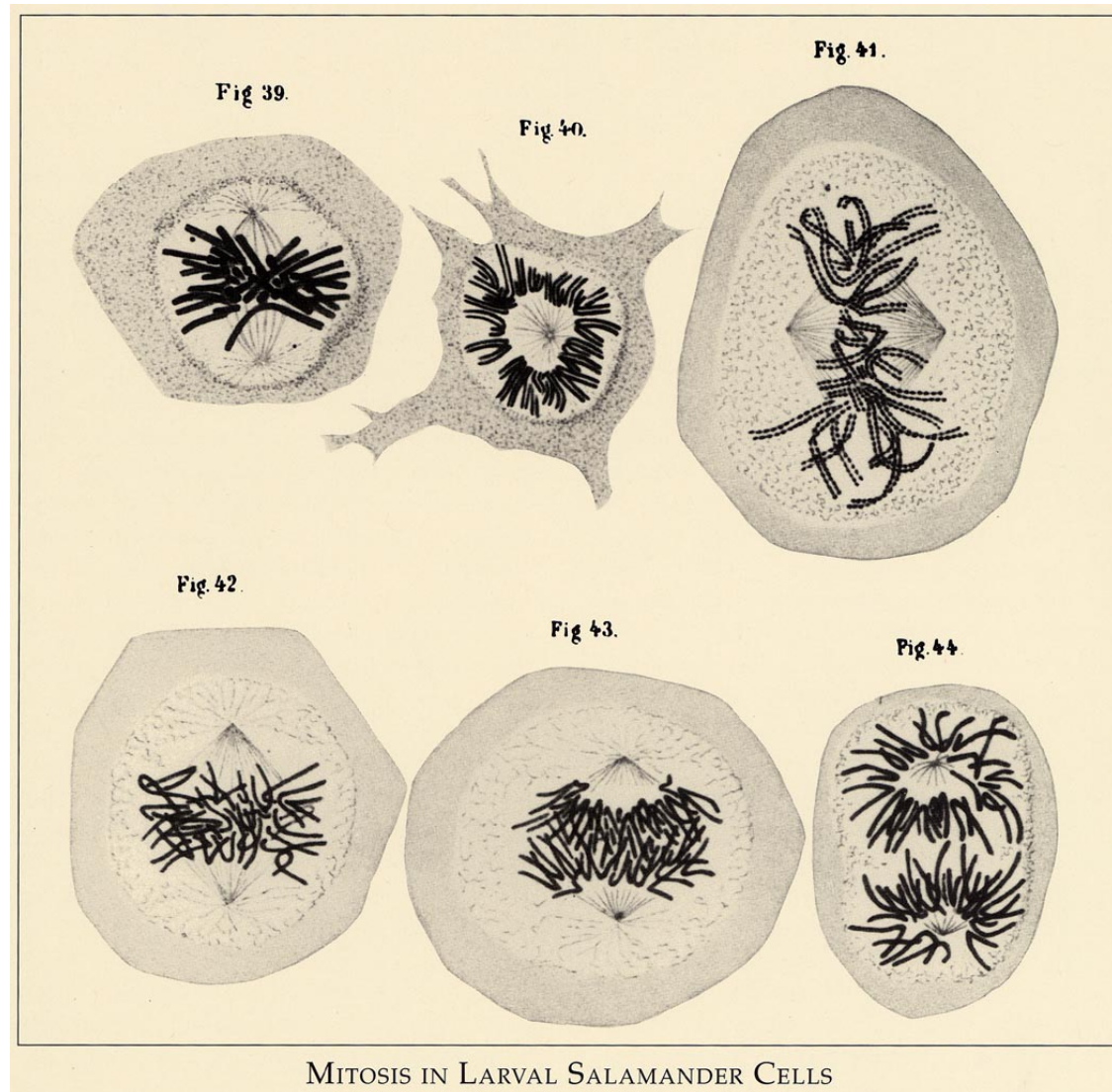
NEBD



spindle
assembly



● The beauty of mitosis... a long time ago

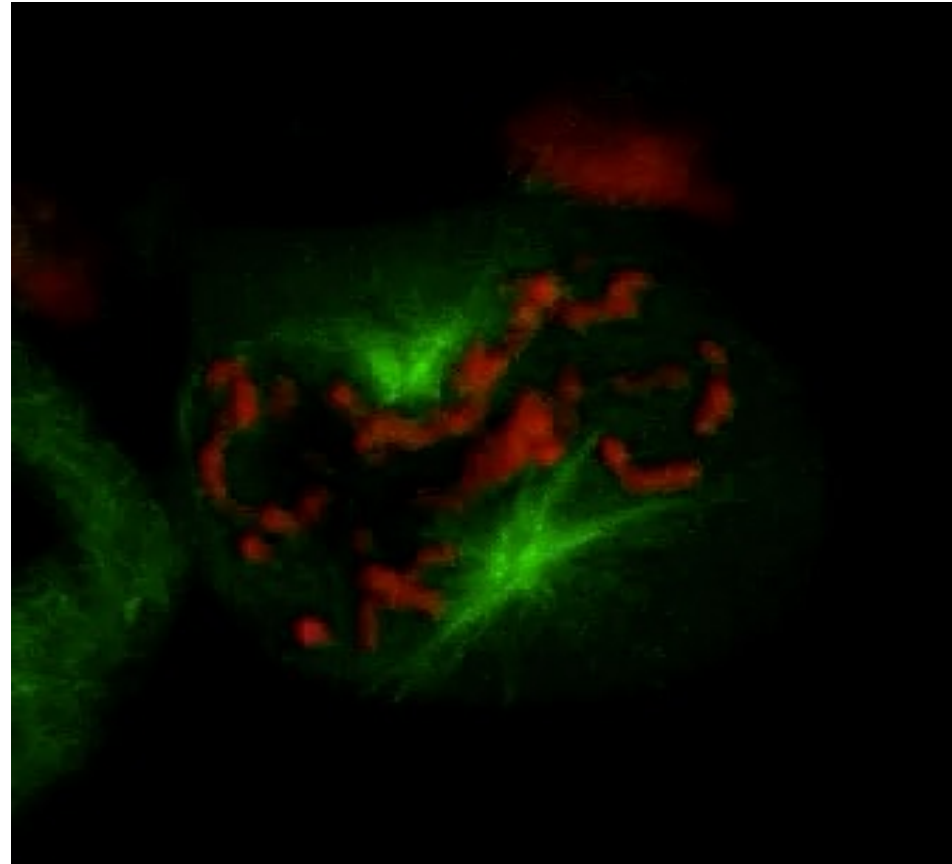


- **Mitosis in newt lung cells**

Mitosis in tissue-cultured lung cell of a newt, *Traicha granulosa*, recorded with the new Pol-Scope.

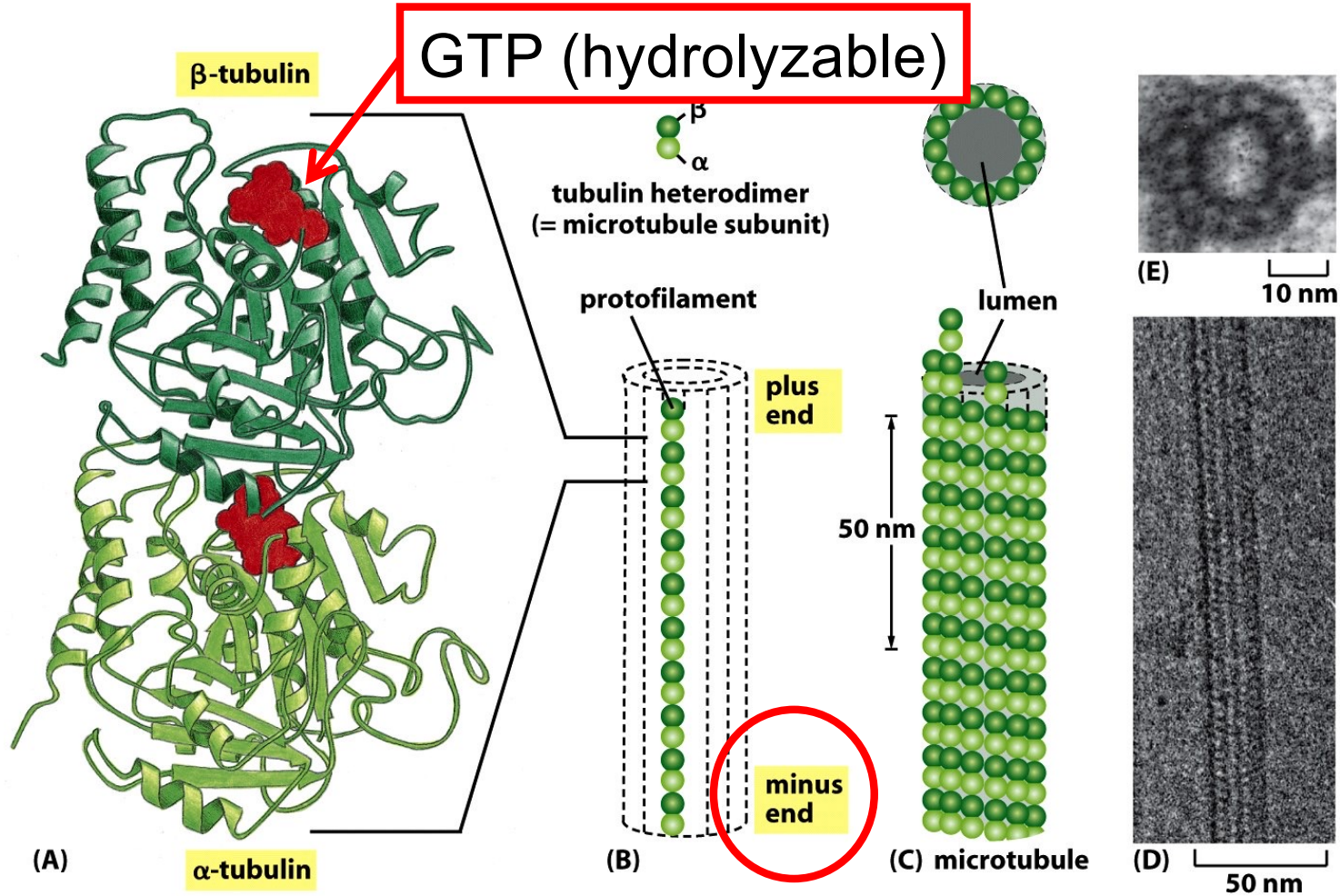
● Mitosis in HeLa cells

HeLa cell



GFP- α -tubulin mCherry-H2B

● Microtubules

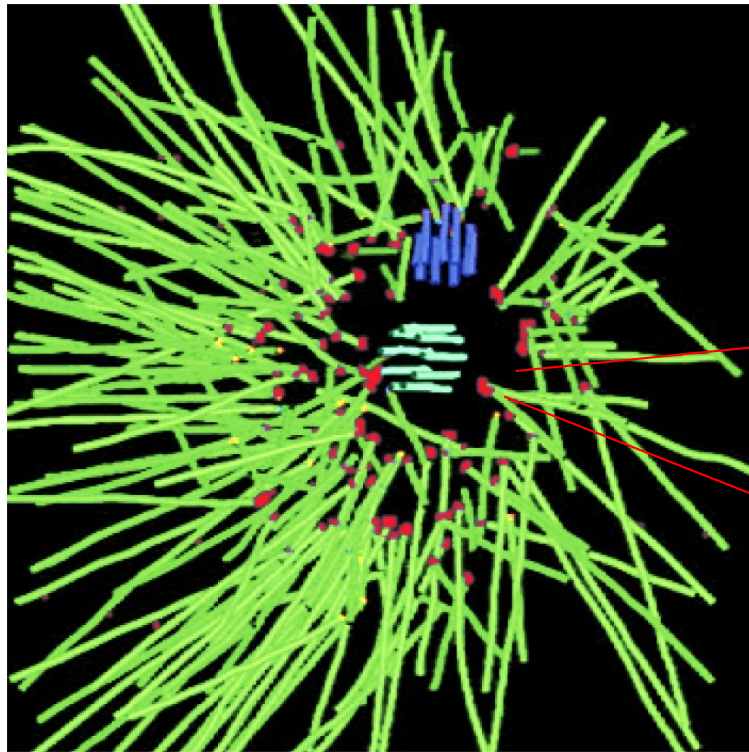


crystal structure of
 α/β tubulin dimer
(with GTP)

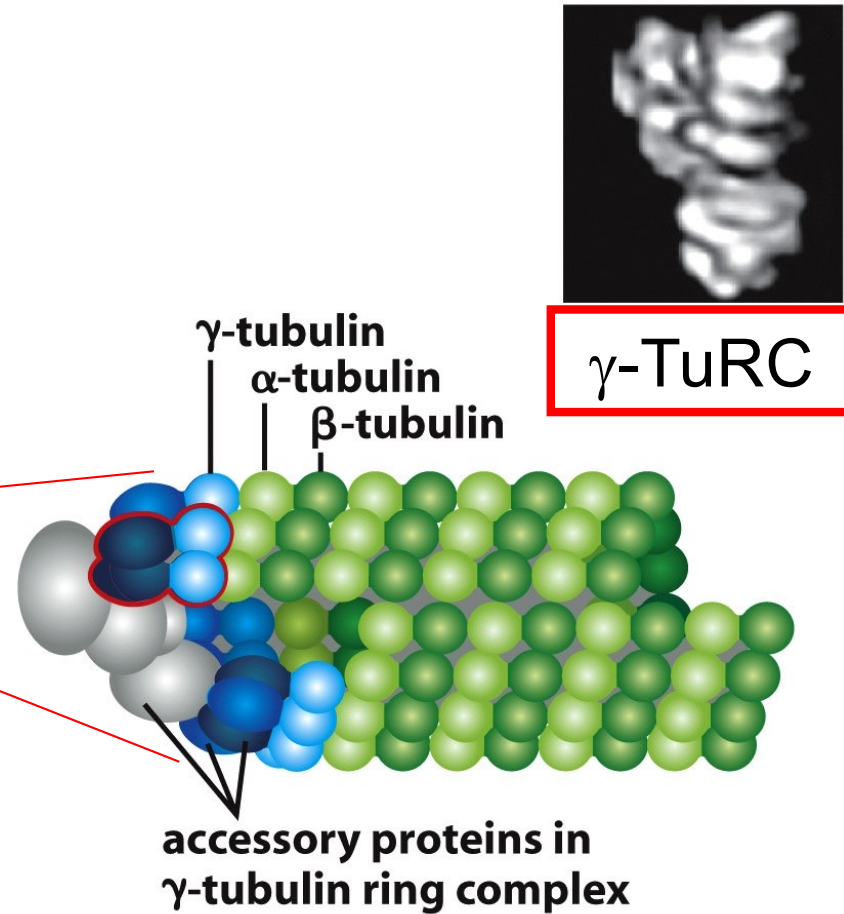
protofilament

microtubule
(typically 13 PFs)

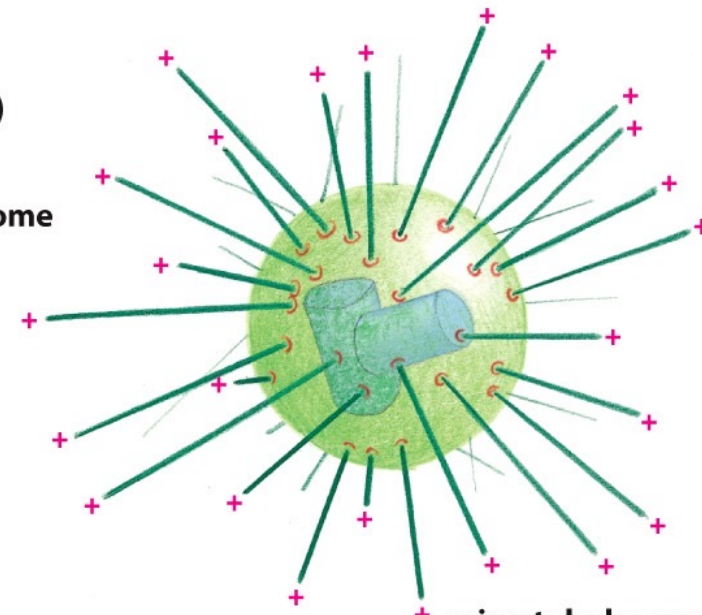
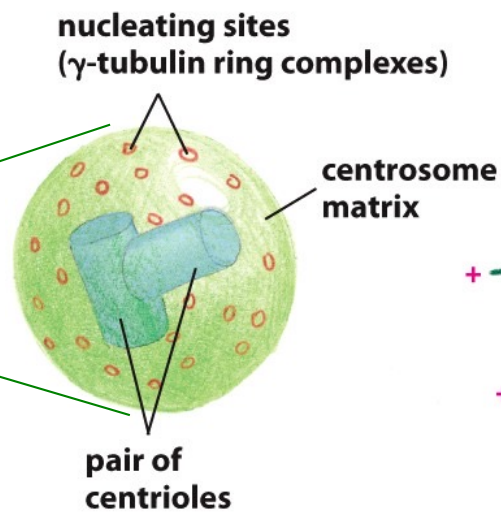
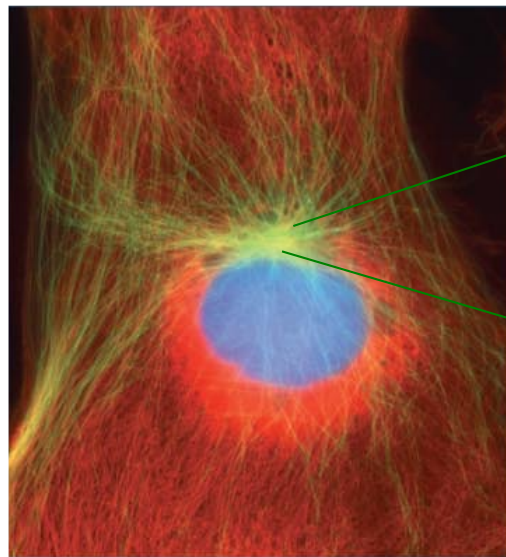
● MT nucleation by γ -tubulin ring complex



Inmunofluorescence
(red: γ -TuRC)



● In most animal cells: from centrosomes

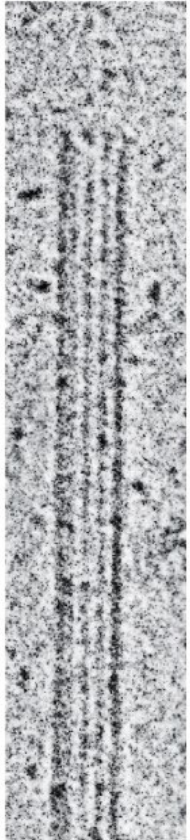


microtubules grow at their plus ends from γ -tubulin ring complexes of the centrosome

But there are exceptions!

After nucleation: dynamic instability

EM

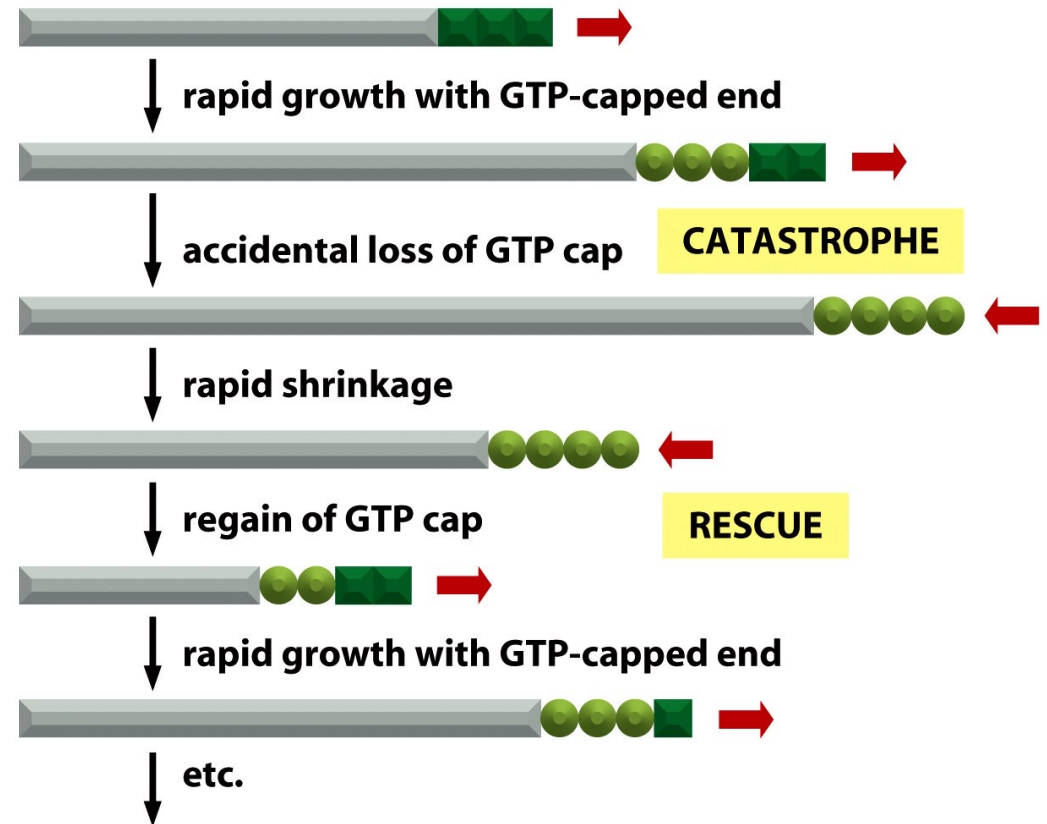


growing

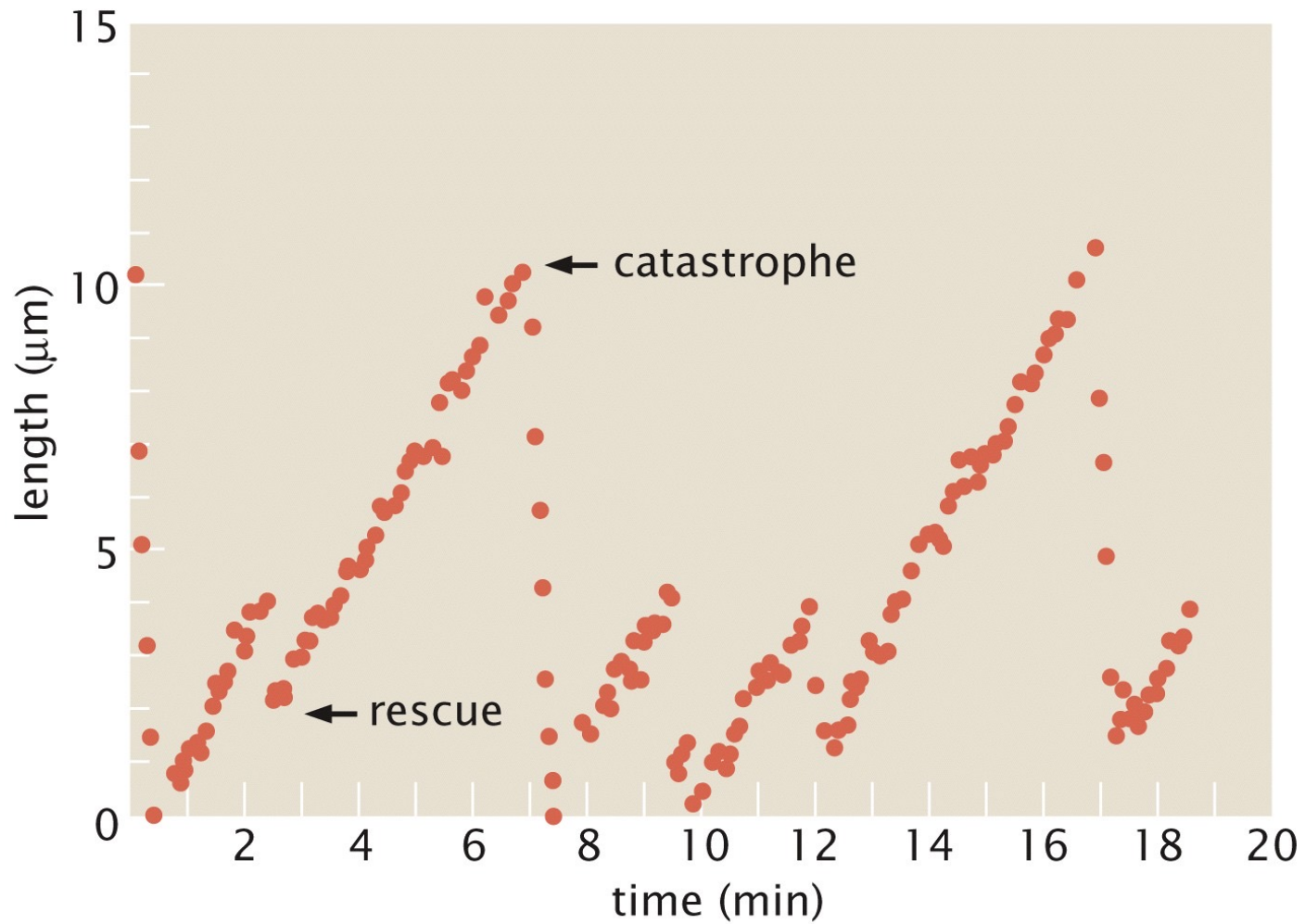
EM



shrinking



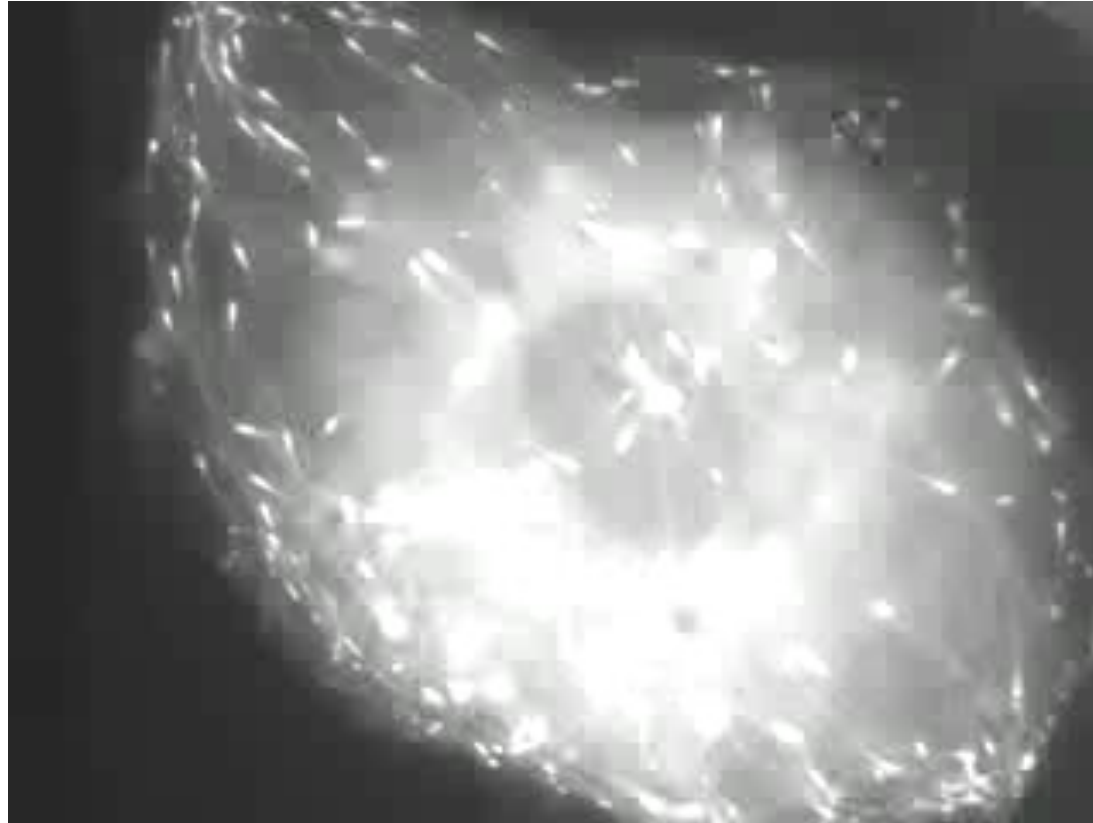
Tracking behavior of single microtubule



● Dynamic instability in action!



- **EB1-GFP marks plus ends of growing MTs**
-



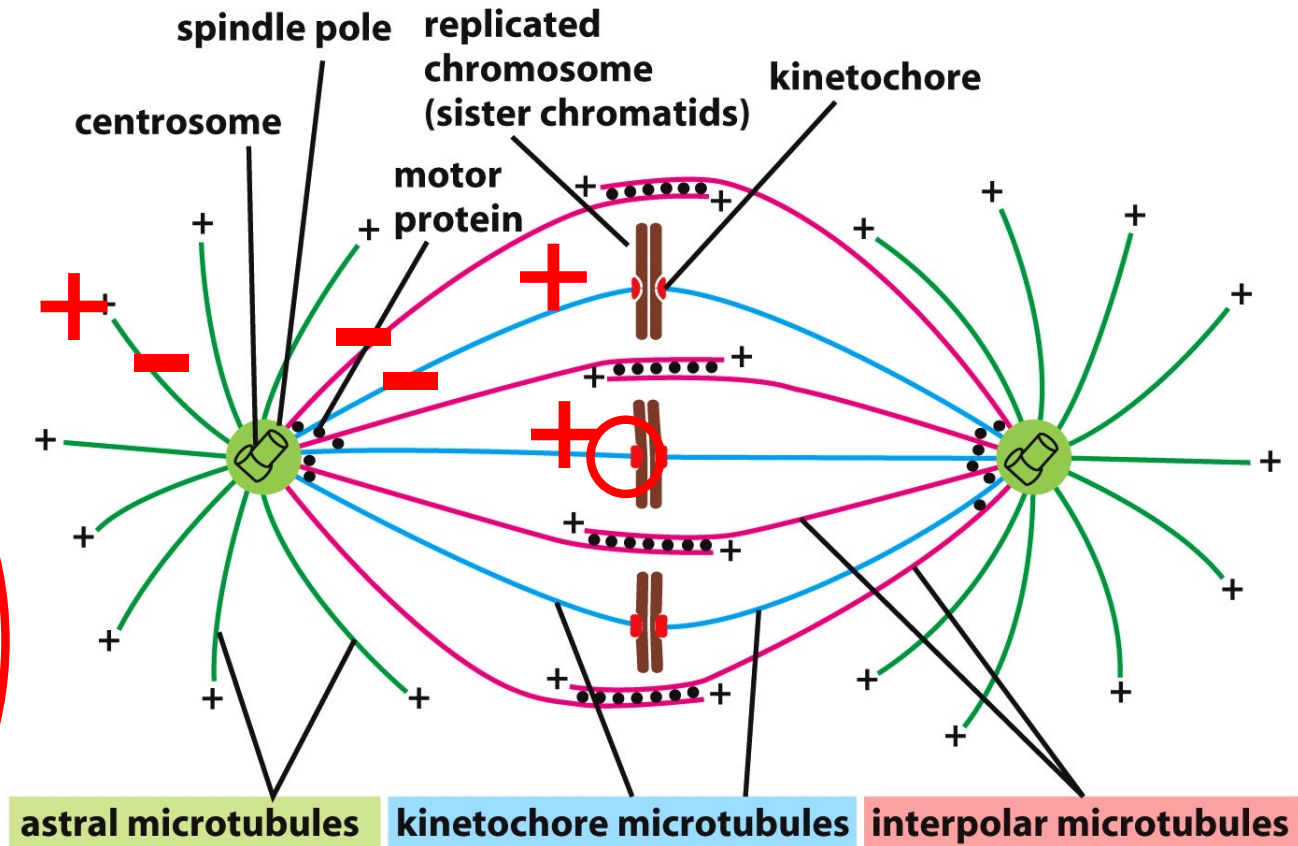
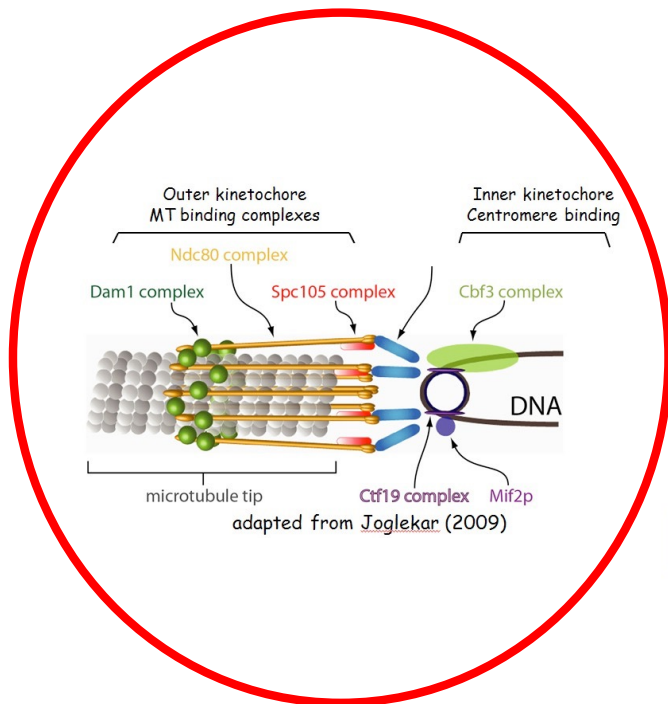
Mitotic spindle organization

- Three types of microtubules:

- kinetochore MTs

- **interpolar MTs**

- astral MTs





metaphase

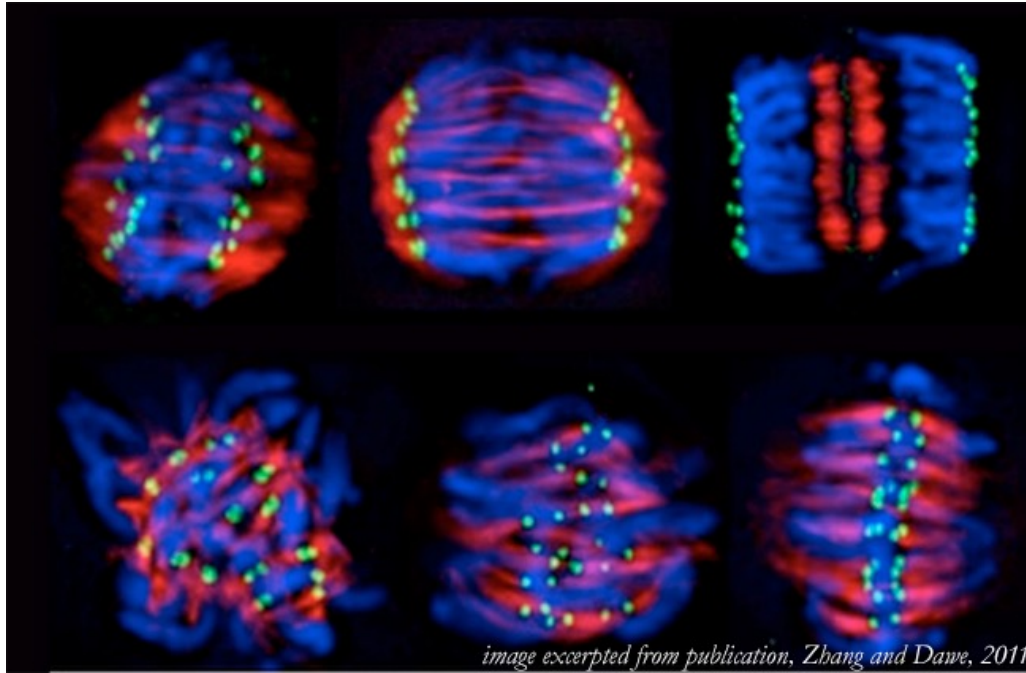


anaphase

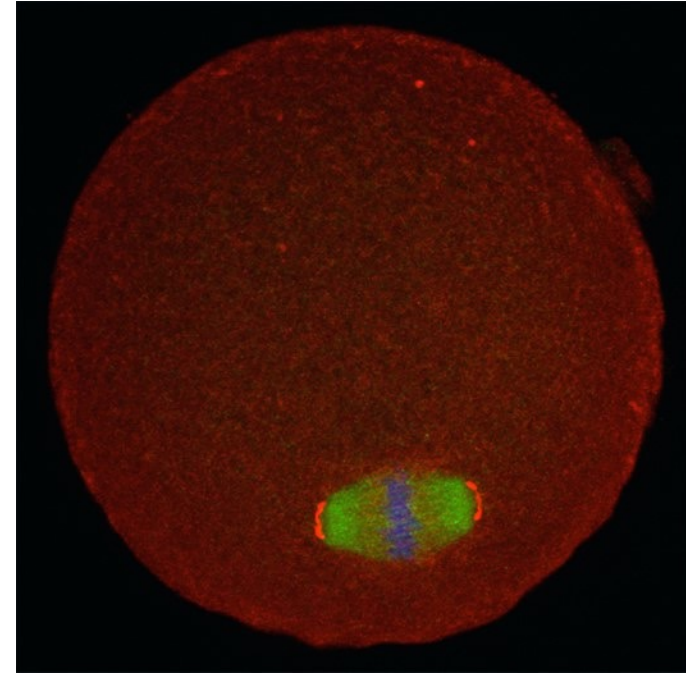
● Paper 1

- Self-organization of microtubules into bipolar spindles around artificial chromosomes in *Xenopus* egg extracts. *Heald et al.; Nature 382: 420-425 (1996)*.

● Assembling a spindle without centrosomes

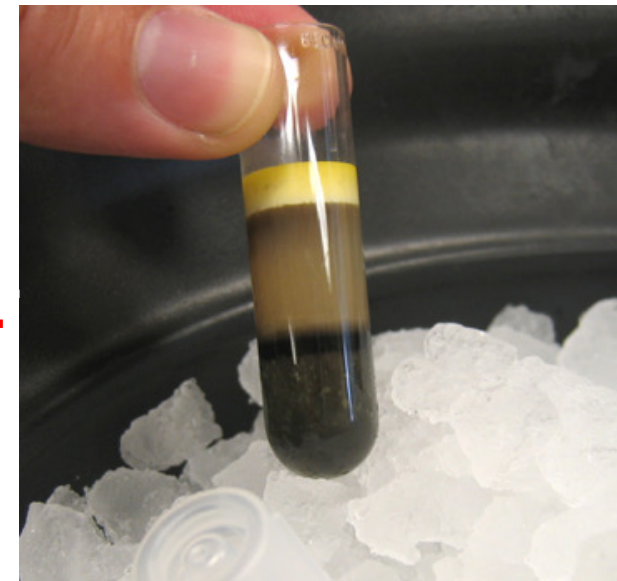


barley root tip
(Dawes lab)



mouse oocyte
(Latham lab)

● Making *Xenopus laevis* egg extracts



CSF extract
(*meiosis II arrest*)

CSF + Ca⁺⁺
(*interphase*)

● Questions?
