



浙江大学
生命演化研究中心

Actin organizes chromosomes and microtubules to ensure mitotic fidelity in the preimplantation embryo

(肌动蛋白组织染色体和微管, 以确保植入前胚胎有丝分裂的准确性)

Blake Hernandez et al, Science, 2025

Zhiqiang Liu

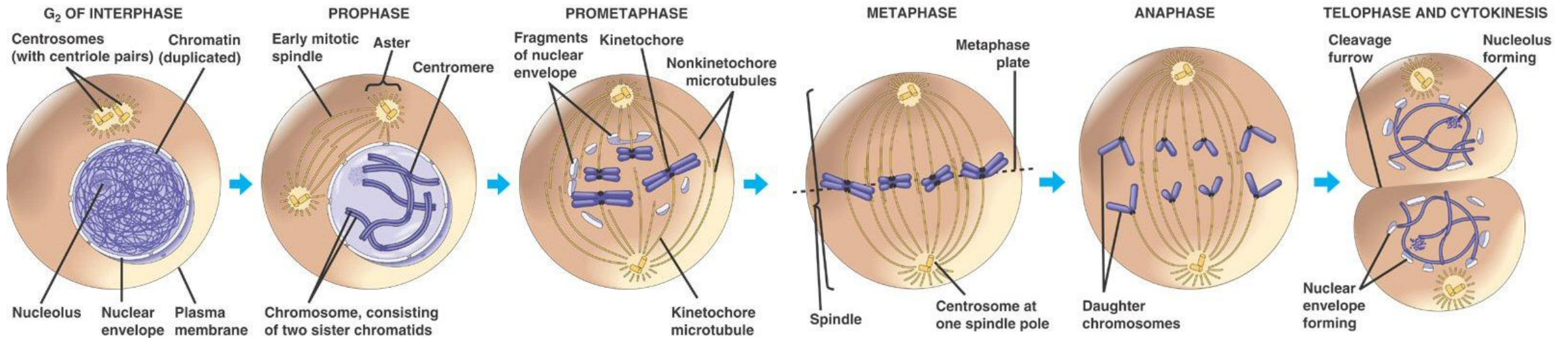
Date: Mar.6th.

Content

- Introduction
- Results
- Summary
- Limitation

◆ Introduction

- Successful preimplantation(植入前) embryo development relies on the error-free transmission of genetic information during each cell division. Chromosomal numerical abnormalities, known as aneuploidy (非整倍体), are a primary cause of developmental defects and infertility.
- Traditional views hold that the spindle is the core structure for chromosome segregation, depending on centrosomes (中心体) to organize microtubules.



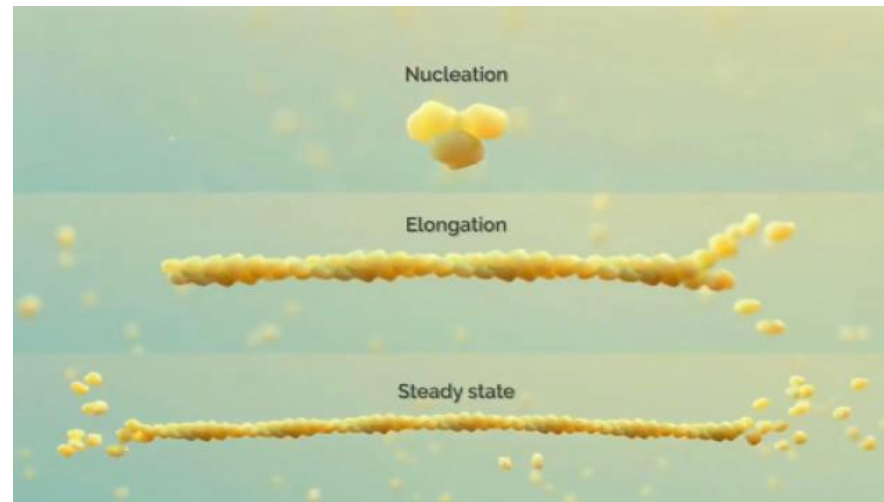
The classical mitosis process

◆ Introduction

- Early mouse embryos lack centrosomes, and spindle assembly is slow and disorganized. This absence of a functional mitotic mechanism contradicts the need to accurately transmit genetic material during development.

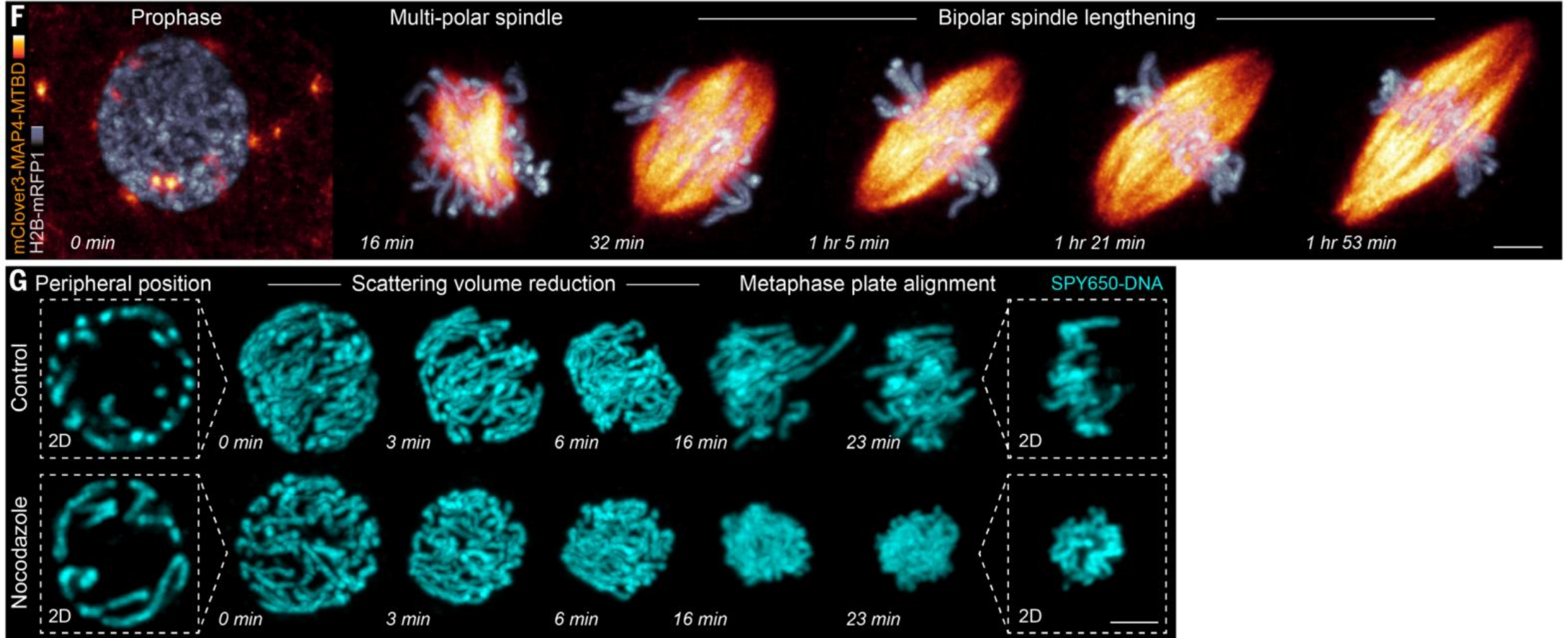
How do early embryos achieve precise chromosome organization?

- There is increasing evidence indicates that F-actin plays multiple roles in mitotic cell division.

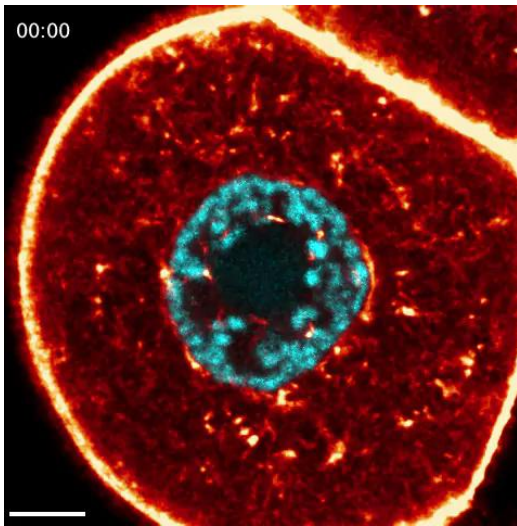
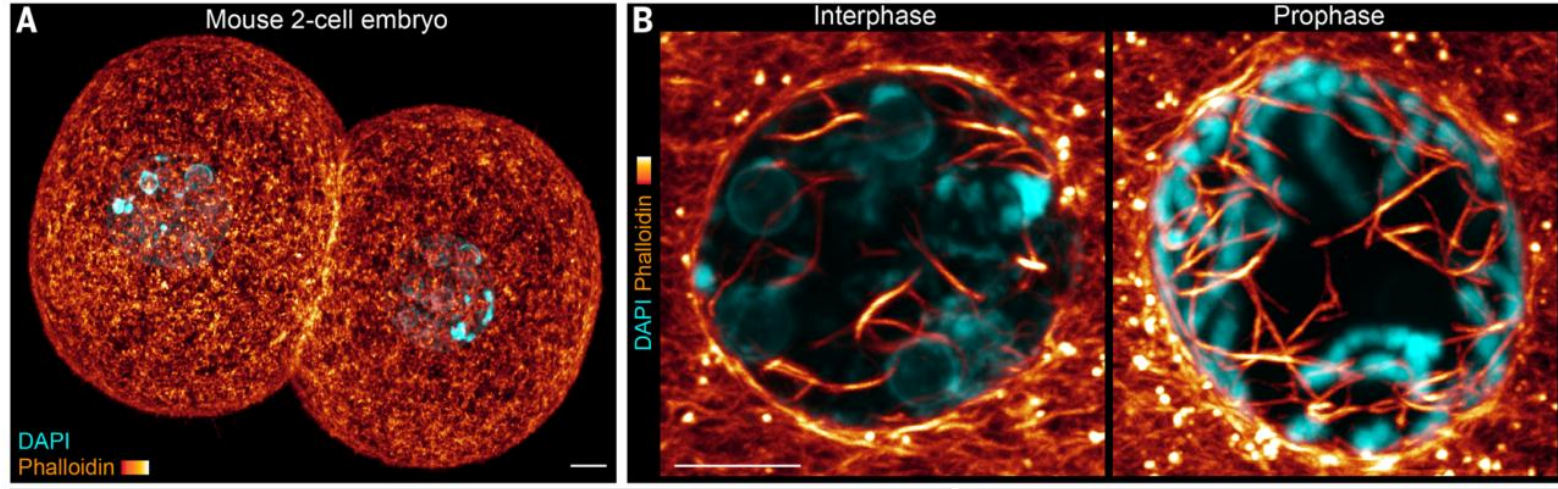


The process of actin assembly

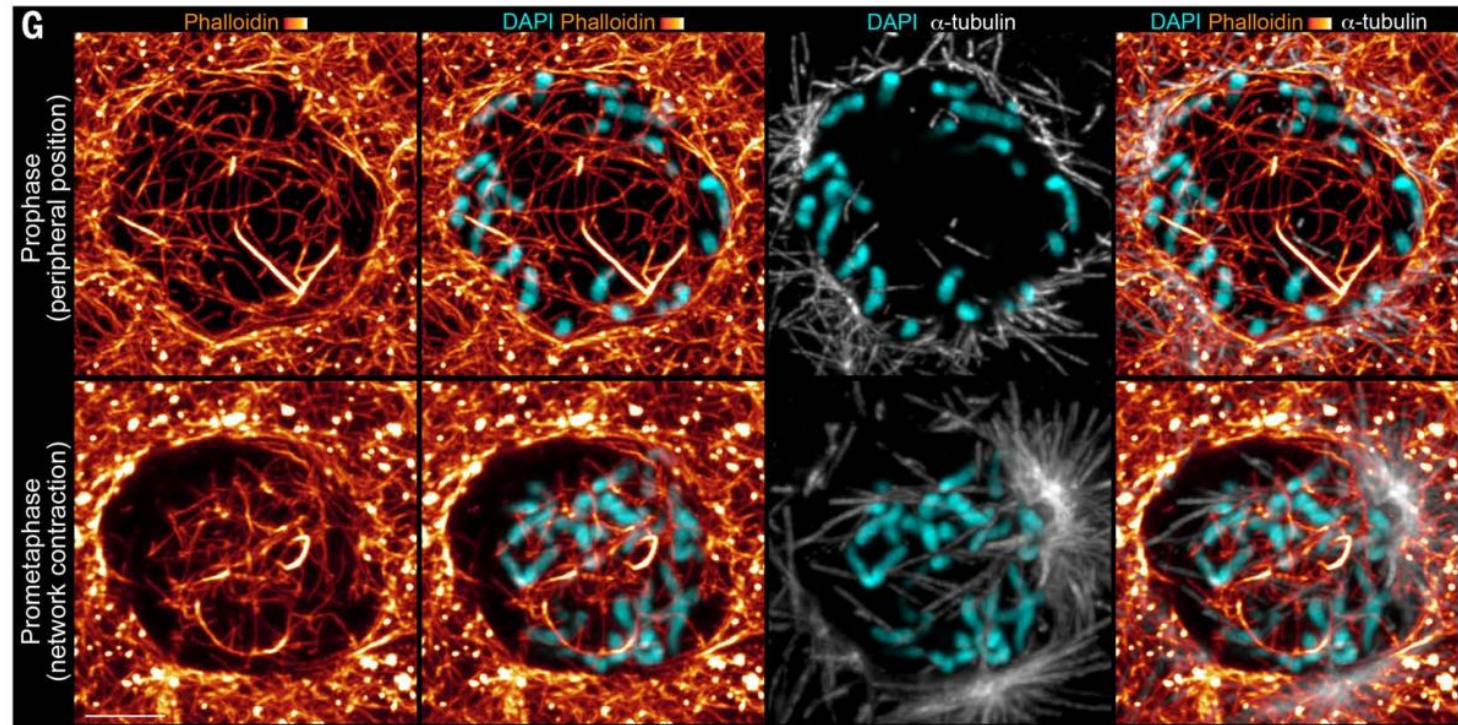
● Visualization of the mitosis process in the early embryo



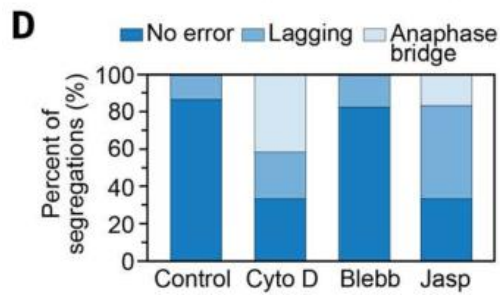
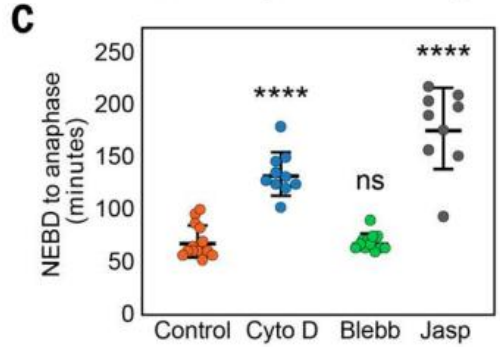
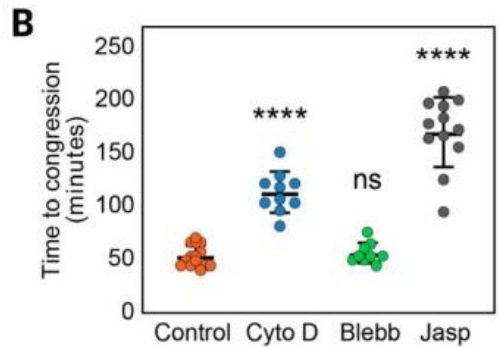
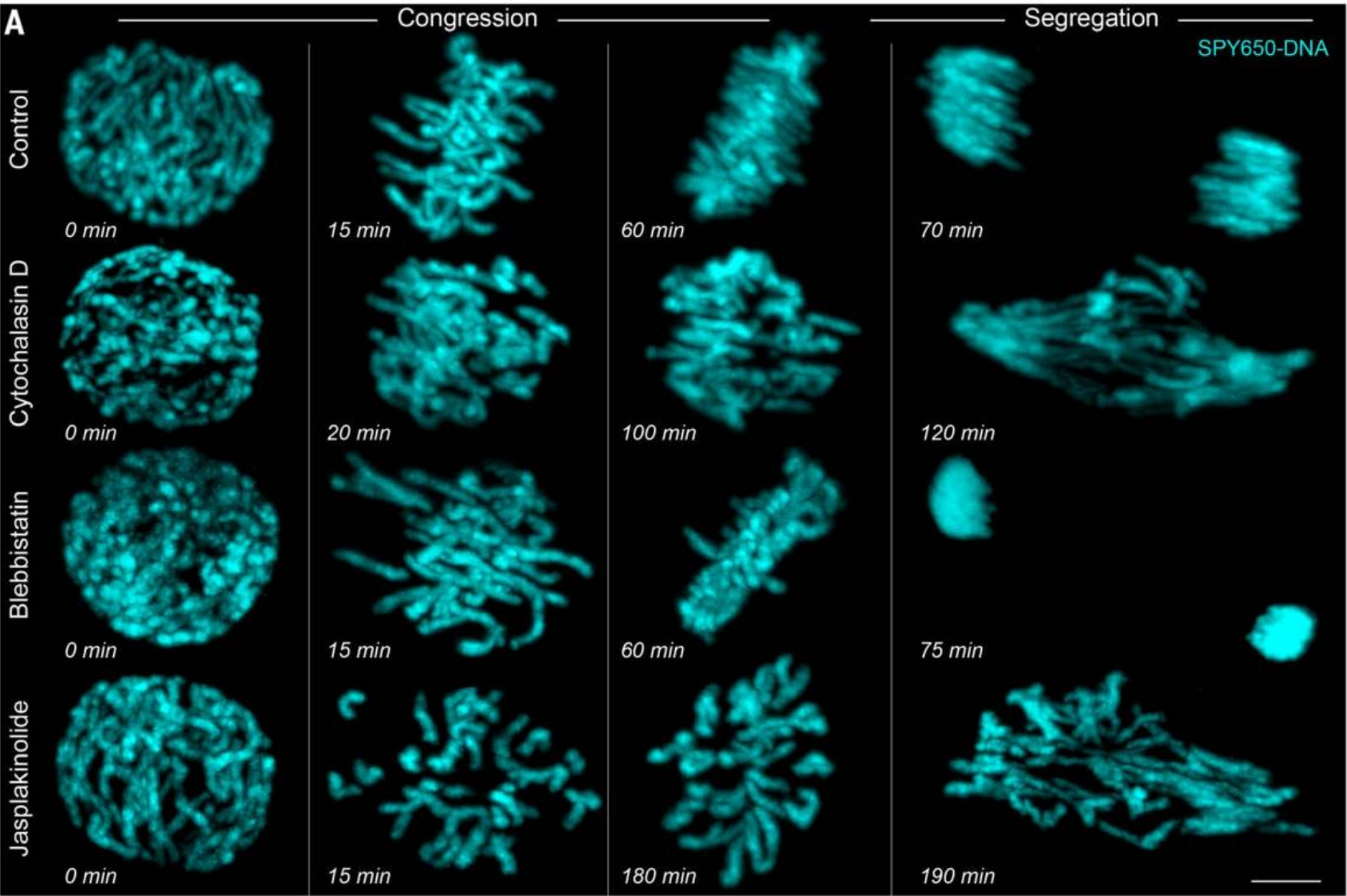
- Nuclear F-actin might organize chromosomes by network contraction



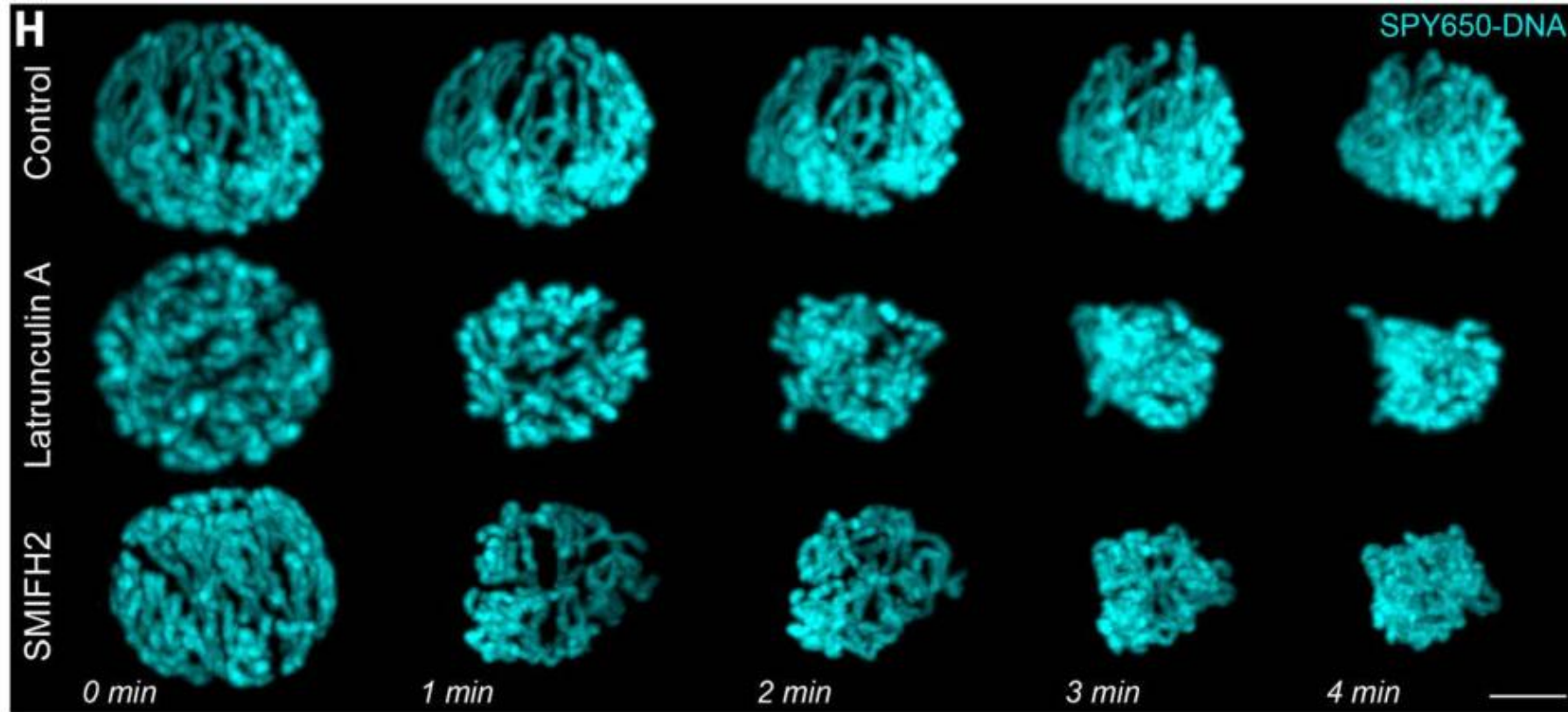
The high-resolution live-cell imaging of F-actin network and chromosomes



● F-actin depolymerization is essential for the organization of chromosome

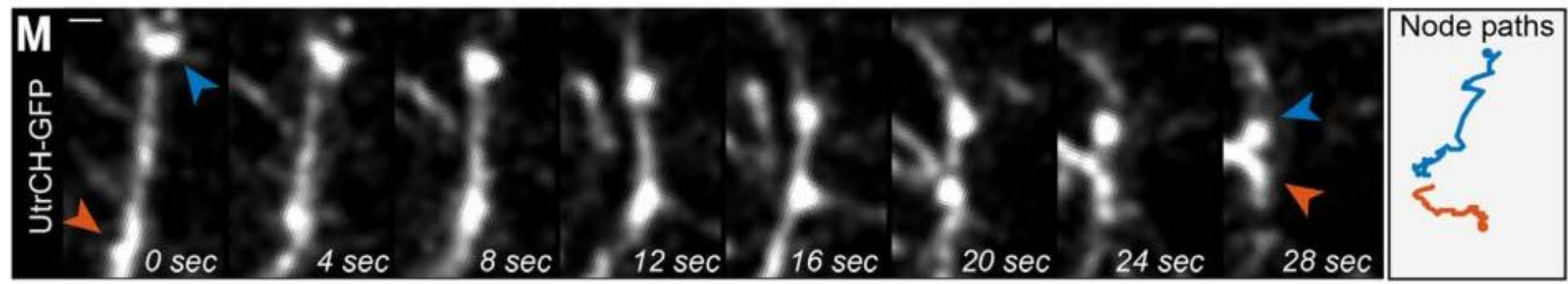


● F-actin depolymerization drives network contraction

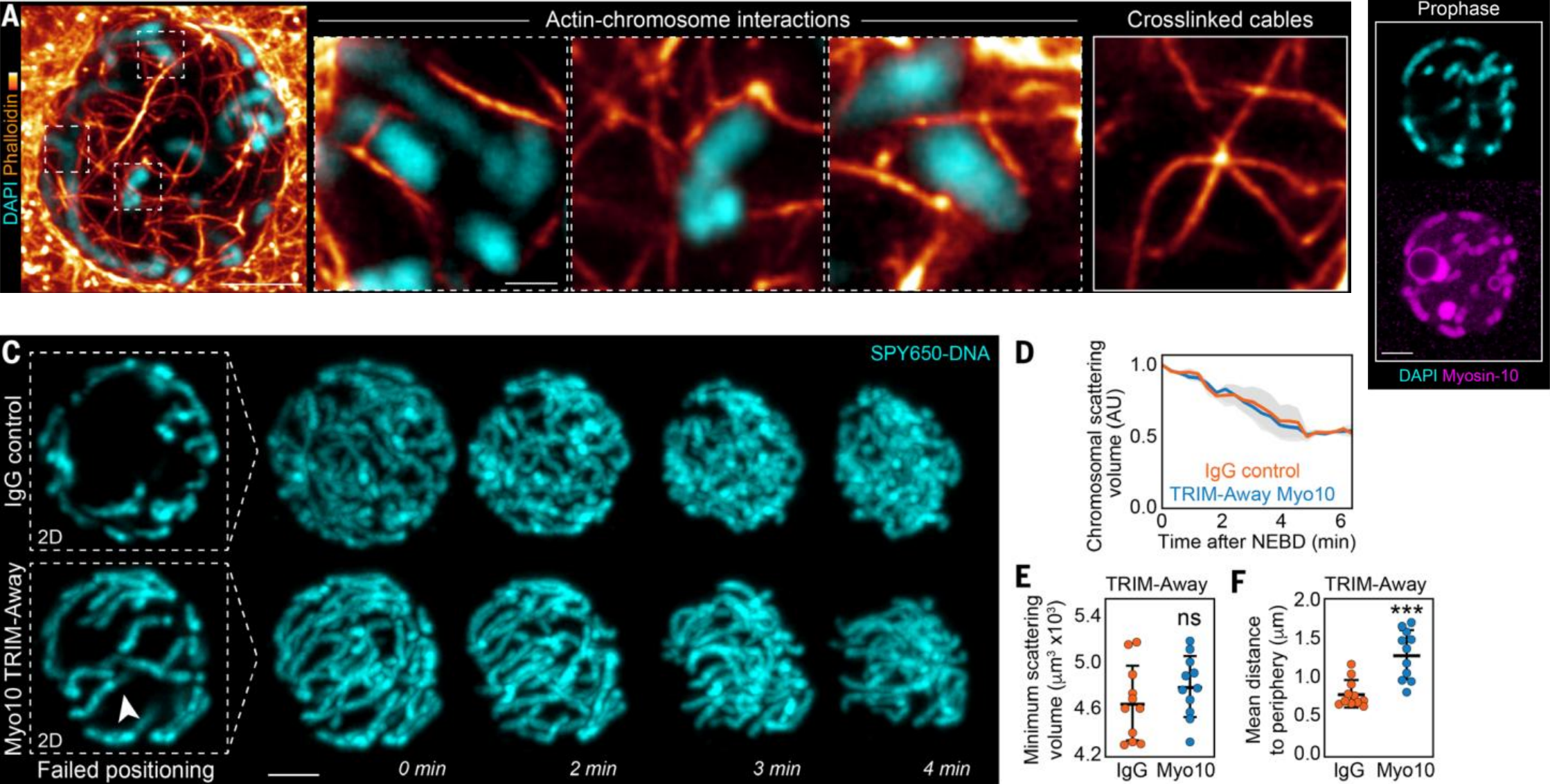


promote F-actin depolymerization

inhibit F-actin polymerization

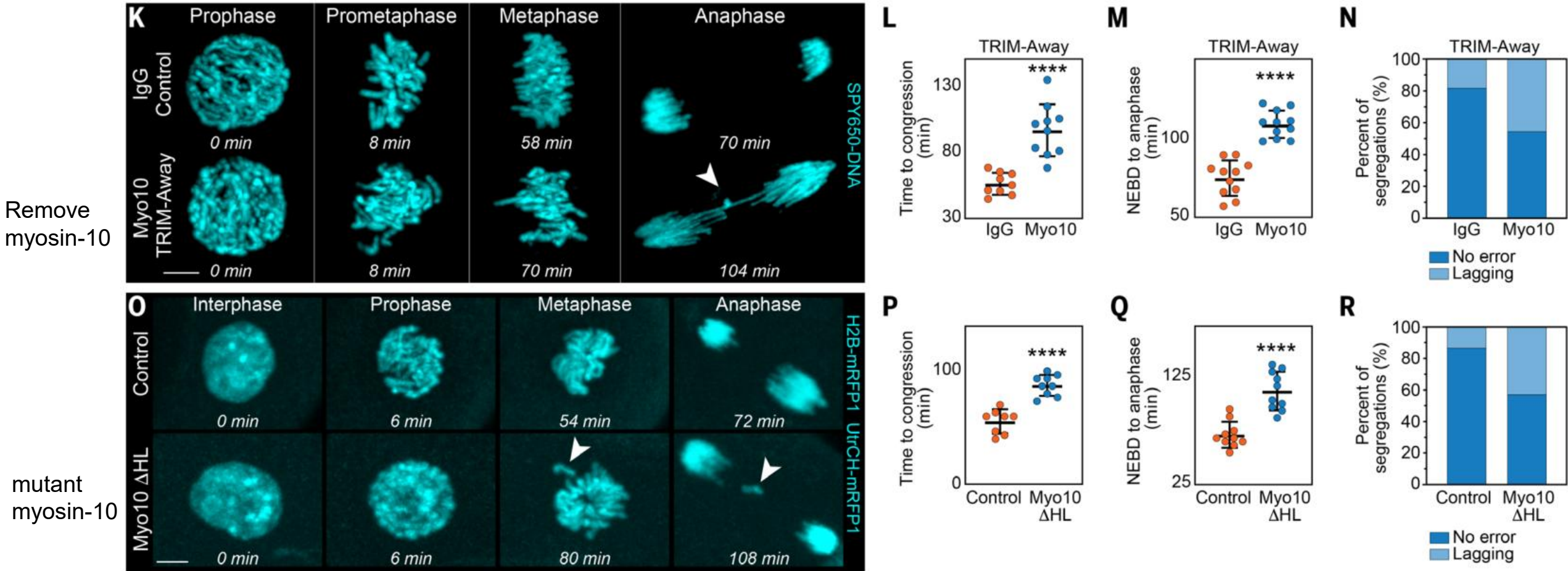


● F-actin positions chromosomes in the right place through myosin-10

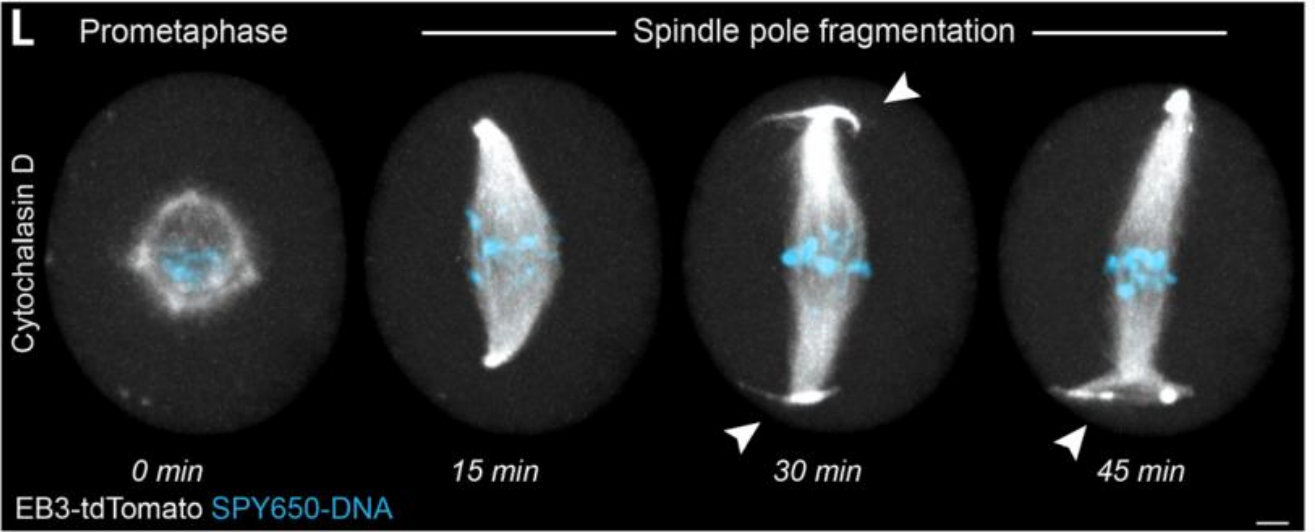
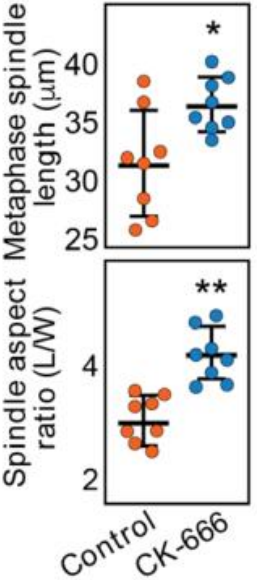
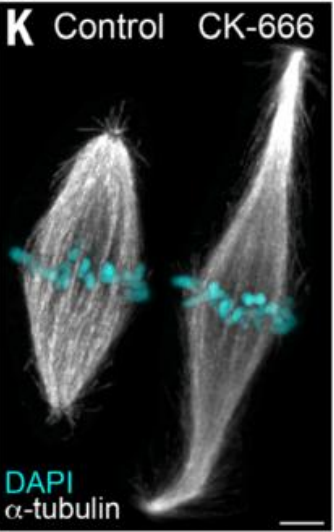
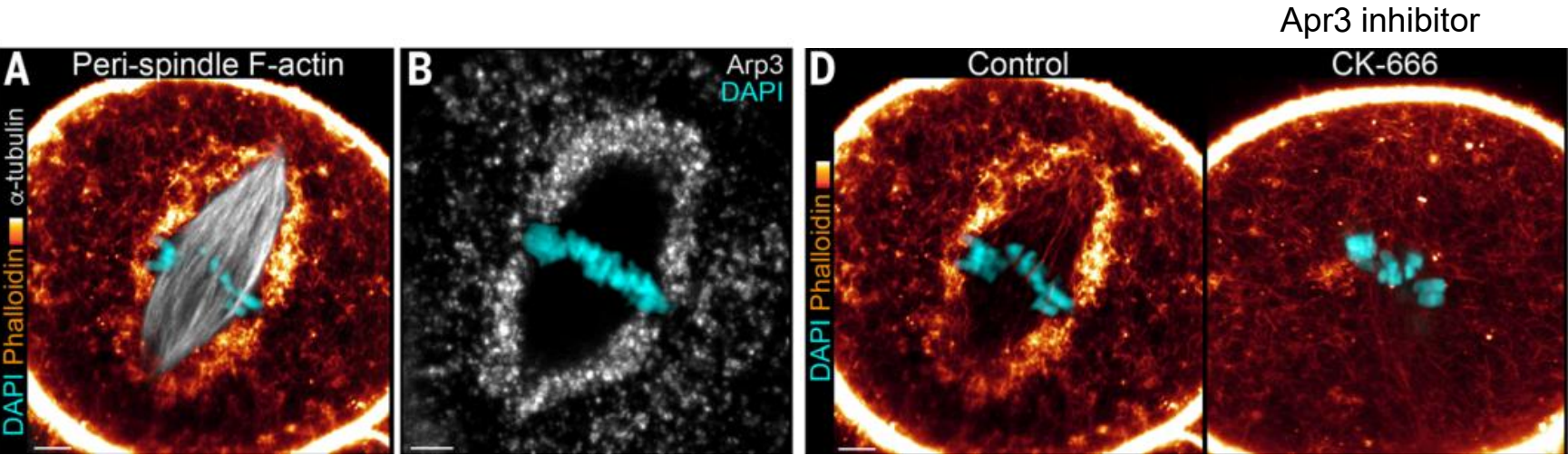


Remove myosin-10

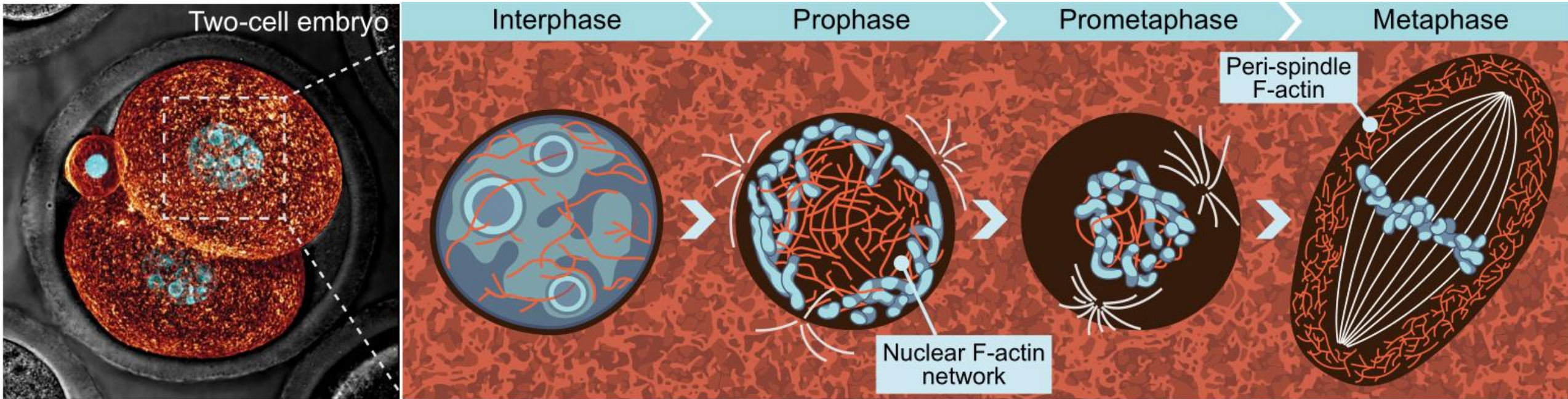
- Nuclear F-actin and myosin 10 arrange the chromosomes at the nuclear periphery in prophase



- Perispindle F-actin controls spindle size and morphology



◆ Summary



In conclusion, they revealed a distinct mechanism in early embryo that ensures accurate mitosis in the absence of efficient spindle assembly.

◆ Limitation

- The mechanism might differ in humans, as the main experiments were done in mouse embryos.
- They didn't propose a good model to explain how the contraction force is generated by F-actin depolymerization.
- Whether the mechanism is the same in four-cell or eight-cell embryos is unclear.

Thank you