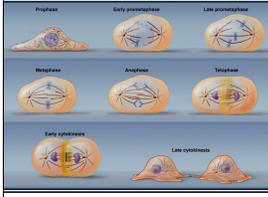


The Mitotic Spindle forms to separate the duplicated chromosomes and centrosomes

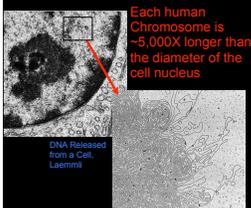


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**Problems faced by the mitotic spindle in segregating the chromosomes**

- Eukaryotic cells contain a large amount of DNA:  $10^7 - 10^9$  base pairs, which corresponds to polymers that are millimeters-to-meters in length, while the cell is 1000s of times smaller
- Chromosomes must be segregated accurately, because the loss of even one will mean the loss of many genes, which is usually lethal

**Eukaryotic cells contain a large amount of DNA**



**Solutions to having so much DNA**

- Package the DNA in pieces, so no one is too big
- Replicate all the DNA before starting to segregate it
- Keep sister chromatids coupled until it is time for division, so good order can be maintained
- Condense the length of each chromosome by many fold before beginning division
- Develop a special machine that can do the segregation job right.

**The DNA is replicated in the S-phase of every cell cycle**

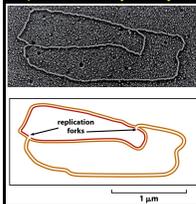


Figure 5-16 Molecular Biology of the Cell (© Garland Science 2008)

**How newly made sister chromatids are held together**



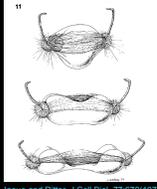
Copies of the cohesin complex assemble to link sister chromatids into one mechanical unit

Pollard et al. 2<sup>nd</sup> ed.





Diagram of the Barbulanympha spindle; it is cytoplasmic while the chromosomes are nuclear!



Inoue and Ritter, J Cell Biol. 77:670(1978)

How does one understand and deal with this kind of variability in form and function?  
Look for features that are consistent.

- All spindles use microtubules as their major fibrous component.
- All spindles are organized with microtubule plus ends projecting out from the spindle poles, forming a structure that is essentially two-fold symmetric, anticipating its action on the chromosomes during anaphase.

How does one understand and deal with this kind of variability in form and function?  
Look for features that are consistent.

- All mitotic chromosomes have attachment sites for microtubules.
- Anaphase always includes the separation of sister chromatids, followed by their motion in opposite directions

In the next lecture, we'll look inside the cell to try to understand how this remarkable machinery works