3d molecular designs
Transforming Science Learning

Chromosomes in Action: New Ways to Model Mitosis and Meiosis

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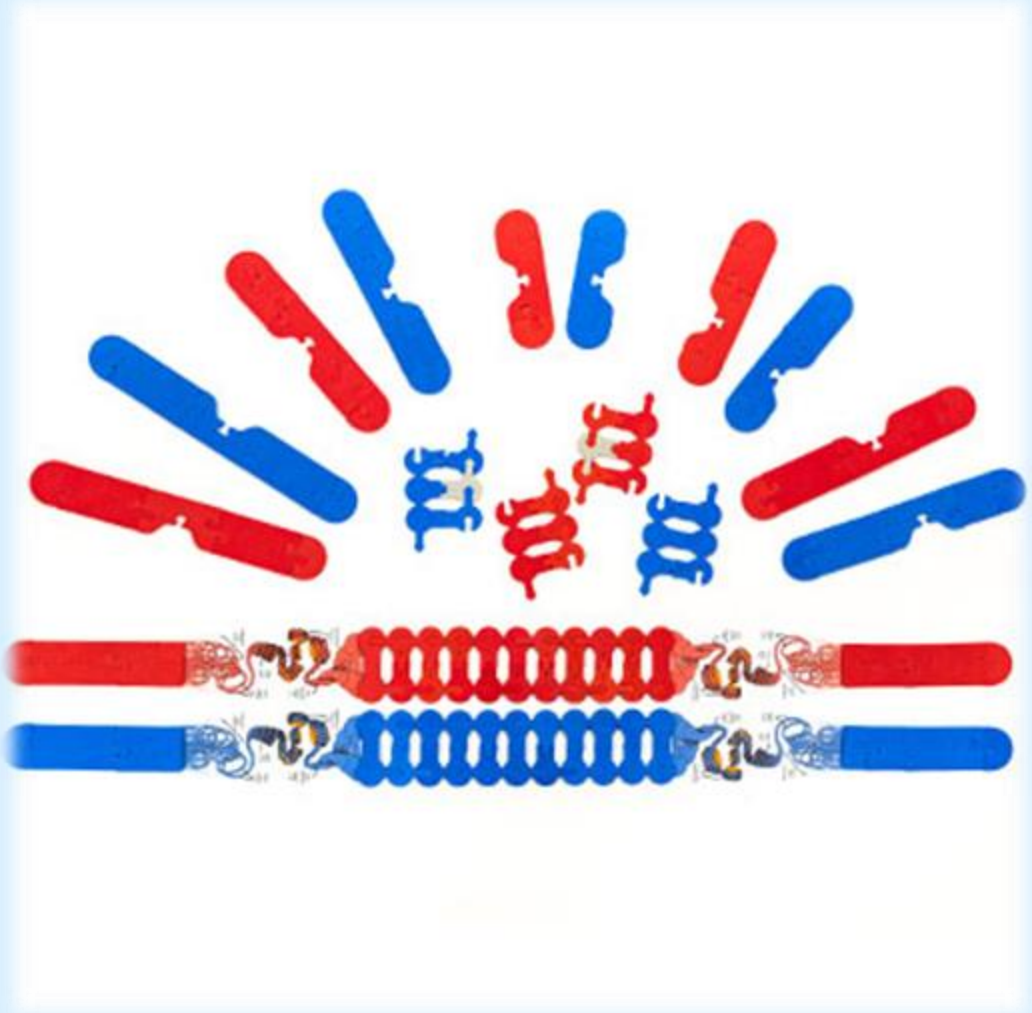
OSTA 2023

3d molecular designs

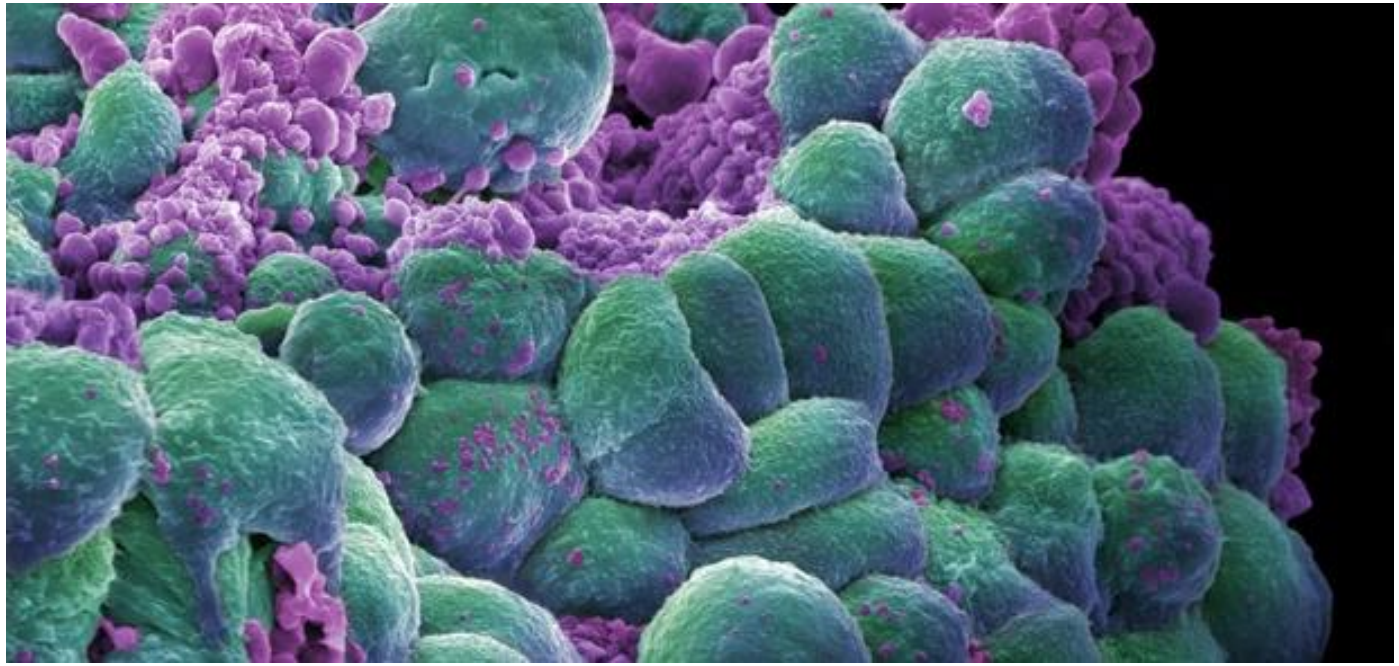
Transforming Science Learning



Workshop Outcomes

- Use a model to illustrate the role of mitosis and differentiation in producing and maintaining complex organisms.
- Explain how mitosis alternates with interphase in the cell cycle.
- Make and defend a claim based on evidence that genetic variations result from a variety of factors
- Demonstrate what processes in meiosis increase gamete diversity.

Why do cells divide without stopping?

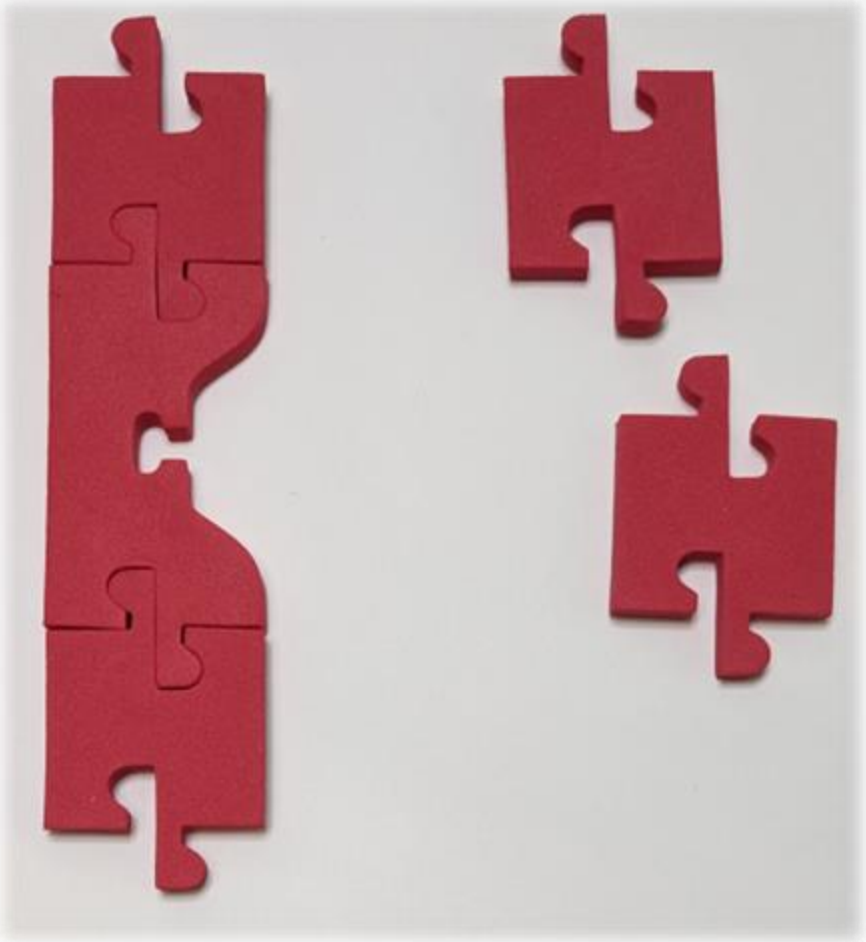


Breast cancer cells. Image credit: Annie Cavanagh (CC BY-NC 4.0

Construct a chromosome

- **Start with one centromere**
- Add 3 to 4 chromosome connectors to each side of the centromere
- Add a cap piece to each end of the chromatid.

Construct a chromosome



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Construct a chromosome

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- Add 3 to 4 chromosome connectors to each side of the centromere
- **Add a cap piece to each end of the chromatid.**

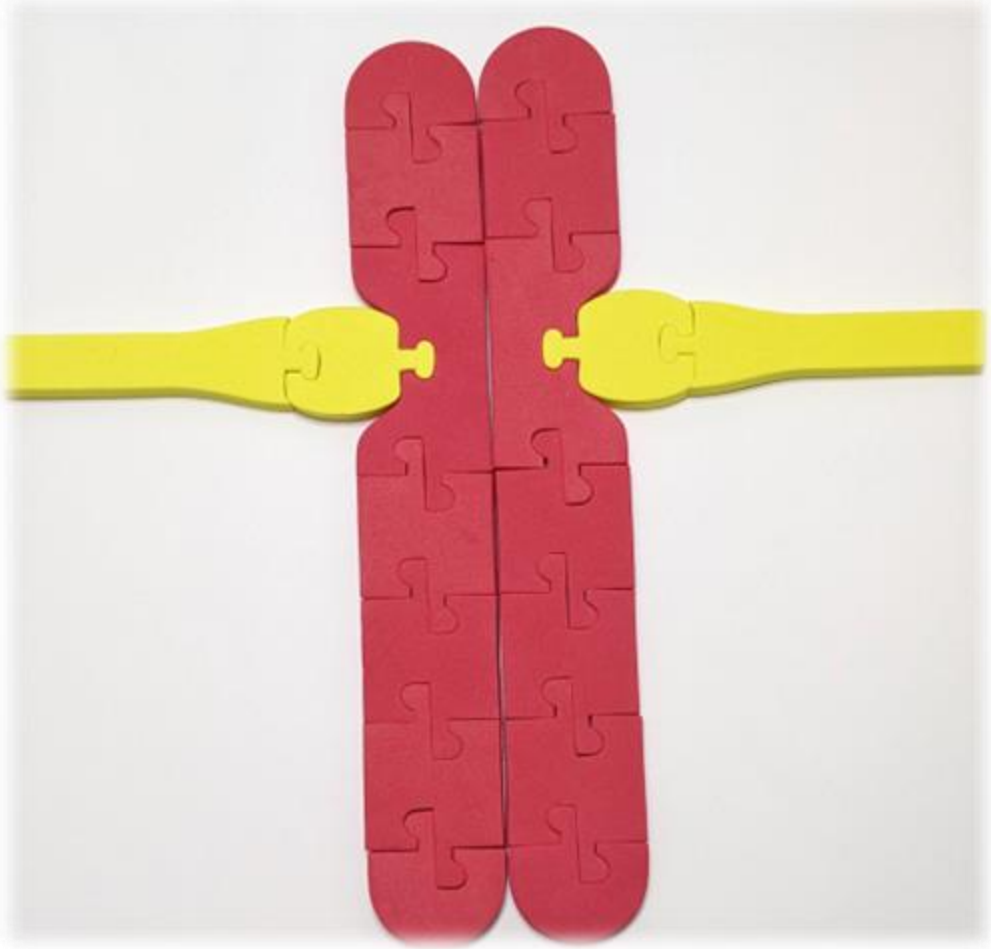
Create a sister chromatid

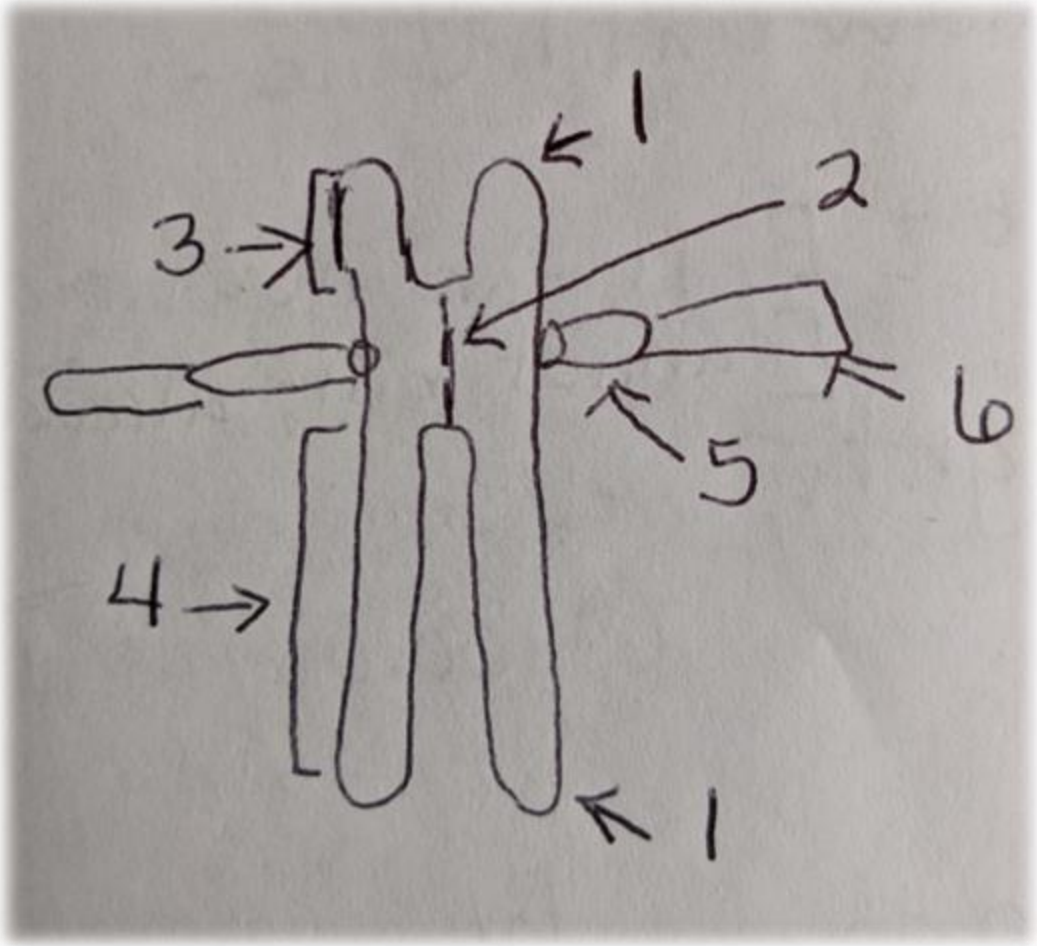
- Create a duplicate copy of the chromosome to make a sister chromatid.

Create a sister chromatid

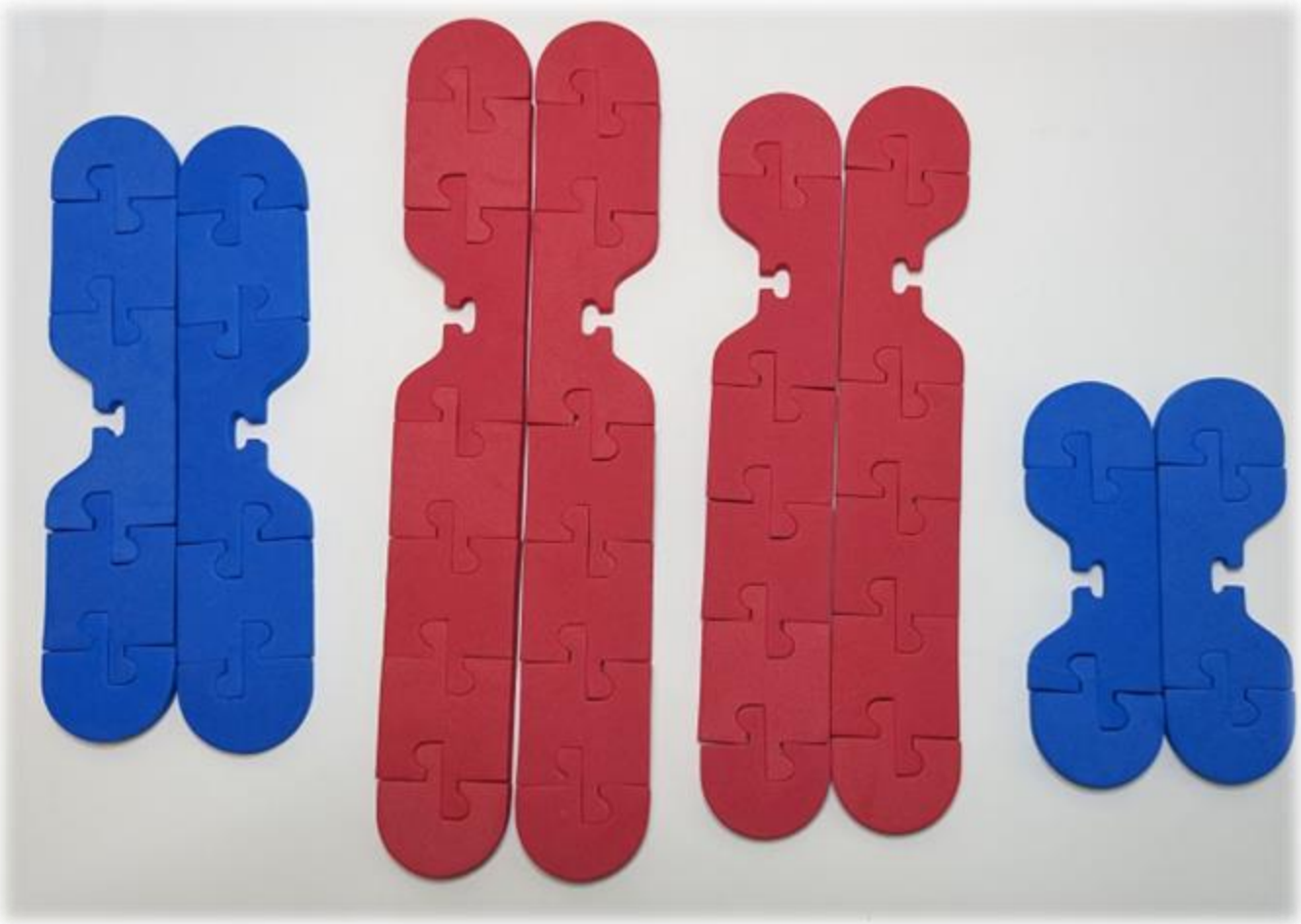
- Create a duplicate copy of the chromosome to make a sister chromatid.

Label the parts to create a shared vocabulary

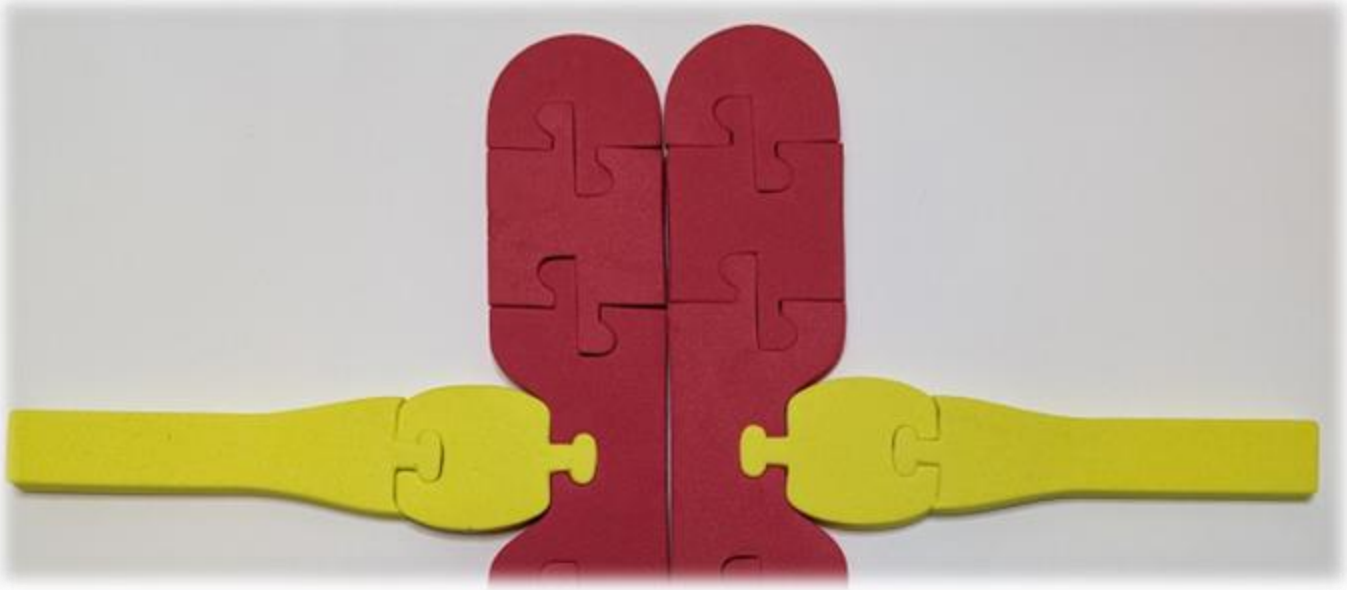


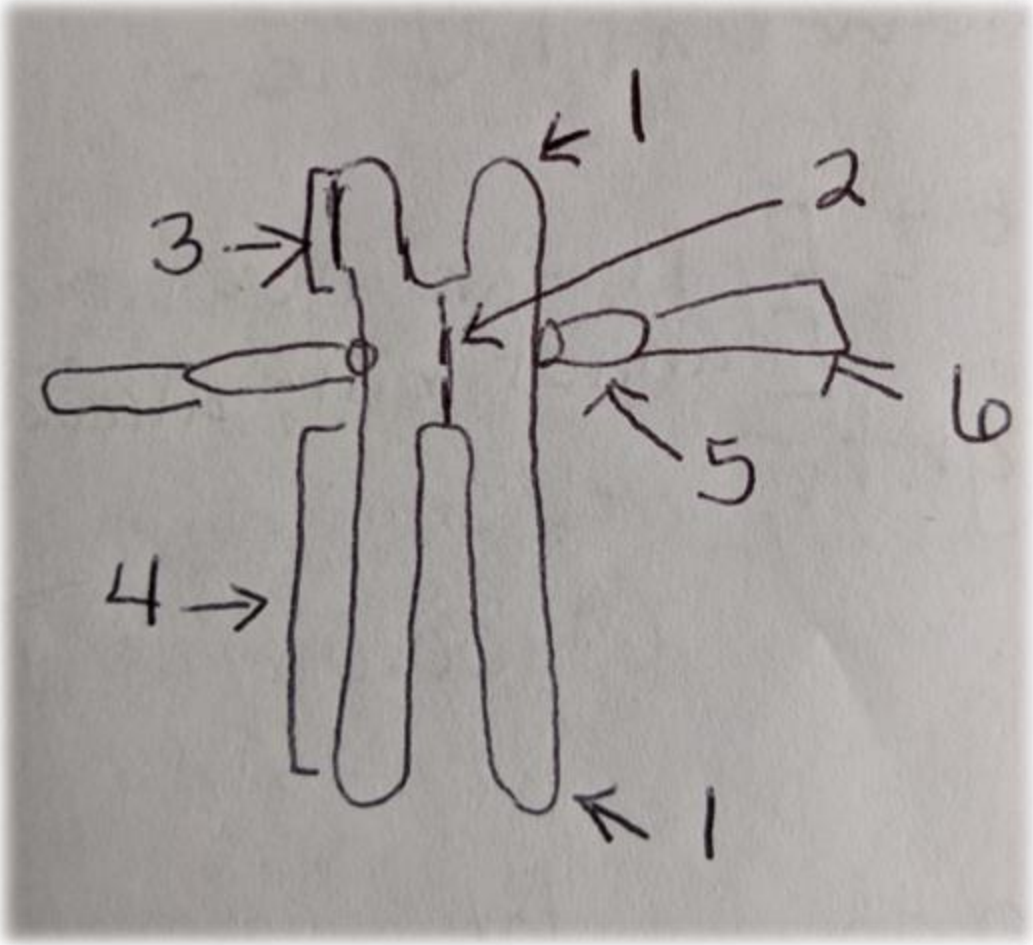


Let’s compare chromosome structure and classification

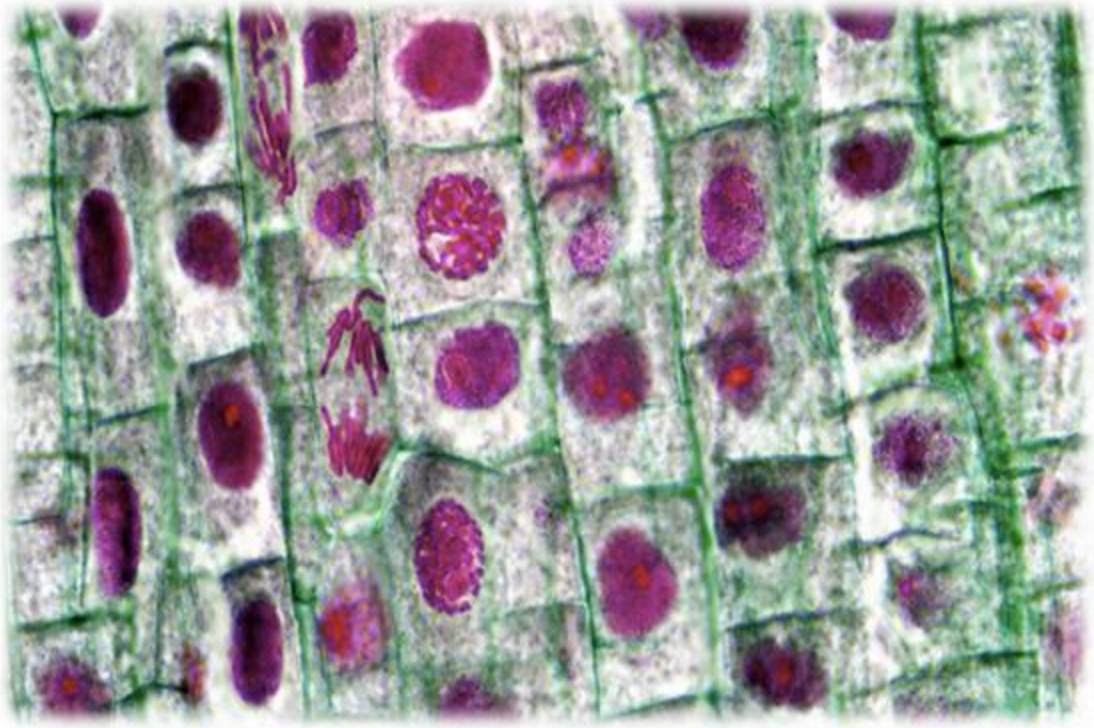


A closer look at the spindle apparatus

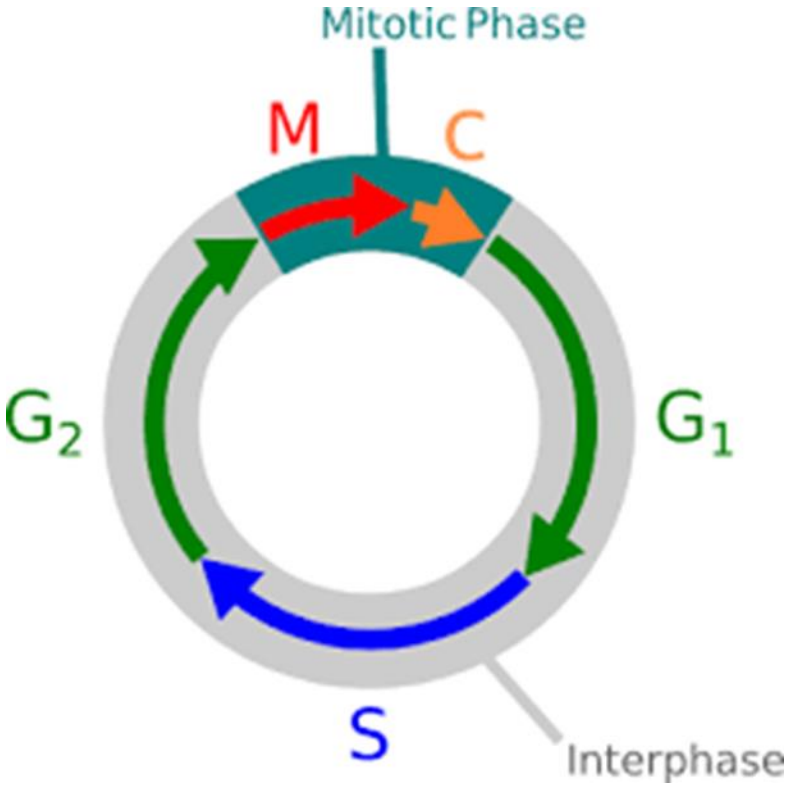




Onion Root Tip Lab



Berkshire Community College Bioscience Image *Library (2014)*



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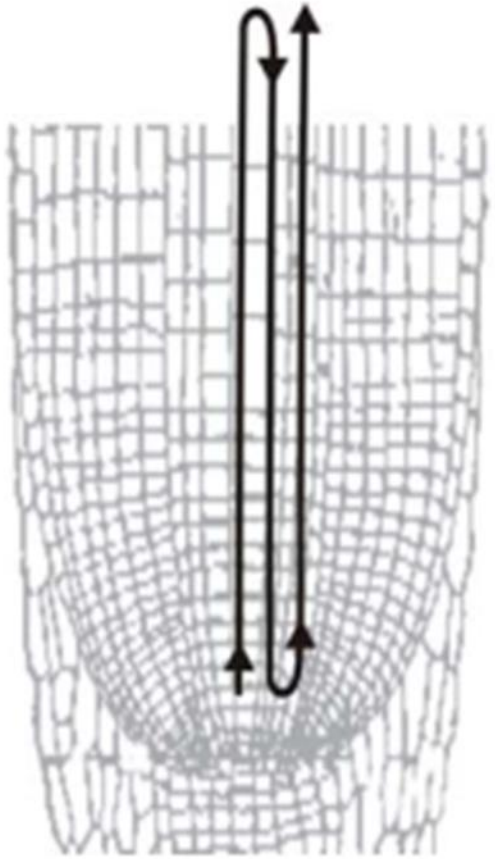
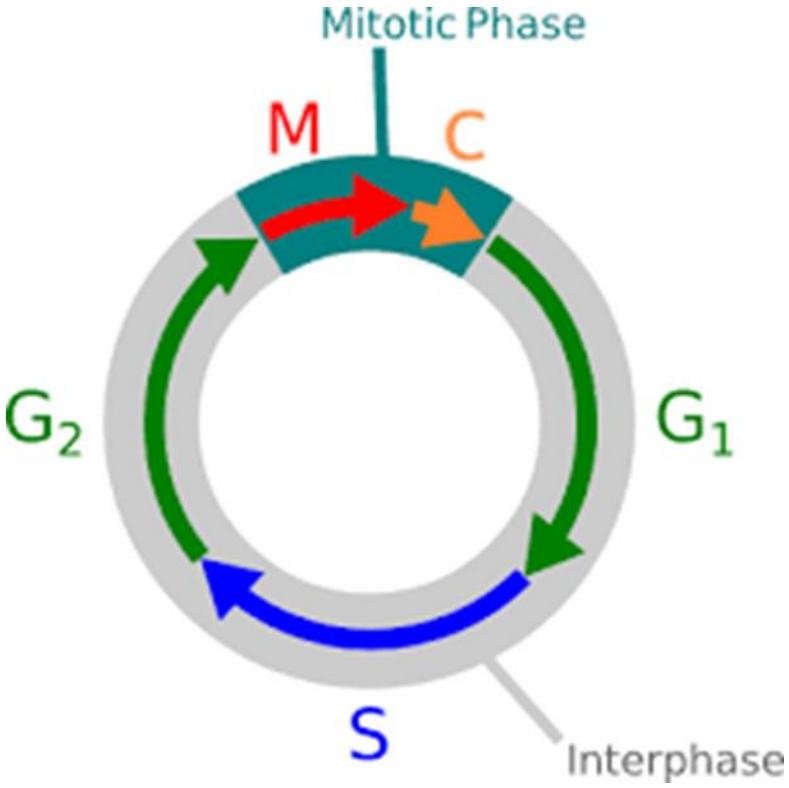
Onion Root Tip Lab





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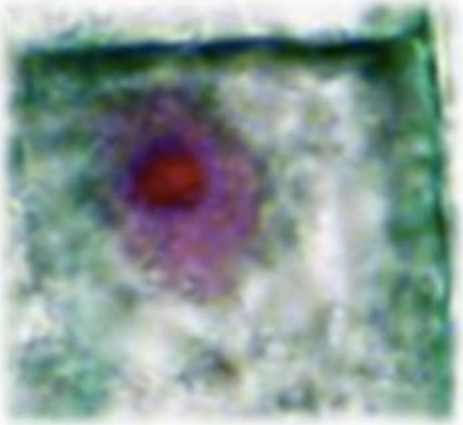
Use an inverted S pattern to count cells

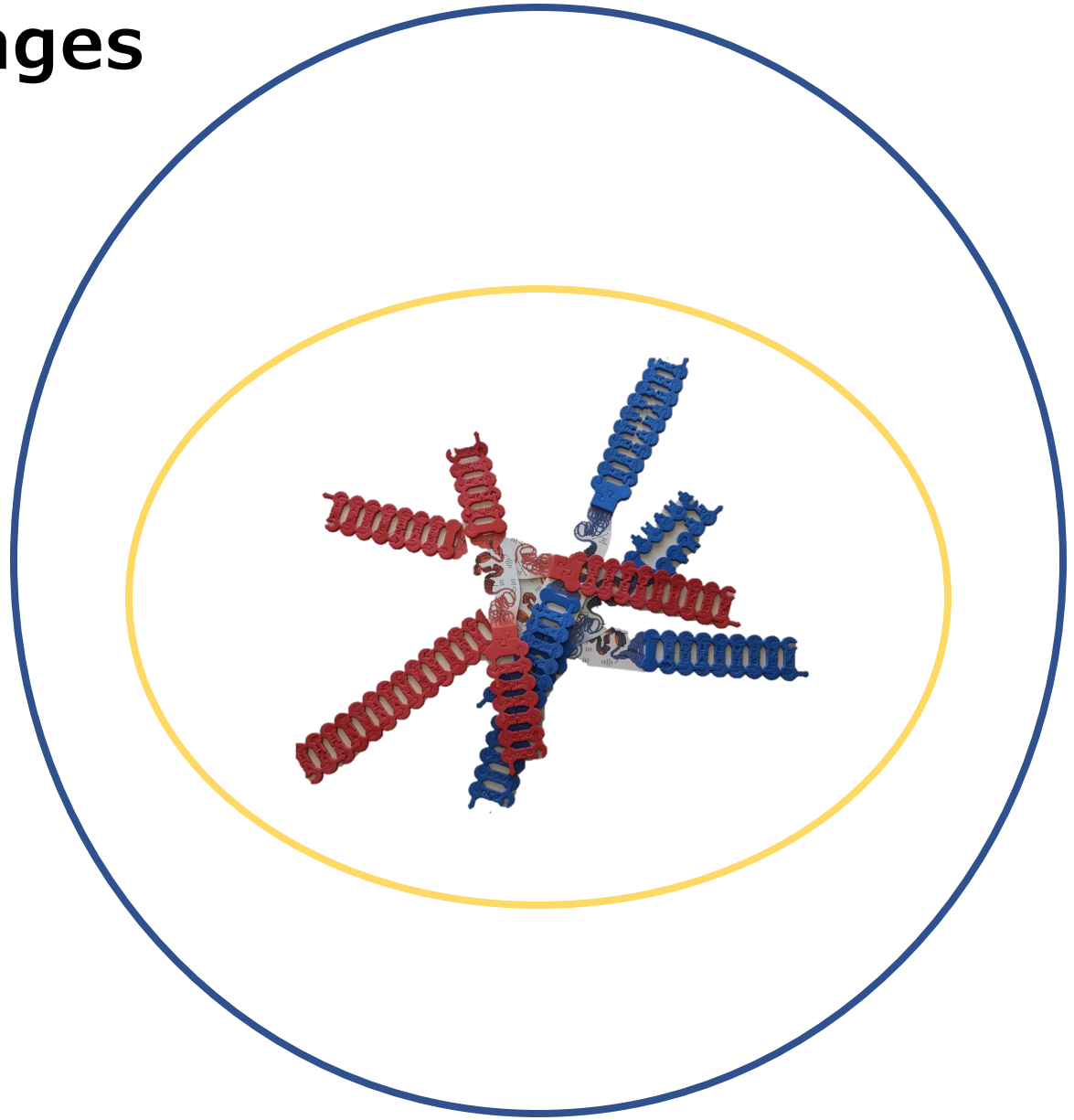
Onion Root Tip Lab

	Interphase	Prophase/ Prometaphase	Metaphase	Anaphase	Telophase	Total
Number of cells						100
Proportion in each phase						1
Approximate Timing						24 hours

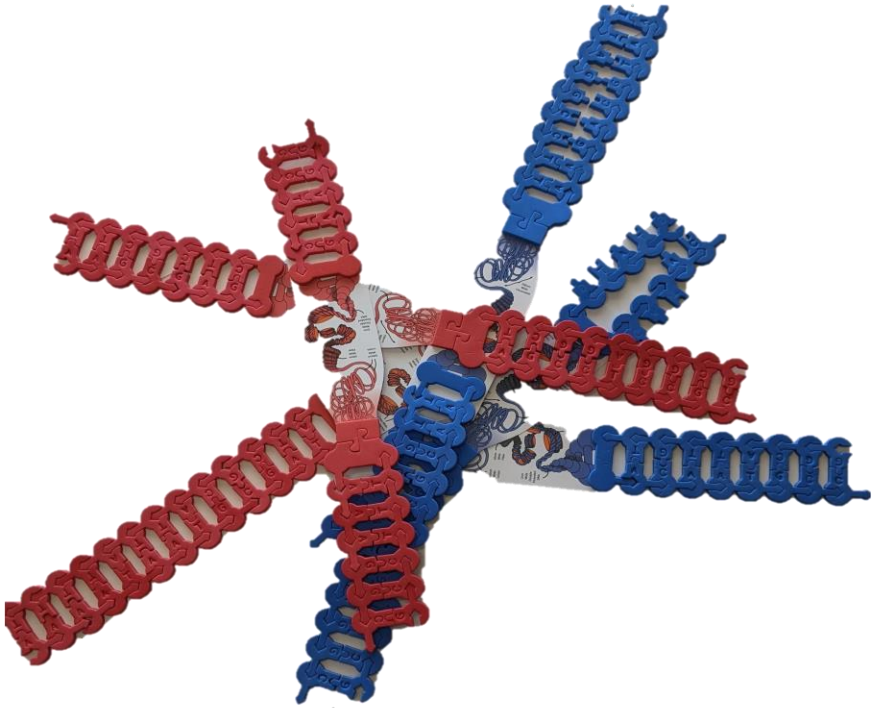
Data table for cell counts for student or professionally prepared slide

Modeling Allium lab images





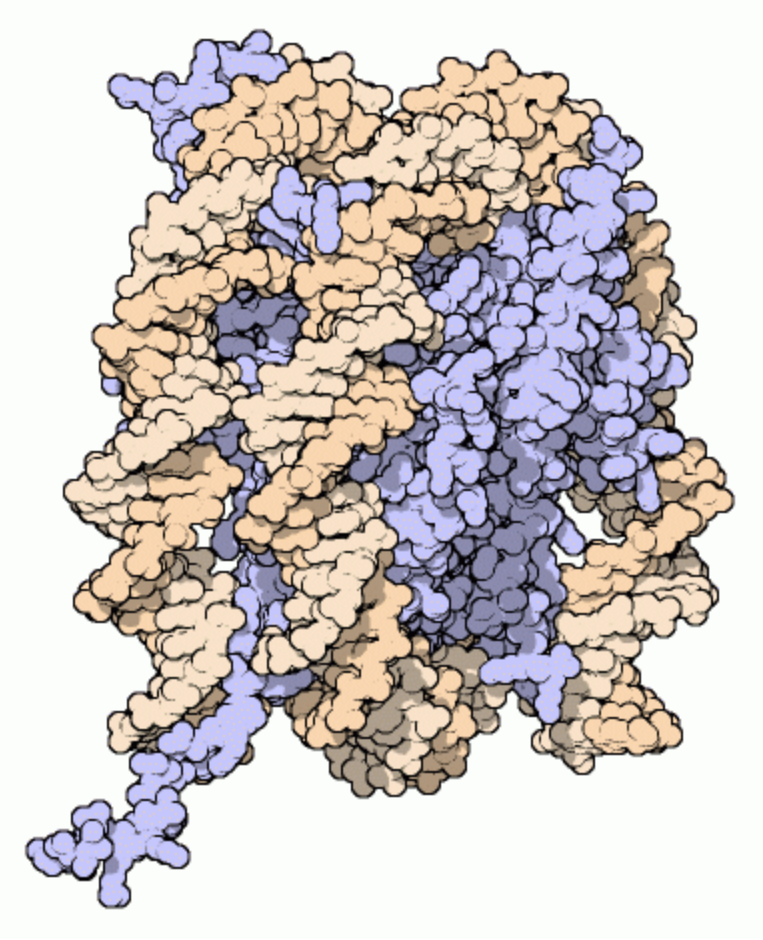
A closer look at the Cell Cycle: Modeling Interphase



What are the key highlights in this phase that students need to understand?

What structures to students need to understand so they can understand cell processes in the future?

A closer look at the nucleosome



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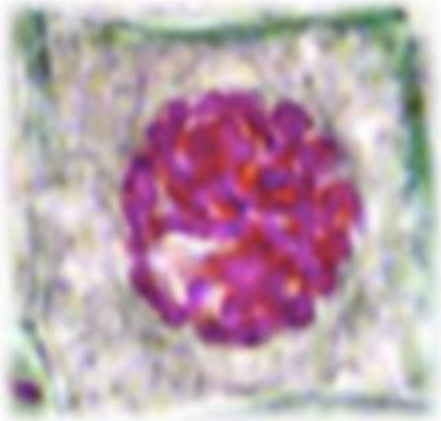
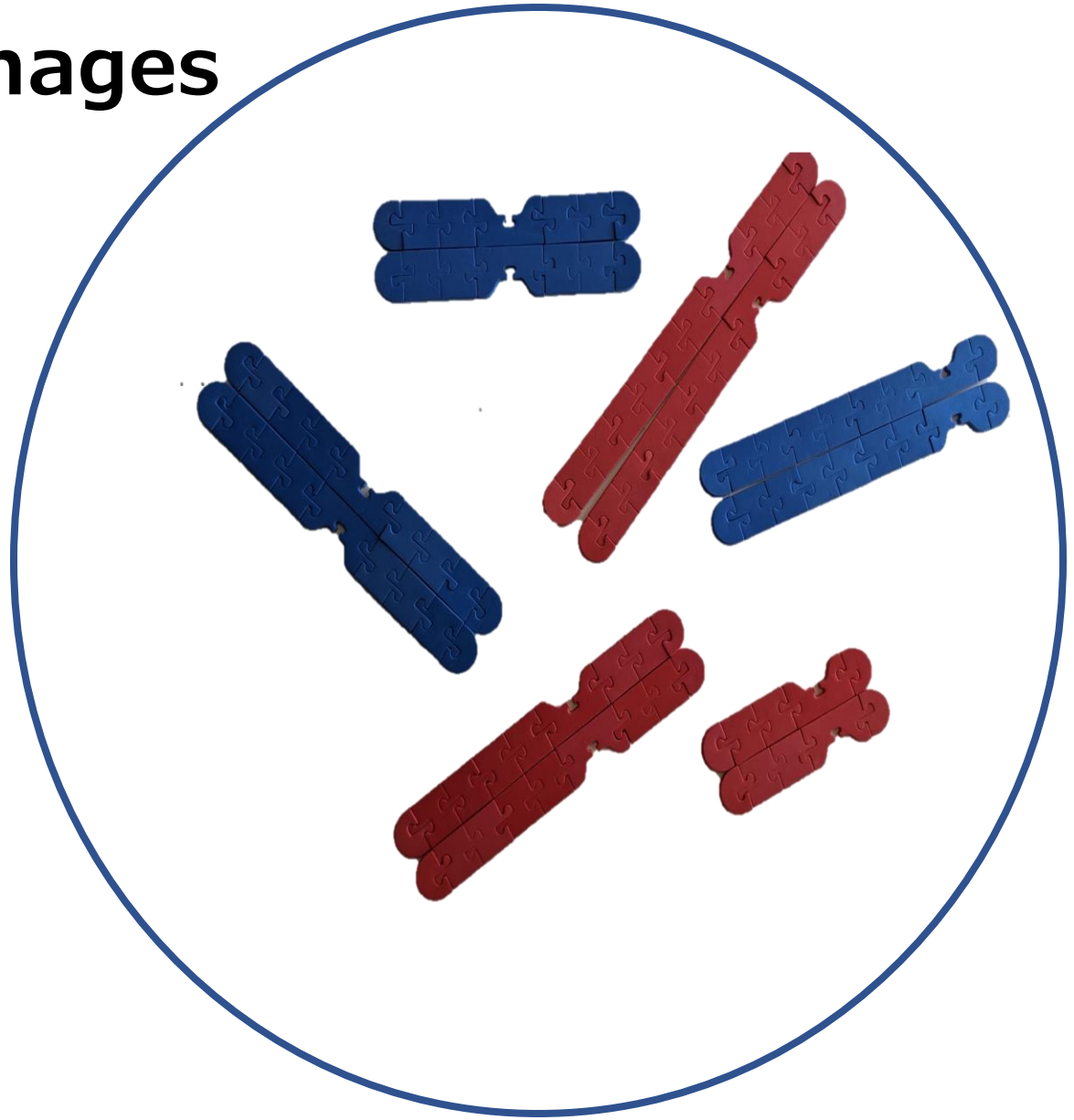
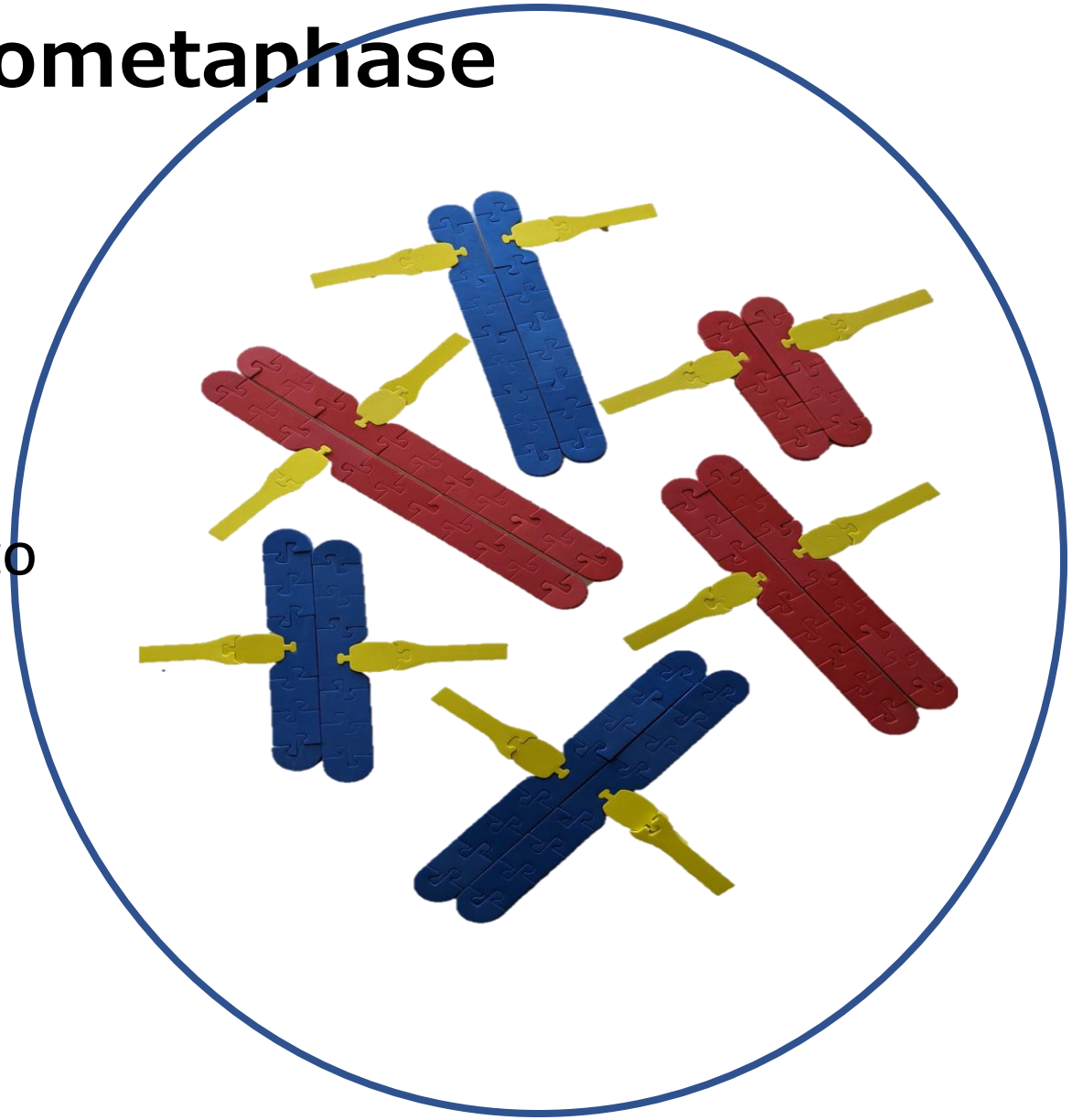




Cell Cycle: Modeling Prometaphase

What are the key highlights in this phase that students need to understand?

What structures to students need to understand so they can understand cell processes in the future?



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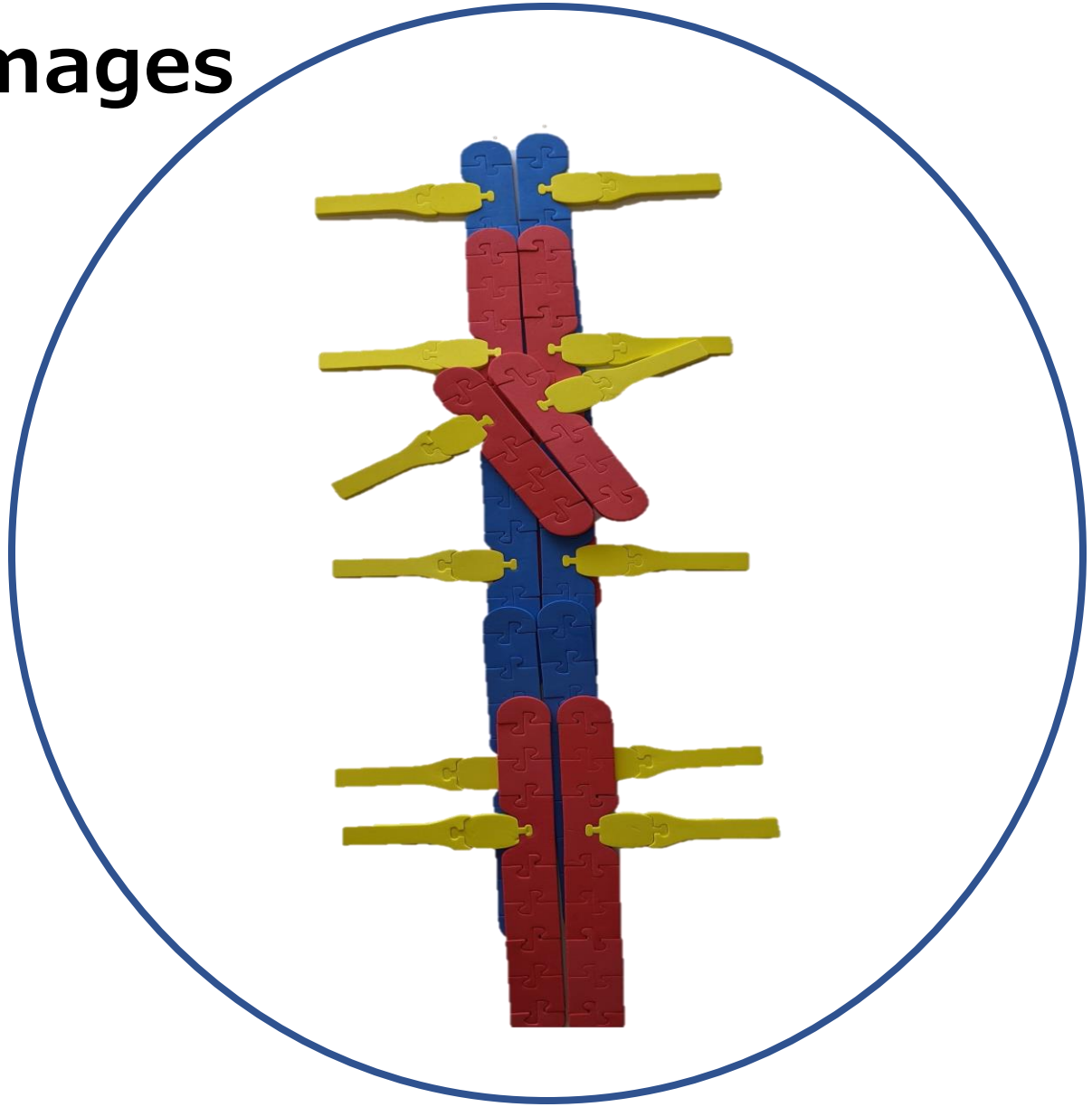

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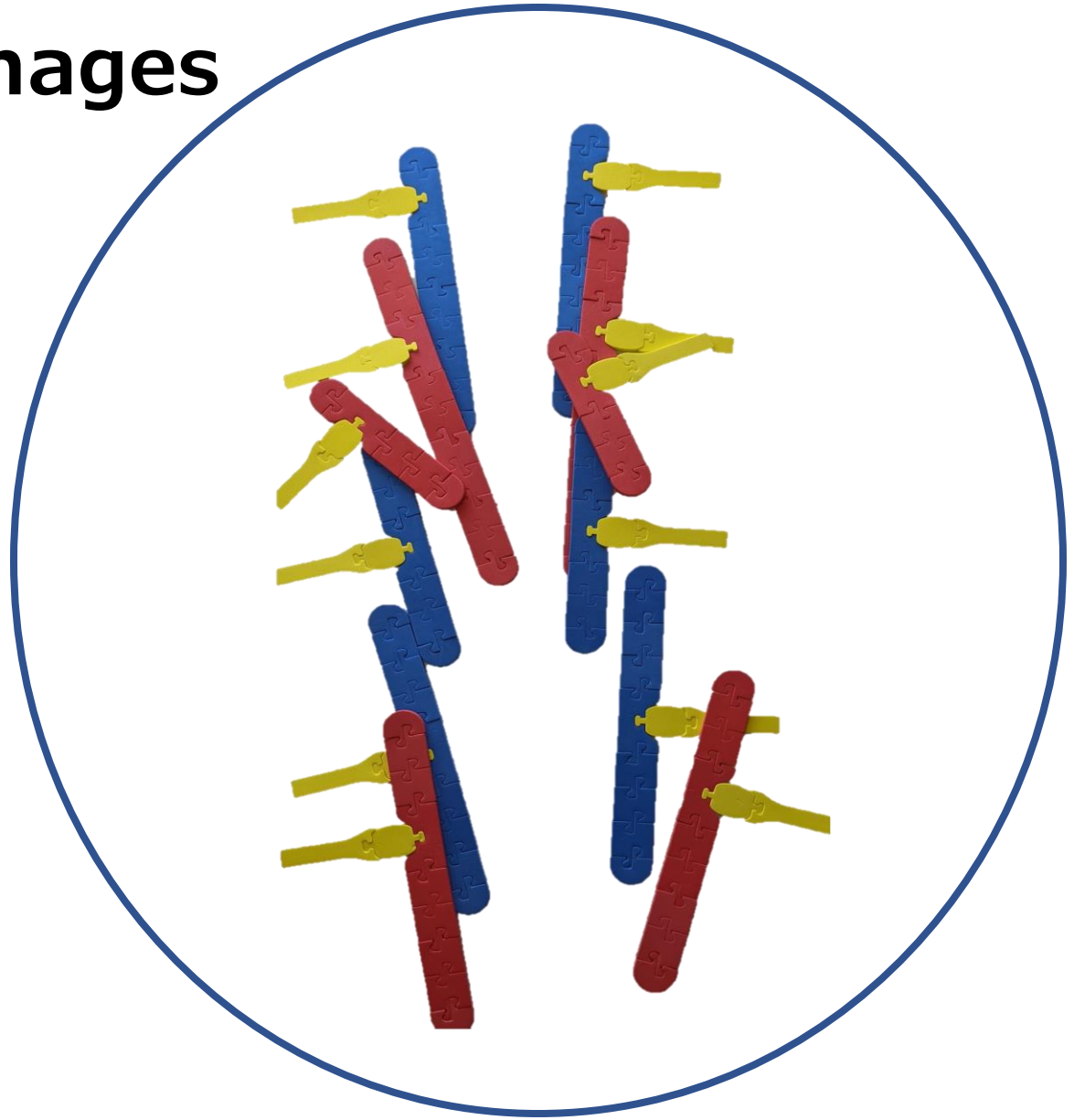
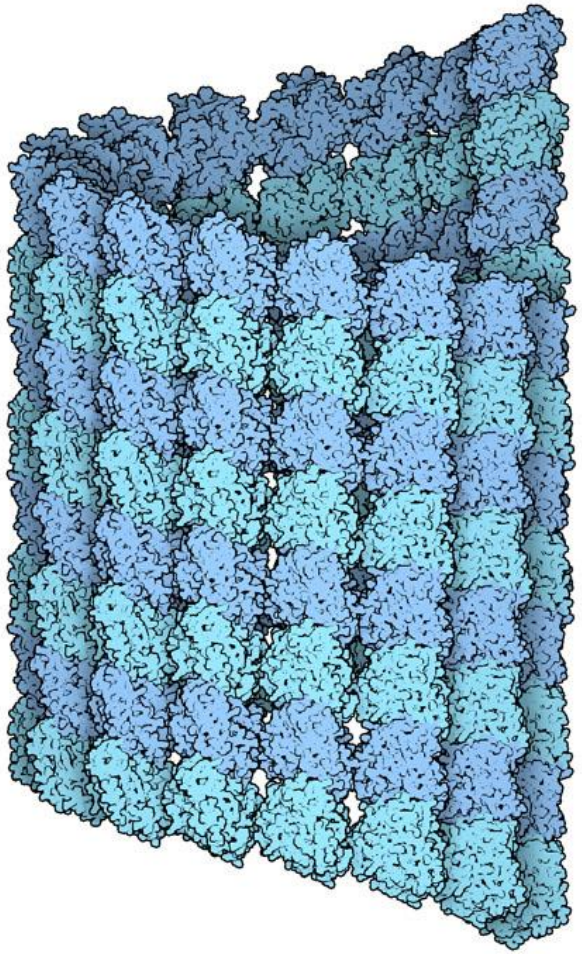
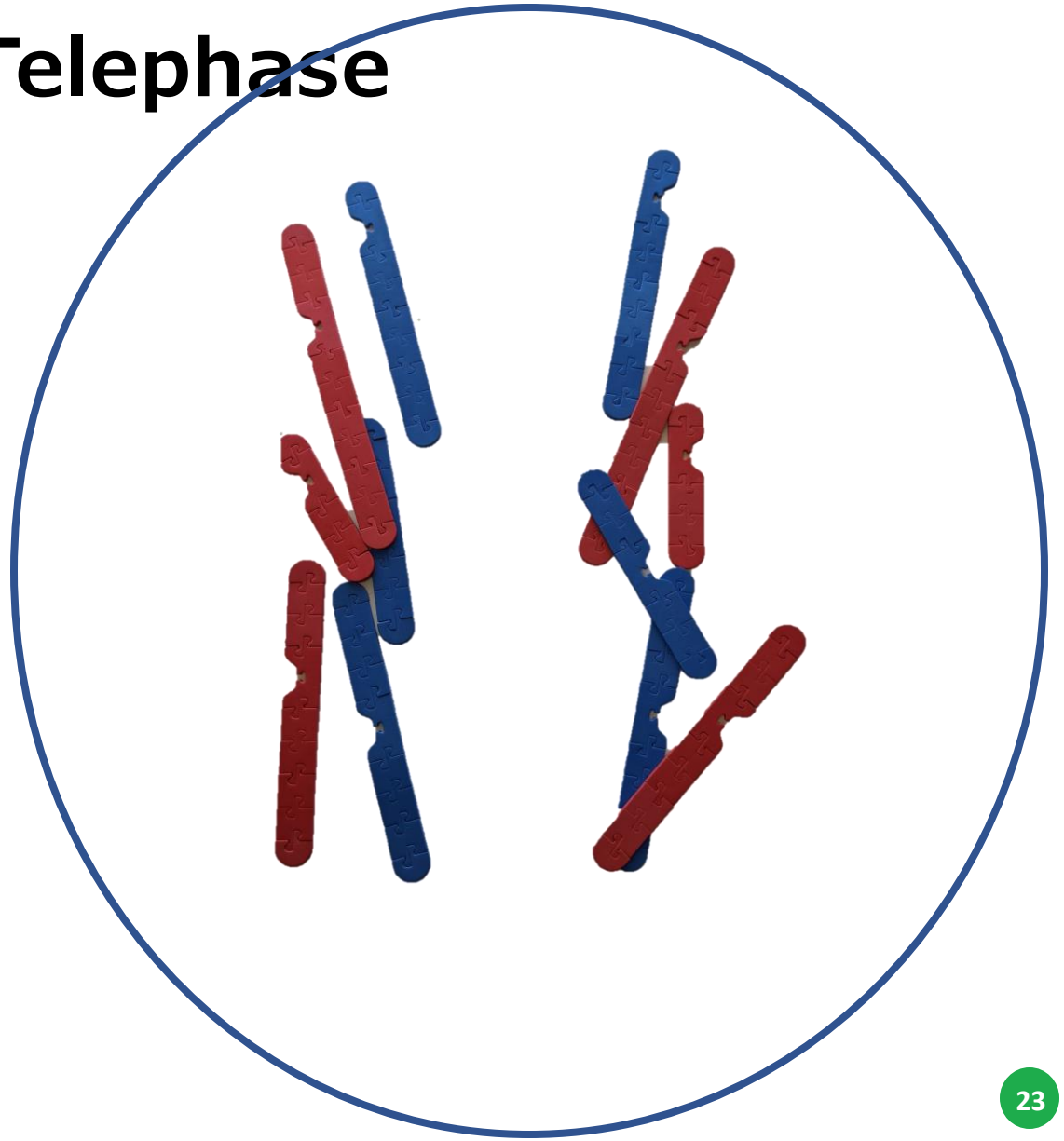
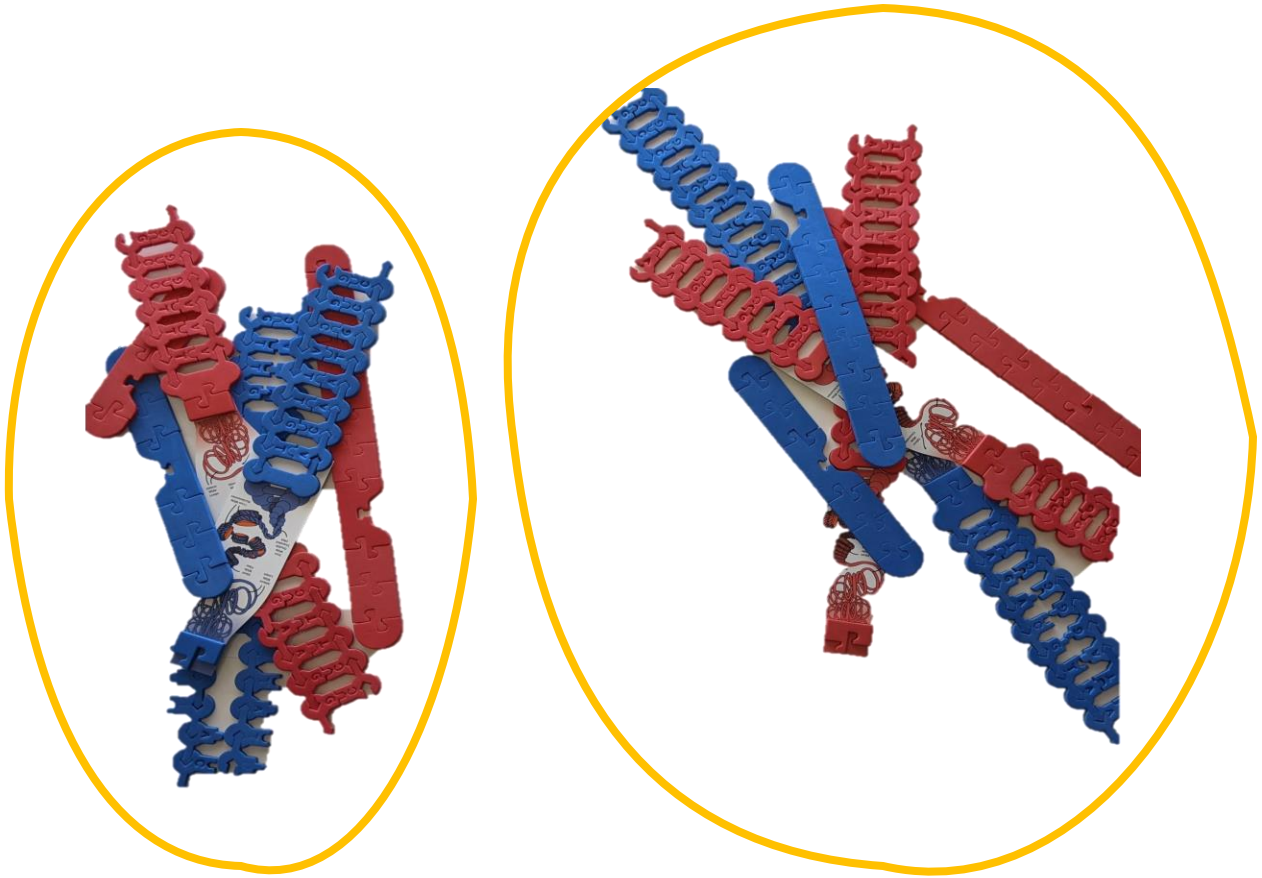


Cell Cycle: Modeling Early Telephase





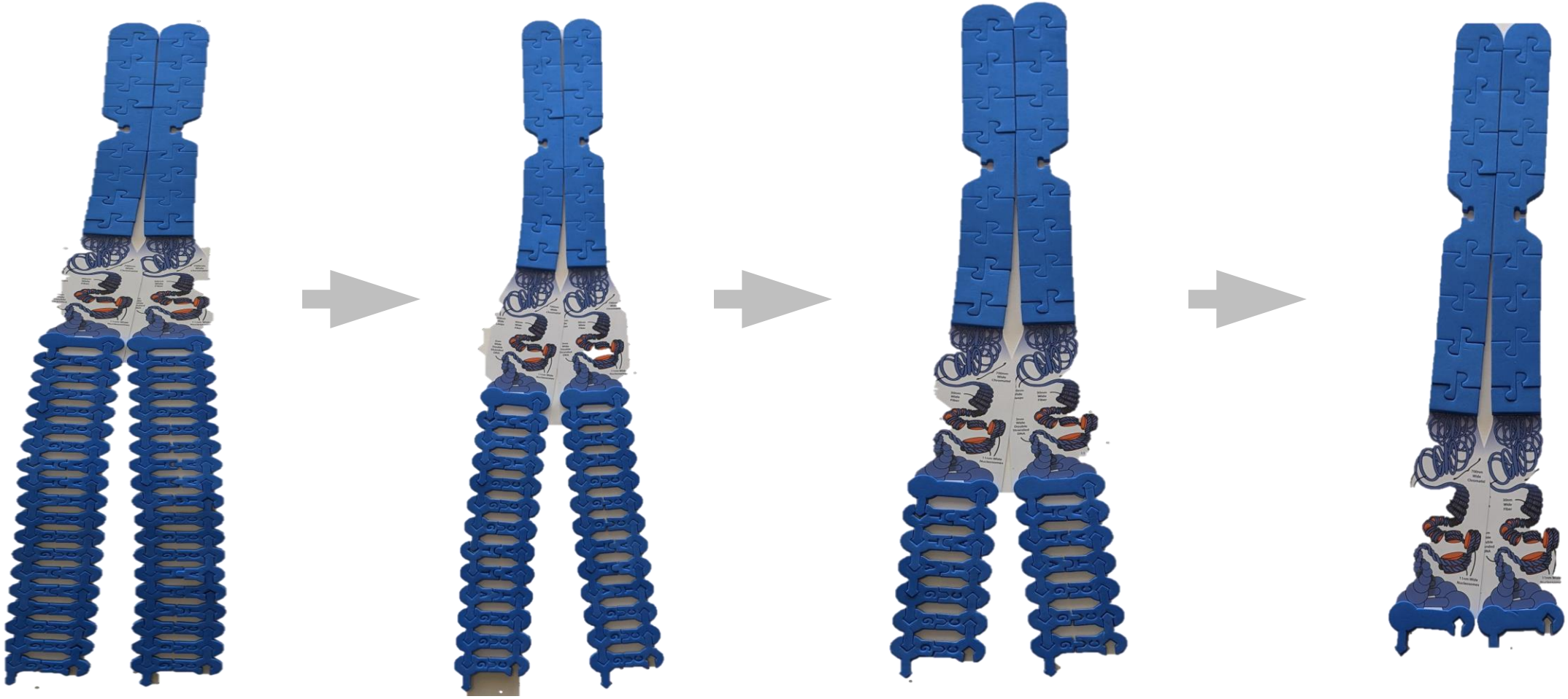
Cell Cycle: Modeling Late Telephase



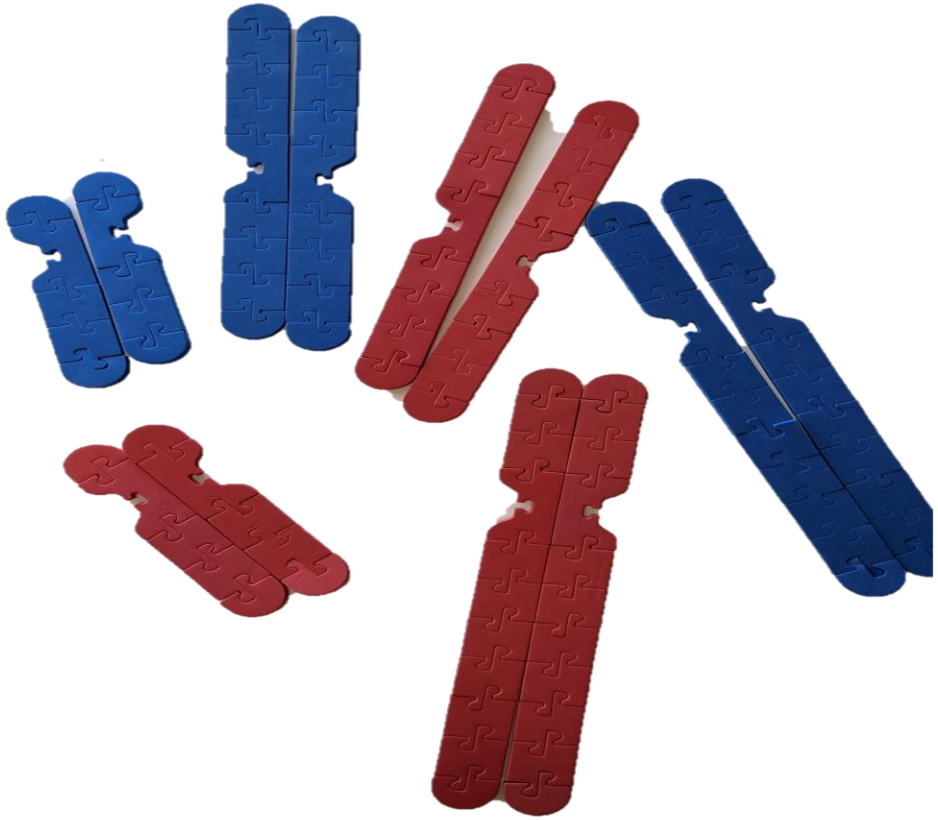
What extensions or phenomenon might help student be interested in this cell process?

A closer look at the telomere

A closer look at the telomere



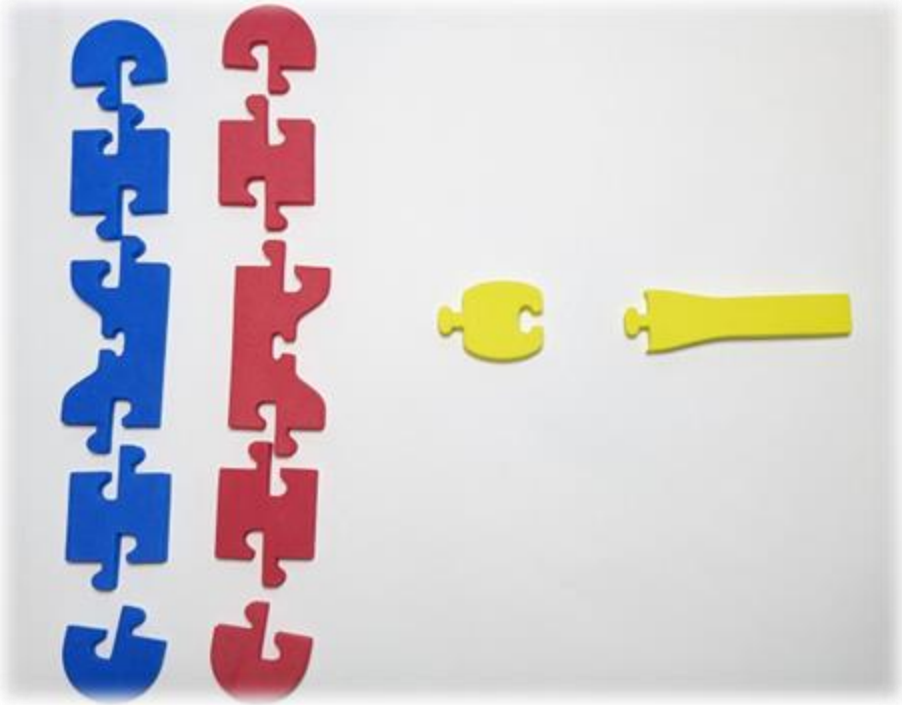
Cell Cycle: Modeling Meiosis



Why do I look different than my siblings?

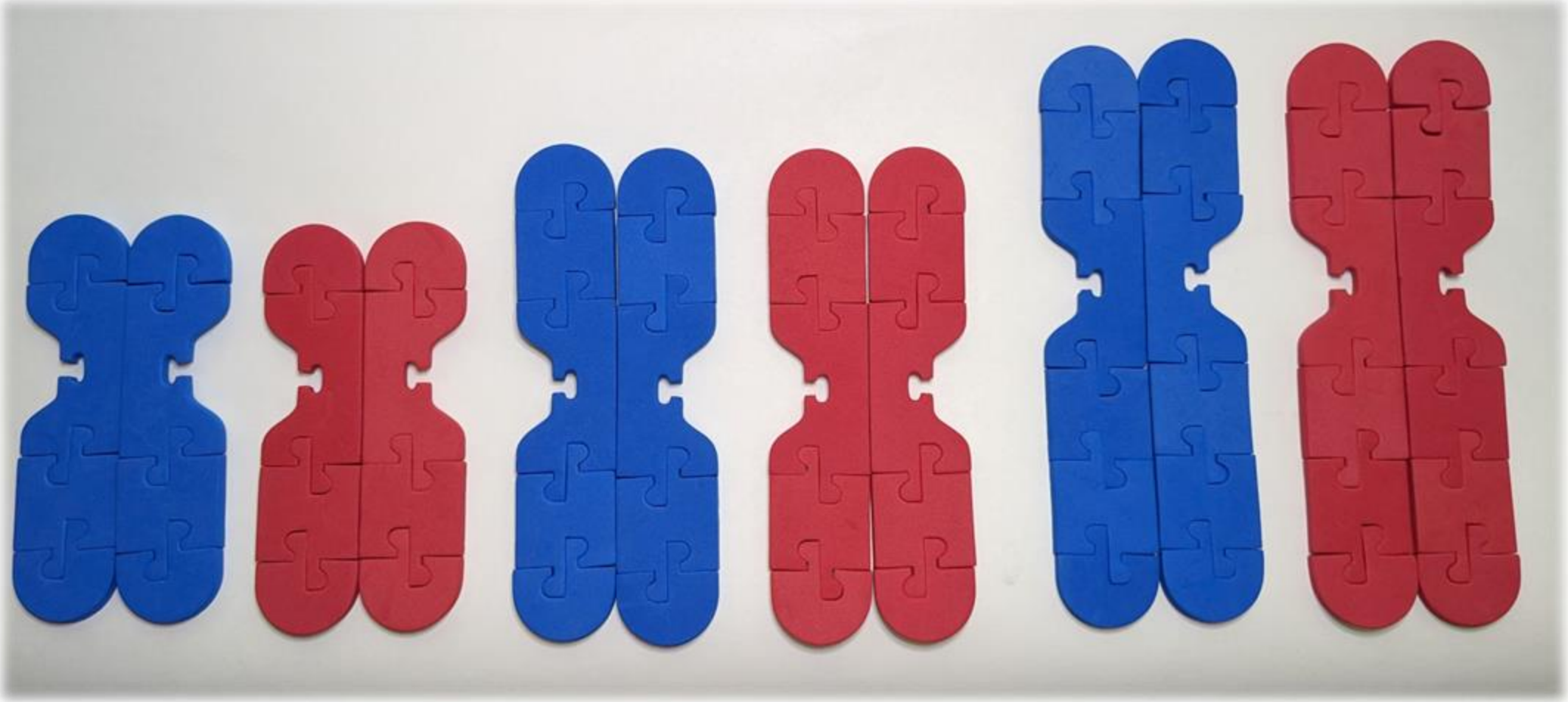
Why do siblings in a litter look differently?

Suggested Chromosome Assembly

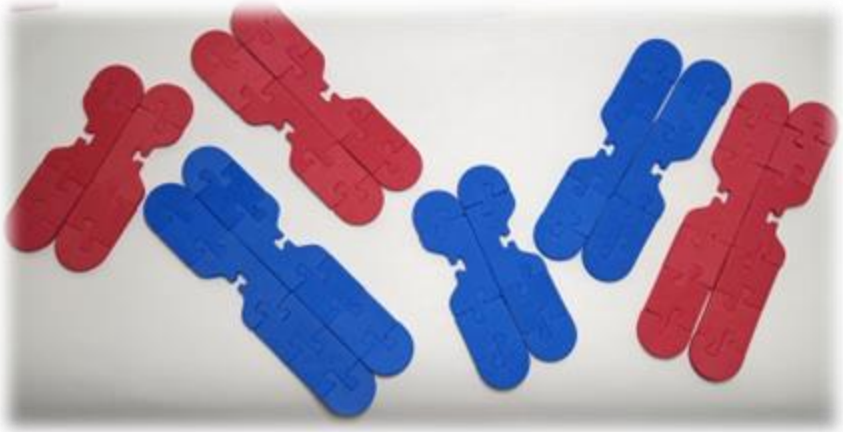


Chromosome Size	Part	Egg donating parent chromosome (Red Foam)	Sperm donating parent chromosome (Blue Foam)
Short chromosome (Acrocentric)	p arm linkers	0	0
	q arm linkers	1	1
Medium Chromosome (Metacentric)	p arm linkers	1	1
	q arm linkers	1	1
Long Chromosome (Submetacentric)	p arm linkers	1	1
	q arm linkers	2	2

Create a duplicate copy to make a sister chromatid



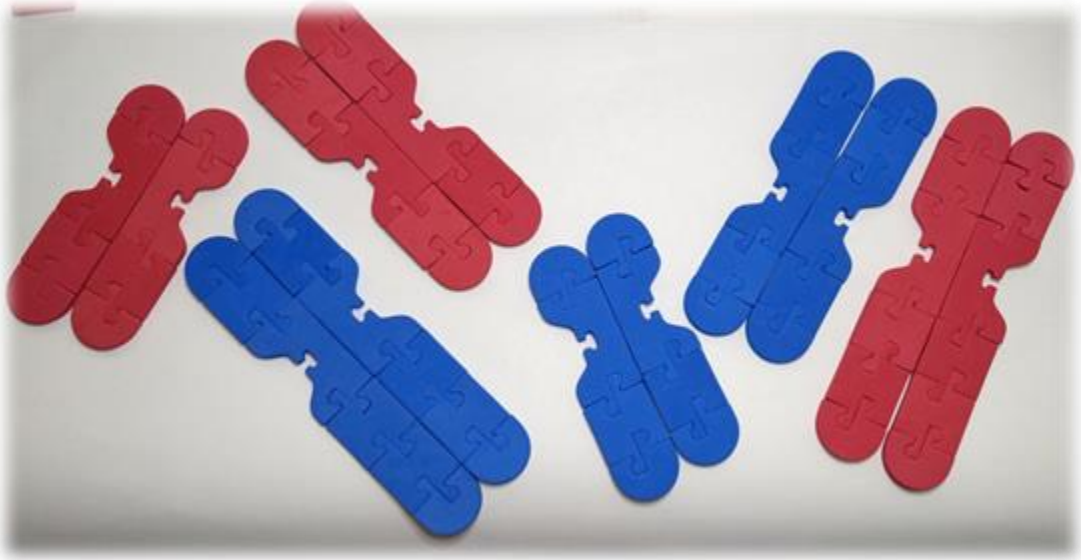
What happens during meiosis?



What occurs next so the end result are four haploid cells?

How can your students model what happens when eggs are made?

Mechanisms that Contribute to Genetic Variation

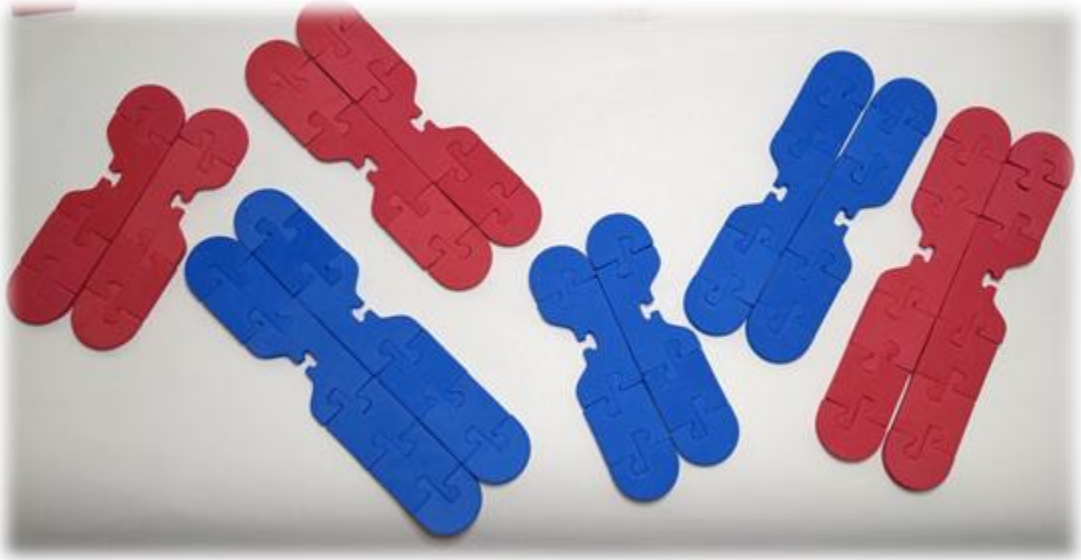


Diploid number of chromosomes:

Haploid number of chromosomes:

How many possibilities of chromosome combinations during meiosis?

Mechanisms that Contribute to Genetic Variation



Diploid number of chromosomes (2n): 6

Haploid number of chromosomes (n): 3

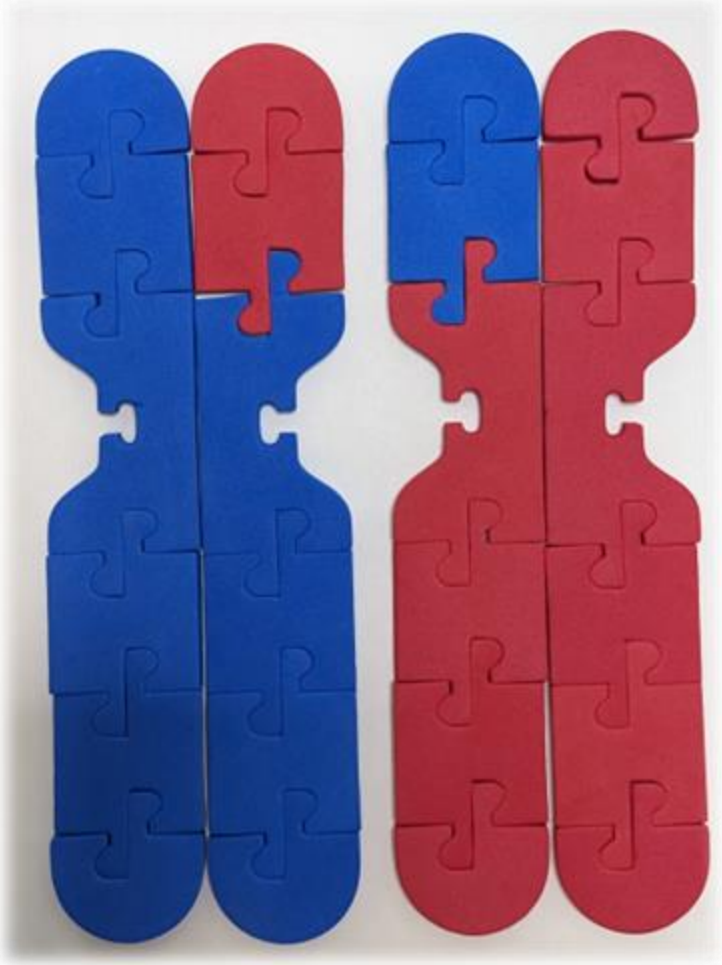
How many possible chromosome combinations during meiosis?
2^n or 8

How many possible combinations in humans?

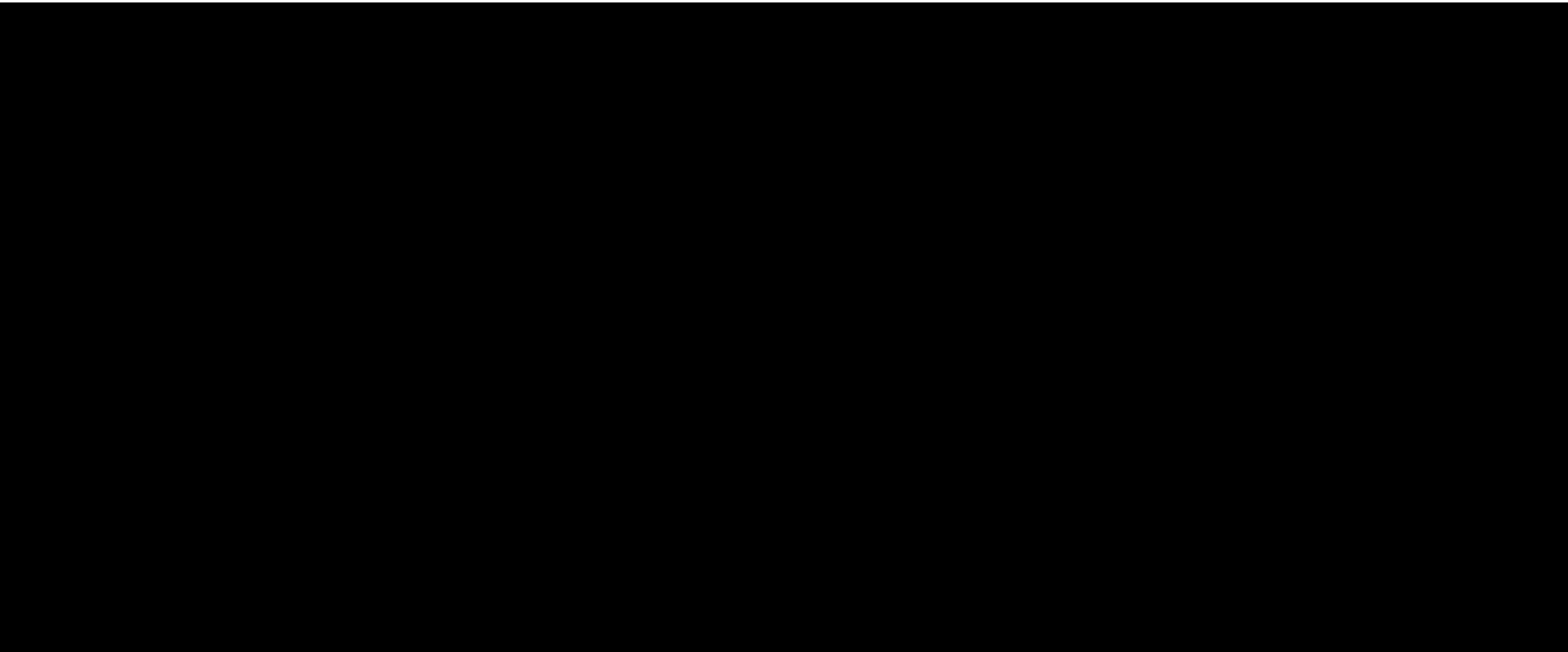
What happens during meiosis?

How do homologous chromosomes find each other?

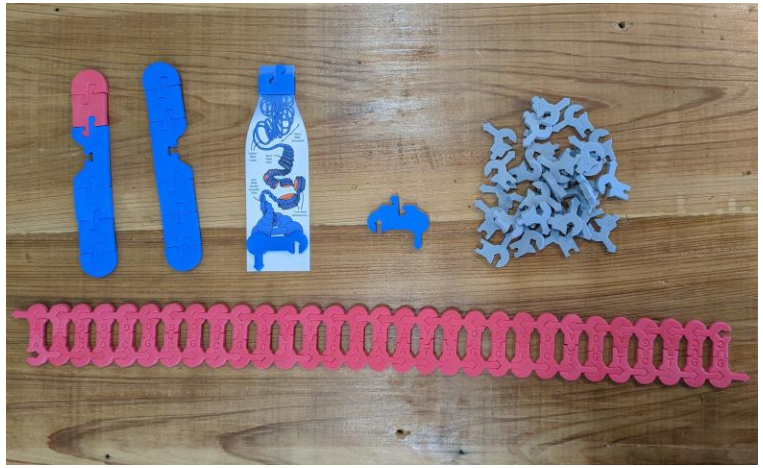
Crossing Over at the Microscopic Scale

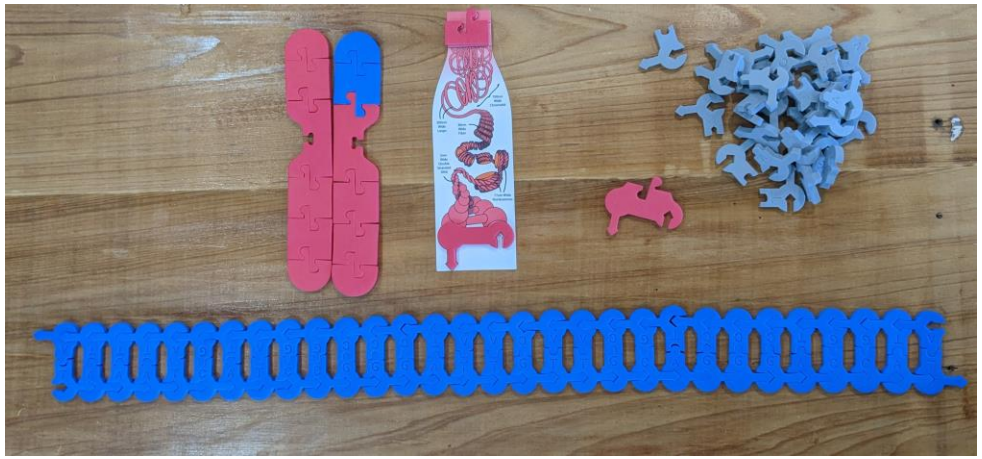


Crossing Over at the Microscopic Scale



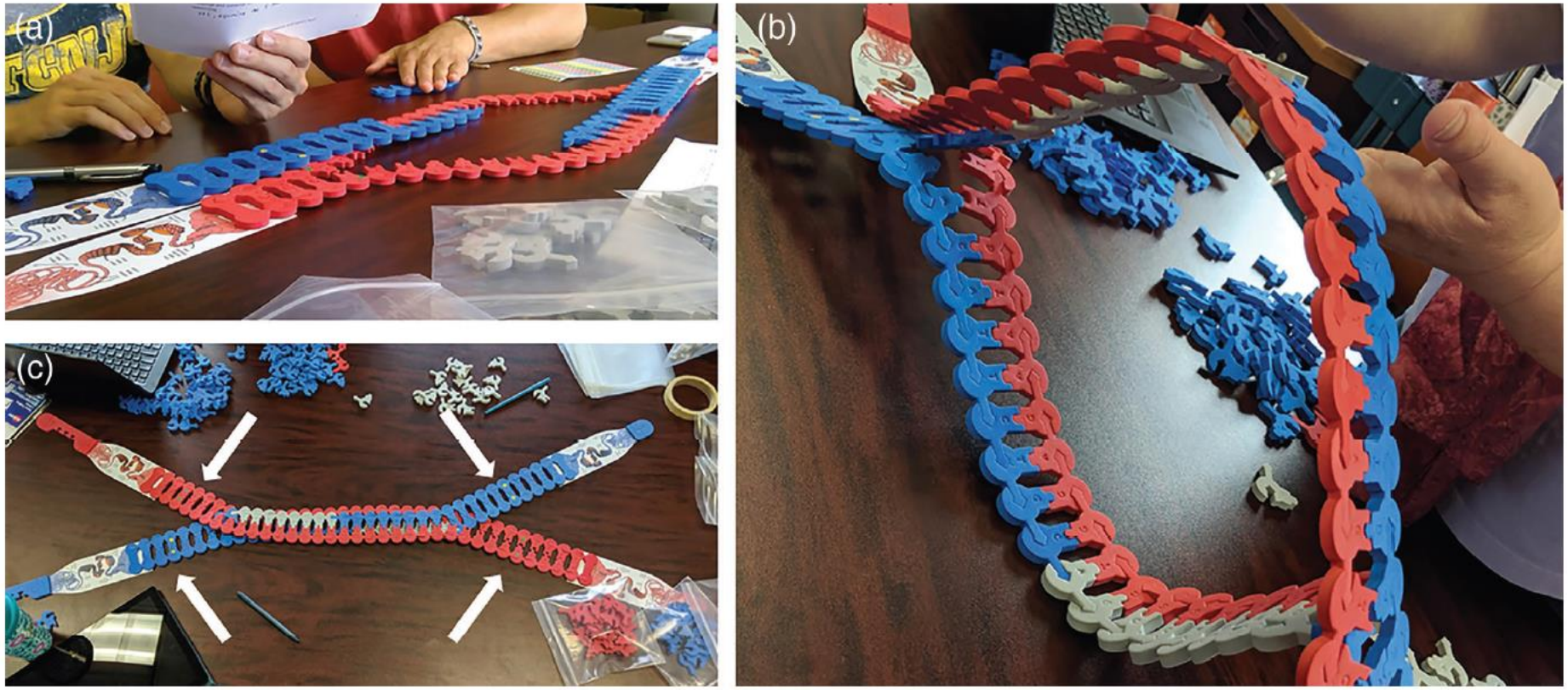
Crossing Over at the Molecular Scale





- Add a 4X scaling graphic to help students under the relationship between DNA and the chromosome.
- Helps students better understand scale and proportion.
- Can explore the Holliday junction

Crossing Over at the Molecular Scale



Wright, et al. 2022. Biochem Mol Biol Educ. 2022;50:44–54. https://doi.org/10.1002/bmb.21583

Crossing Over at the Molecular Scale

Workshop NGSS Connections

SEPs	CCCs	DCIs
Asking Questions and Defining Problems	Systems and System Models	HS-LS1-4
Developing and Using Models	Cause and Effect	HS-LS3-2
	Scale, Proportion, and Quantity	

We value your opinion! Let us know what you think.

Scan the QR Code and complete this short survey.

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