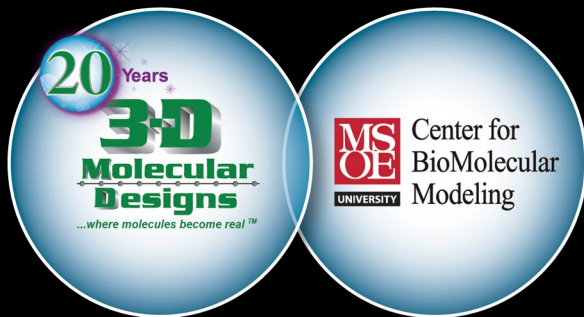


Chromosomes & DNA





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Wednesday, January 13, 2021



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Physical & Chemical Properties of Water

Wednesday, January 20, 2021



Watch webinar and explore related resources!

Transcription, Translation & Sickle Cell Anemia

Wednesday, January 27, 2021



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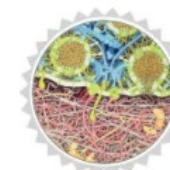
Neurotransmitters, Synapses & Acetylcholinesterase

Wednesday, February 10, 2021



Watch webinar and explore related resources!

Certificate of Participation



Name

Participated in

Proteins & the Protein Folding Problem
Wednesday, February 17, 2021, 6:00 PM Central

Tim Herman
Tim Herman, Ph.D.
Center for BioMolecular Modeling

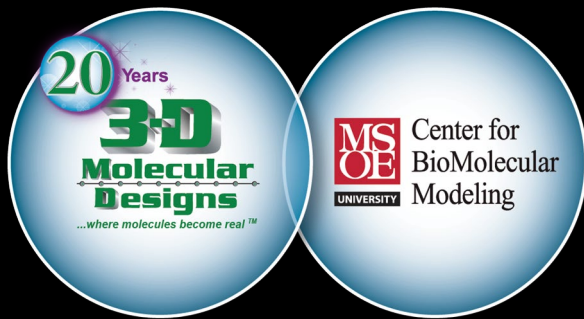
Diane Herman
Diane Herman
3D Molecular Designs



MSOE Center for BioMolecular Modeling
<https://cbm.msoe.edu>

3D Molecular Designs
www.3dmoleculardesigns.com

Chat



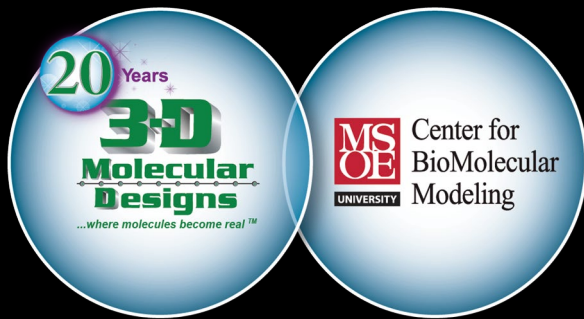
Chris Chou

**B.S. Bioengineering
Ed.M. Curriculum & Instruction**

**Longmont High School (Longmont, CO)
Courses: AP Biology, Biotechnology**

cn_chou@yahoo.com





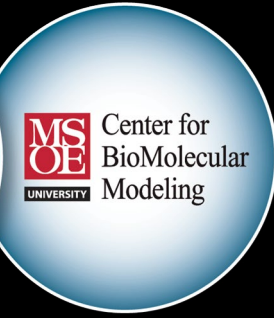
Using Models to Make Connections Between DNA and Chromosomes



Chat Time

Where do you live?

What grades/subjects do you teach?

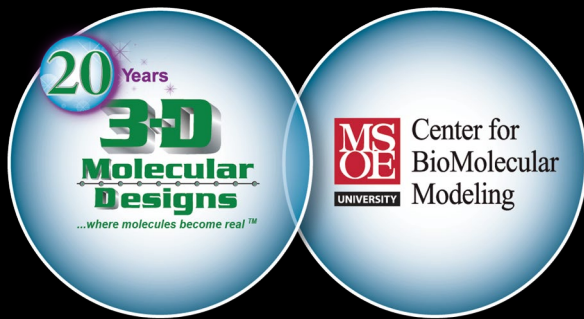


Workshop Learning Goals

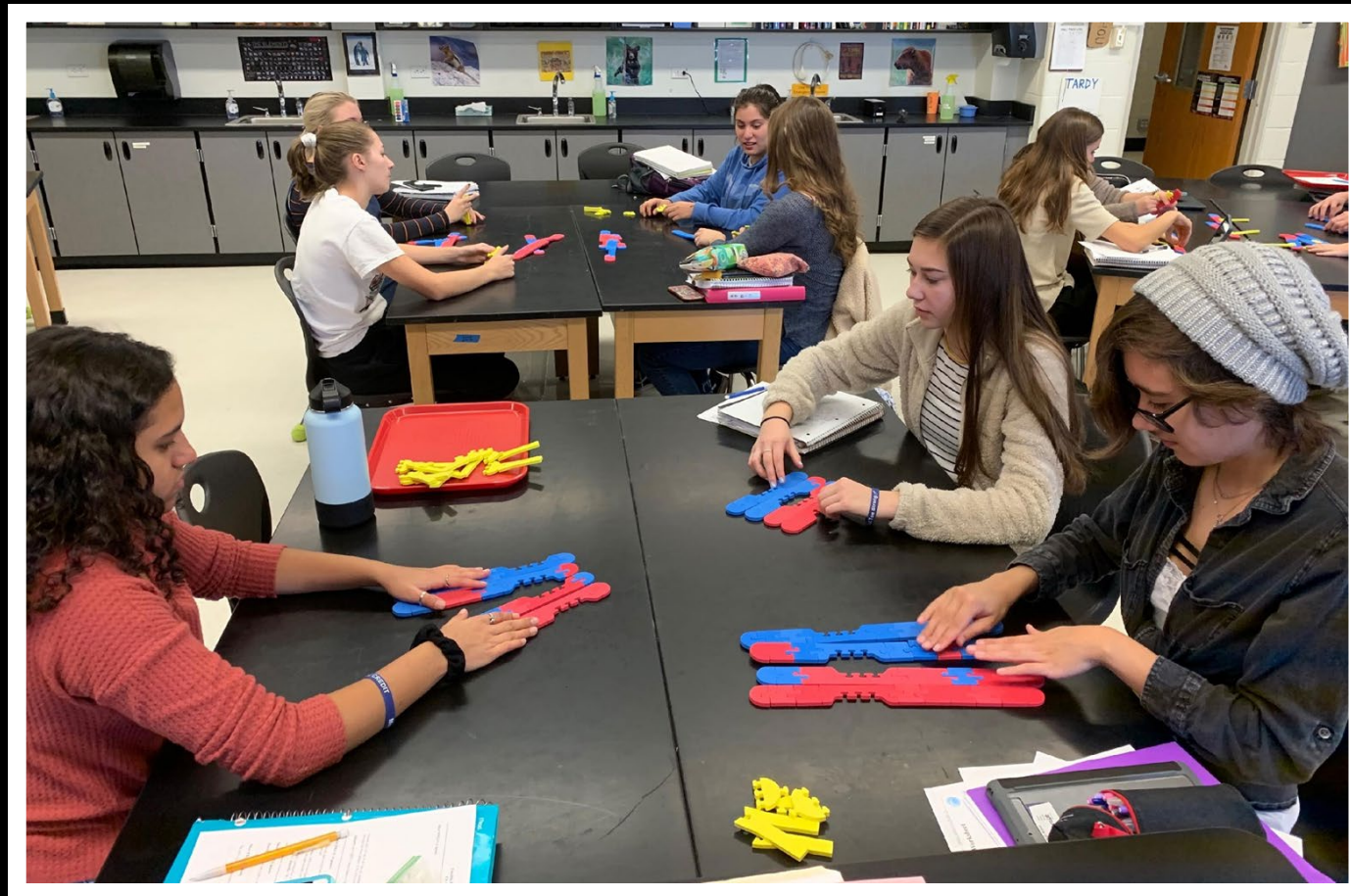
- Model chromosome structure and anatomy
- Compare and contrast mitosis and meiosis
- Model mechanisms that contribute to genetic variation
- Construct Punnett squares to connect inheritance of traits to chromosomes at the molecular level

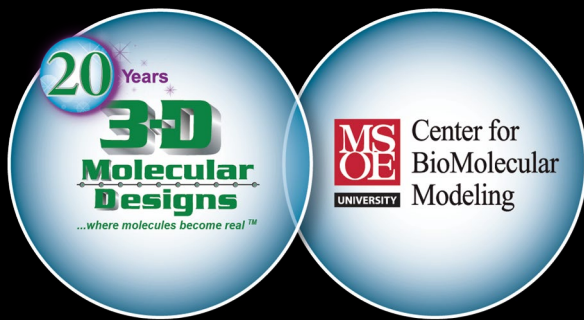
Why Models?



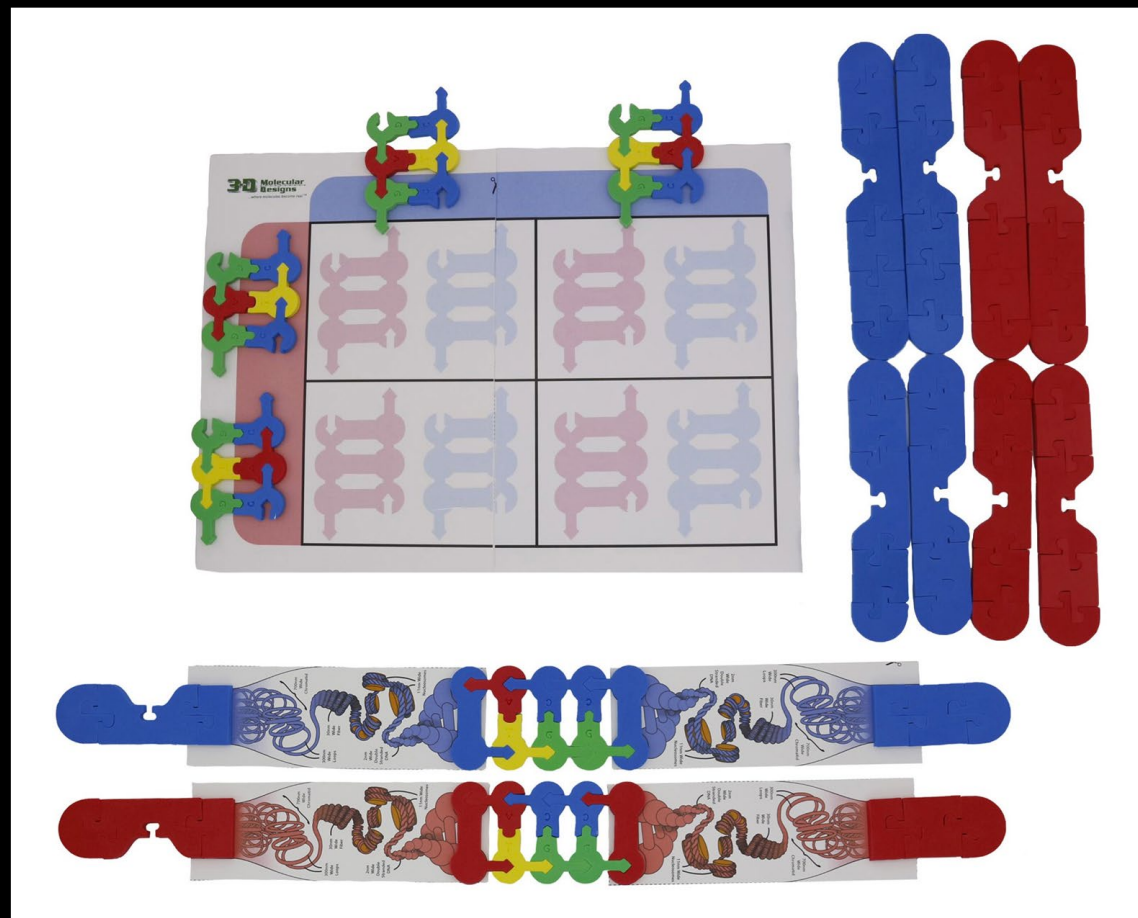


Chromosome Connections Kit

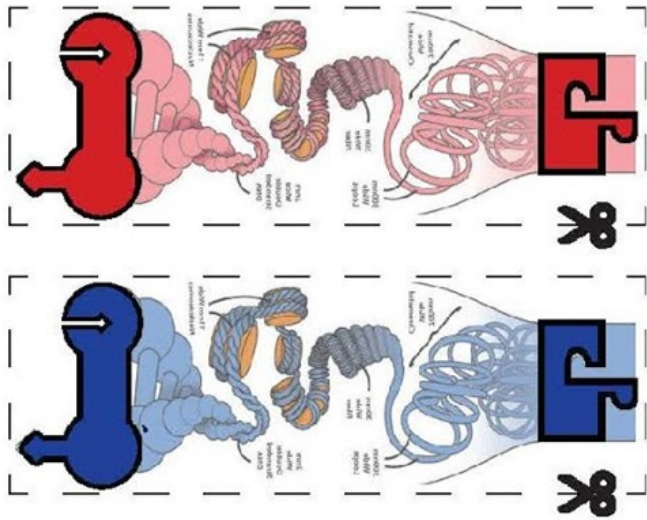




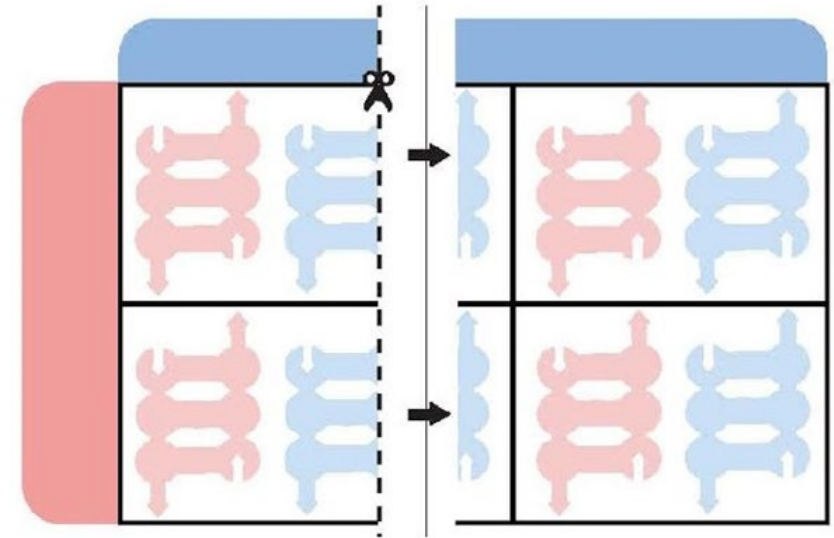
Chromosome Student Modeling Pack



Some Assembly is Required

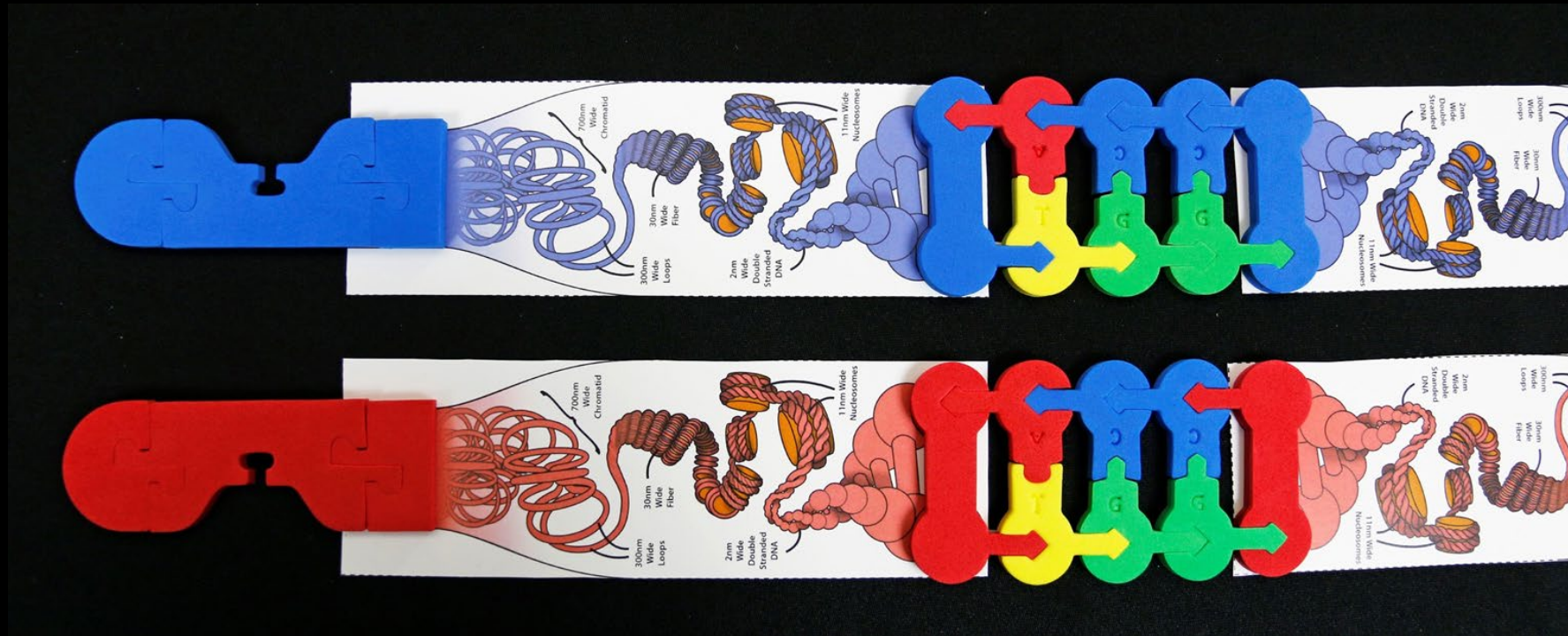


Cut apart the Chromosome Scaling Graphics and attach the corresponding foam parts with glue (recommended) or tape.

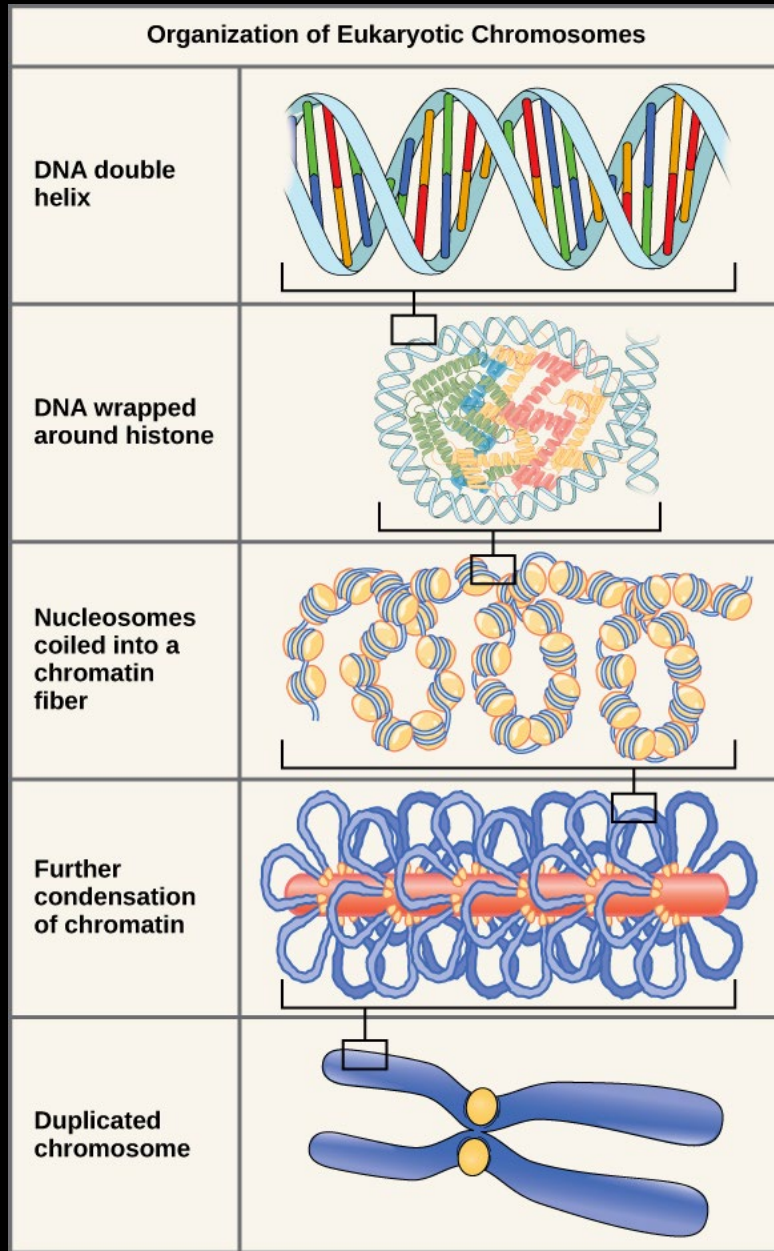


Cut edge off Punnett Square graphic and attach to second page with glue or tape.

Assemble Chromosomes Shown



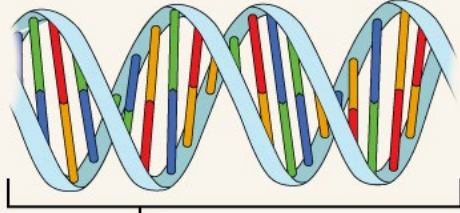
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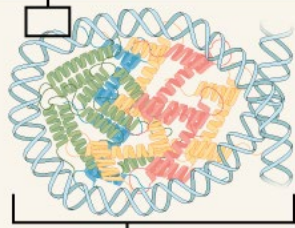
Organization of Eukaryotic Chromosomes

Organization of Eukaryotic Chromosomes

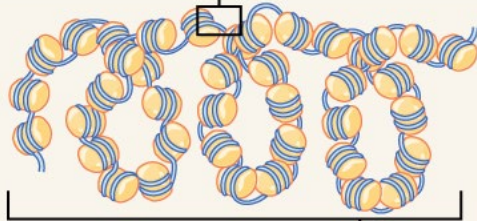
DNA double helix



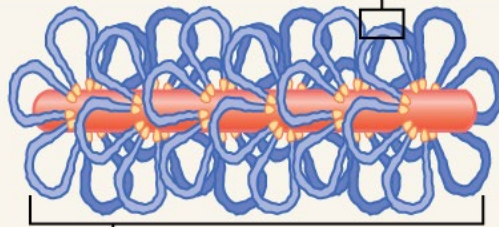
**DNA wrapped
around histone**



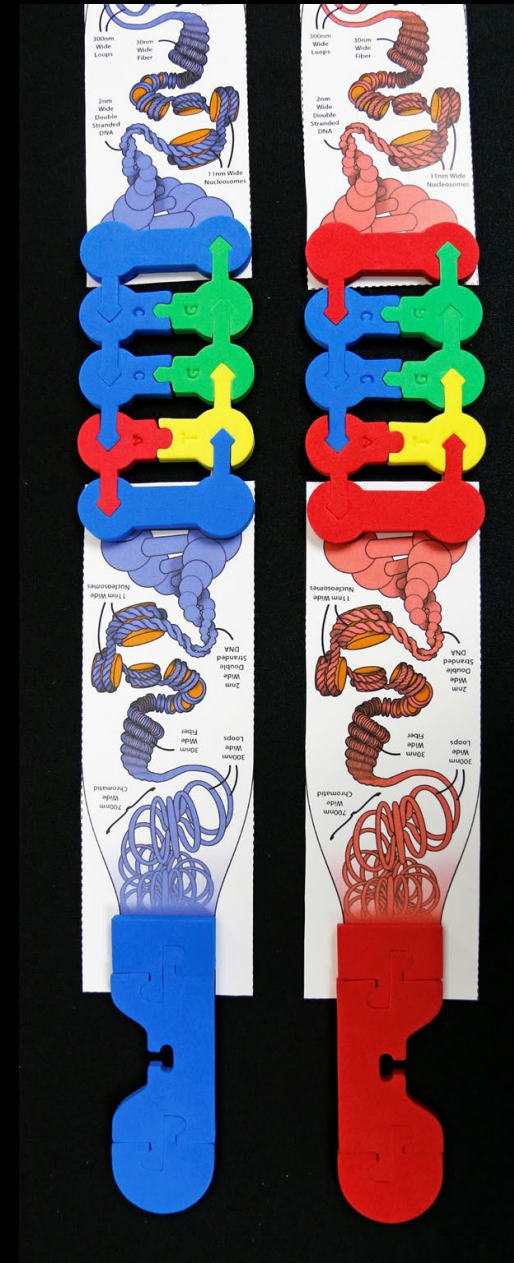
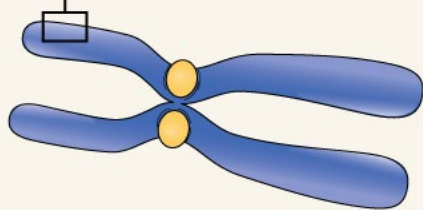
**Nucleosomes
coiled into a
chromatin
fiber**

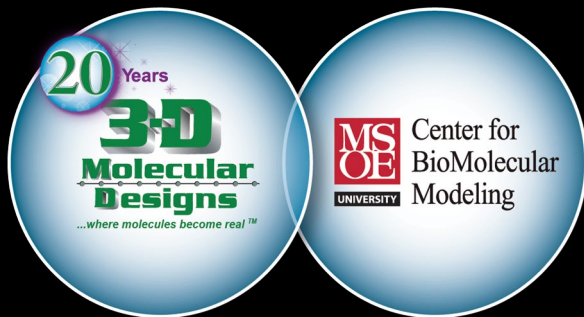


Further condensation of chromatin

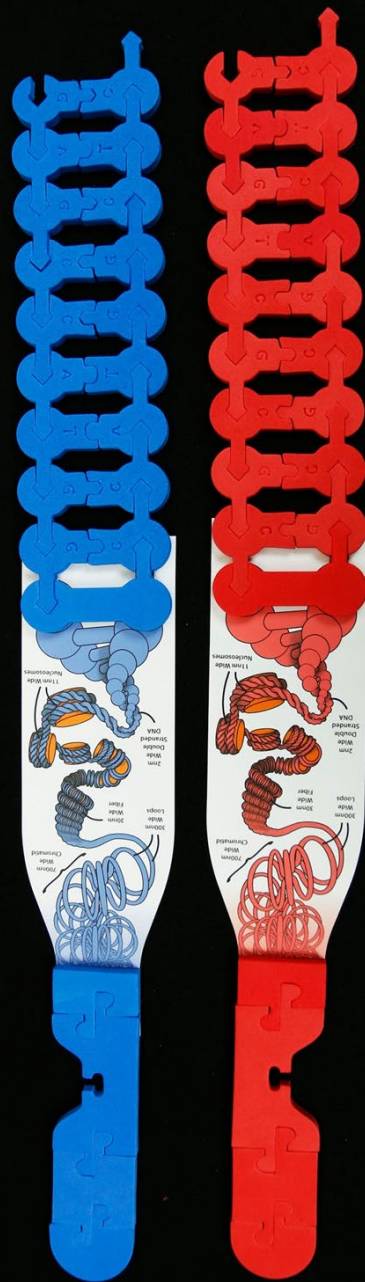


Duplicated chromosome



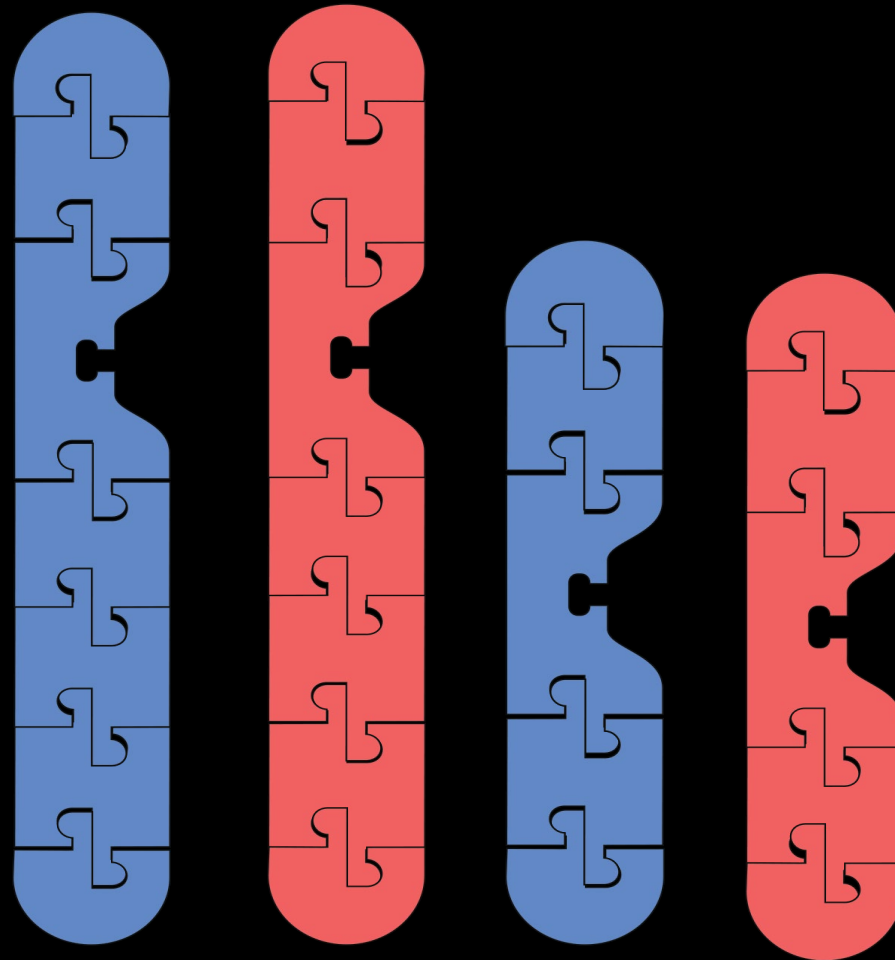


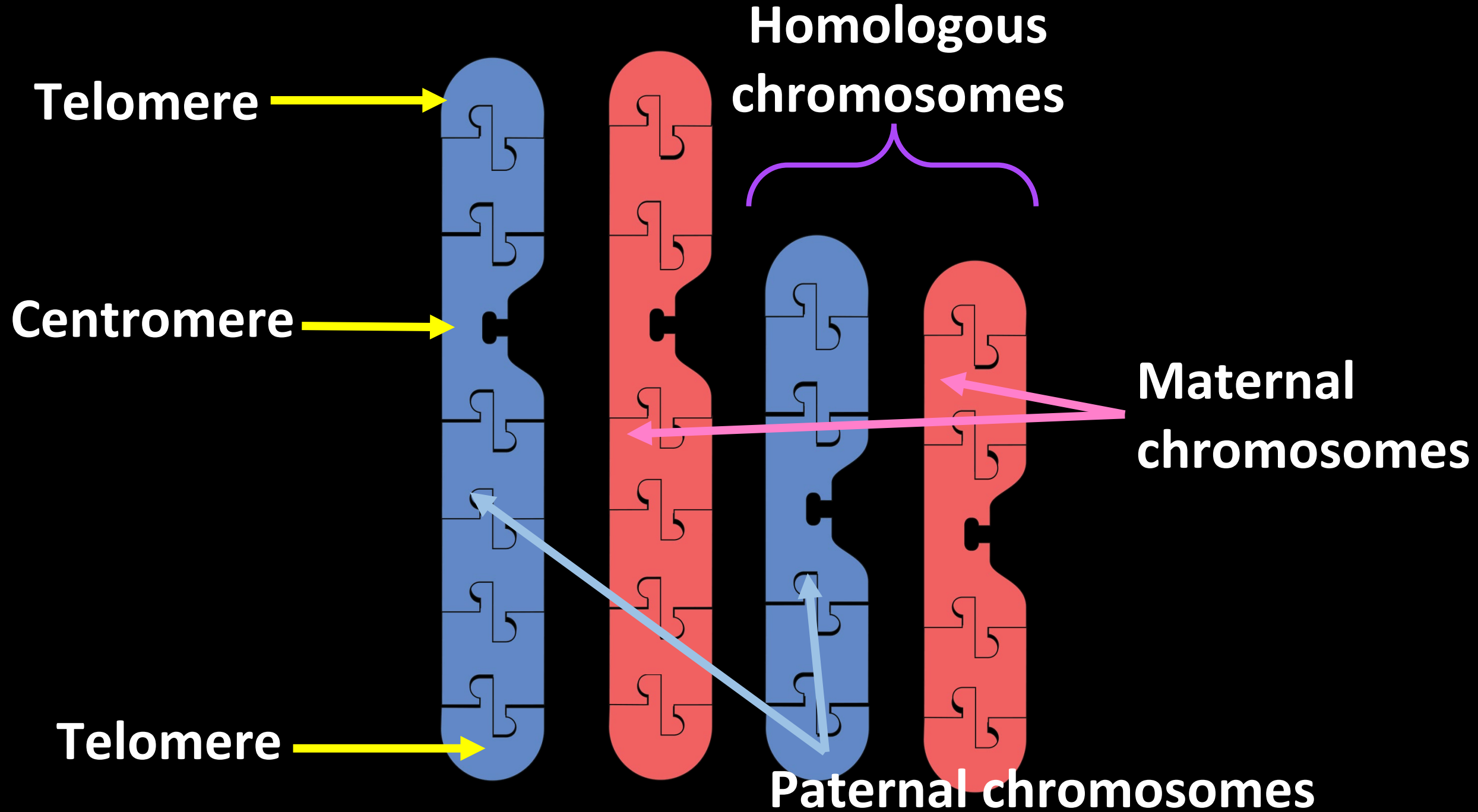
Chromosome Connections Kit



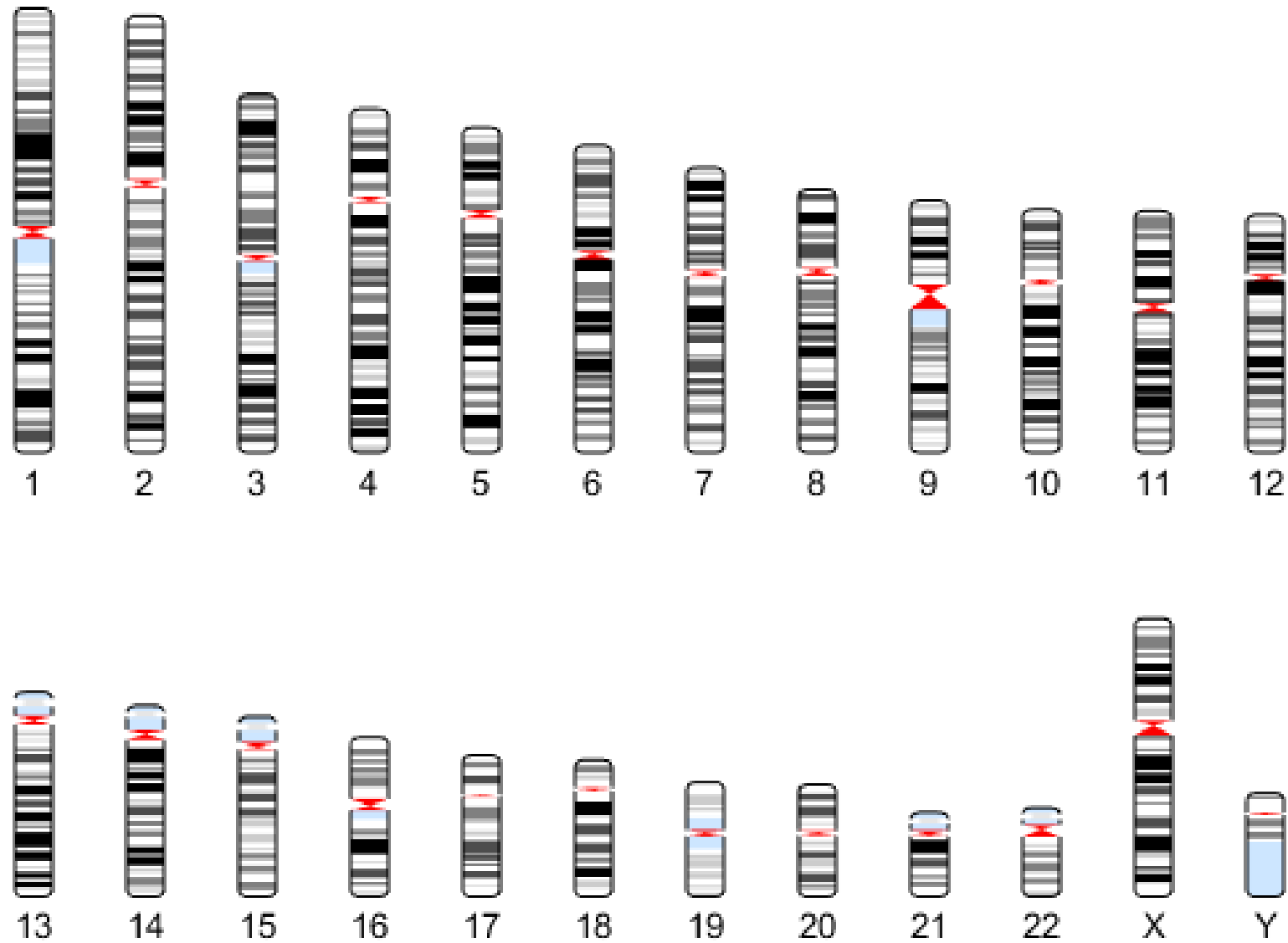
Chromosome Student Modeling Pack

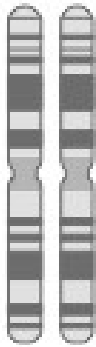
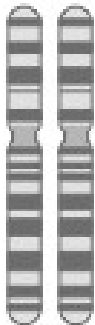
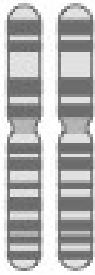
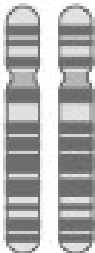
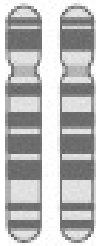
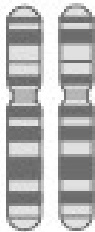
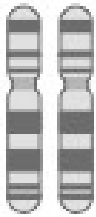
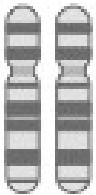
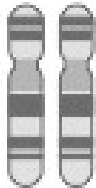
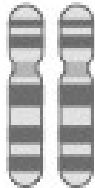
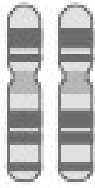
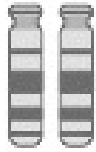
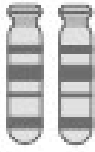
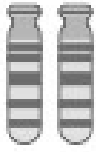
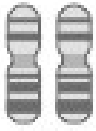
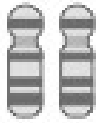
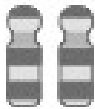
Assemble Chromosomes Shown

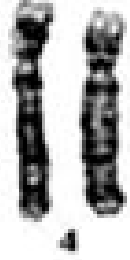
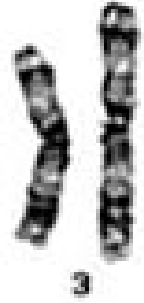
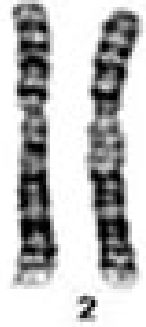
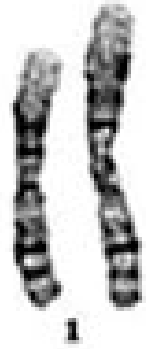




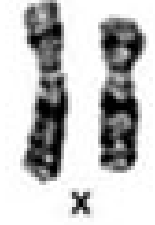
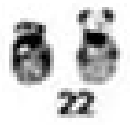
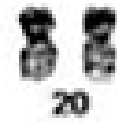
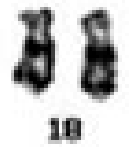
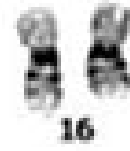
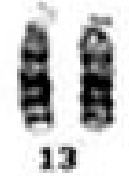
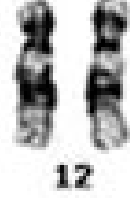
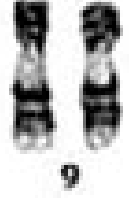
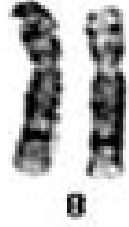
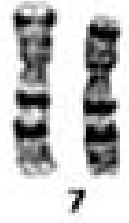
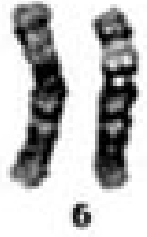
Human Karyogram



							
1	2	3	4	5	6	7	8
							
9	10	11	12	13	14	15	16
							
17	18	19	20	21	22	X	Y



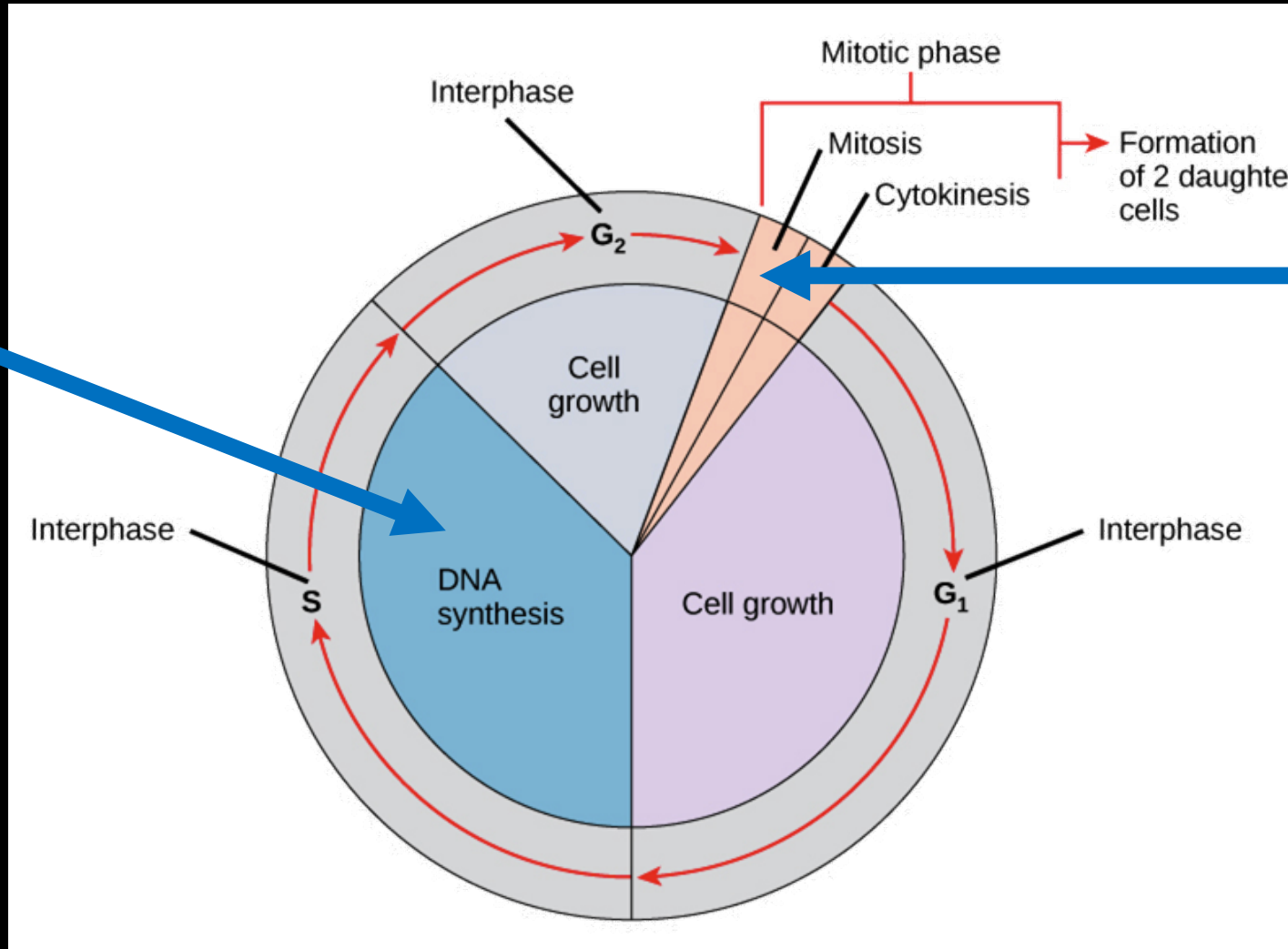
A pair of medium-sized, acrocentric chromosomes, similar in size to pair 2.



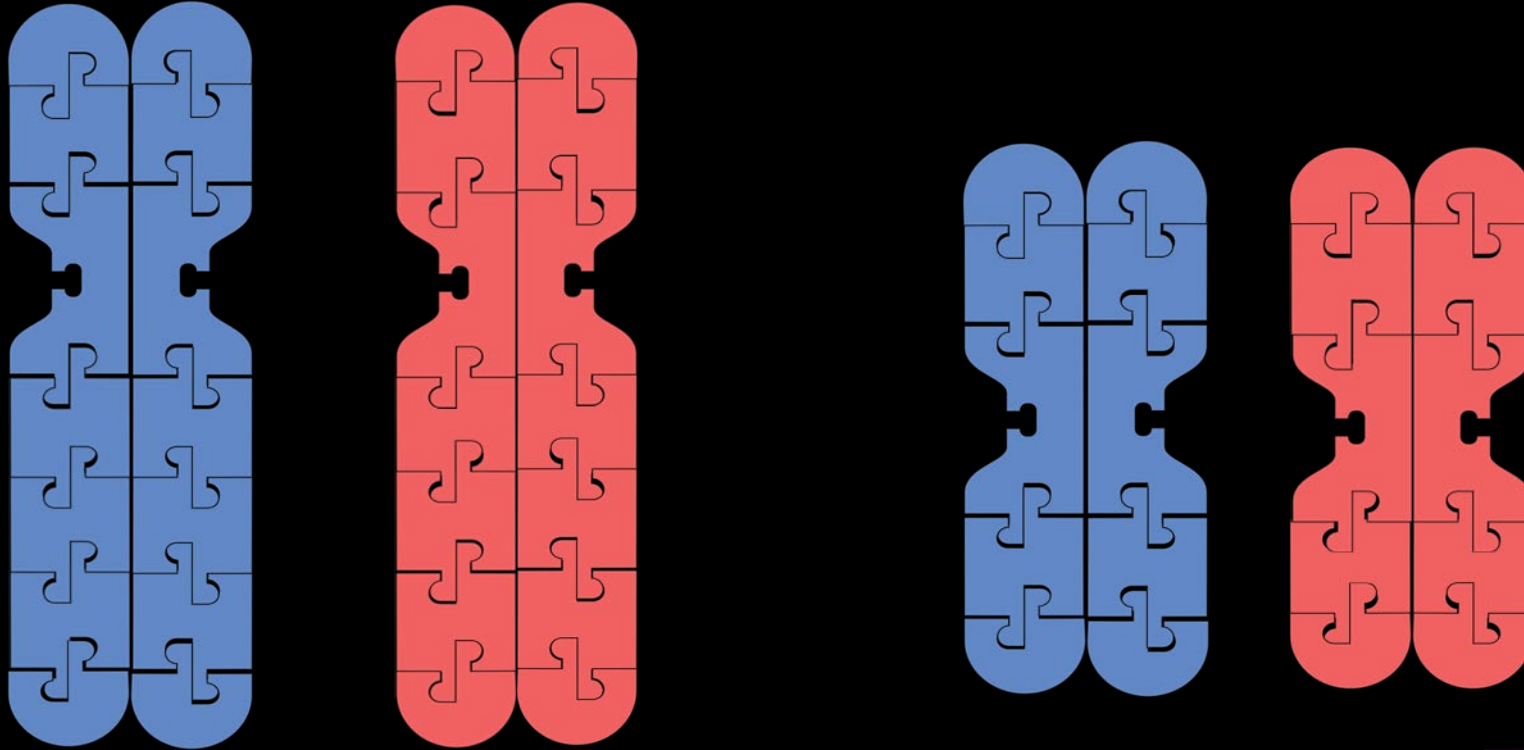
The Cell Cycle

**DNA
Replication**

Karyotype

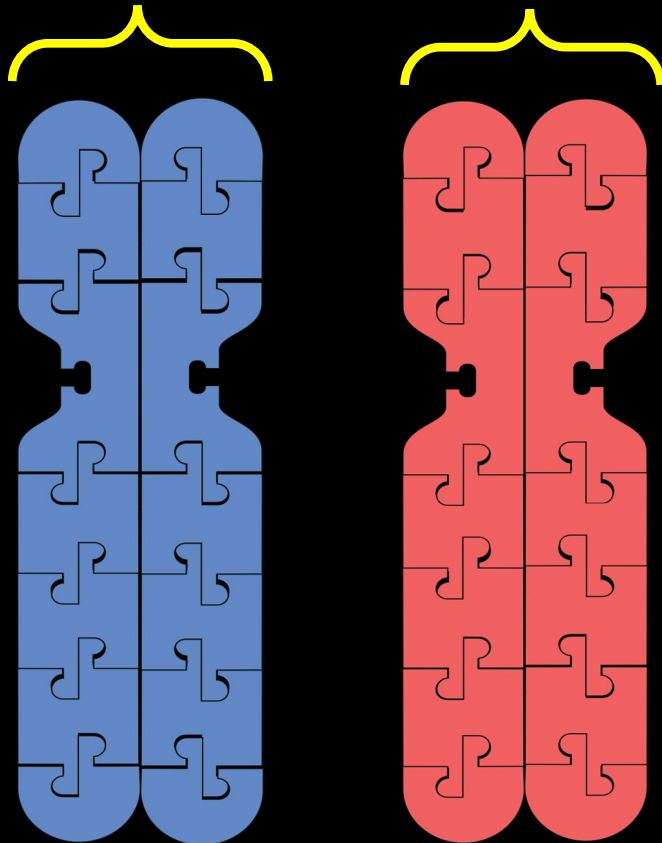


Replicate Your Chromosomes!

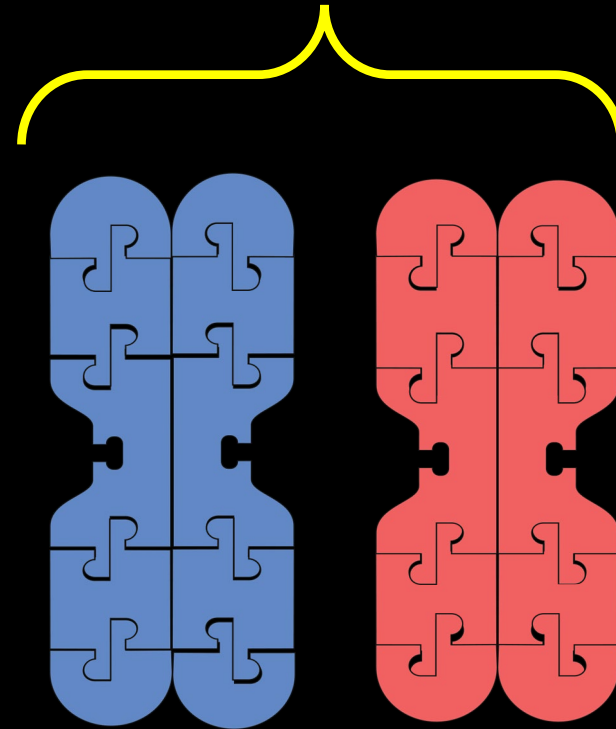


Each chromosome = 2 identical **sister chromatids**

chromosome chromosome

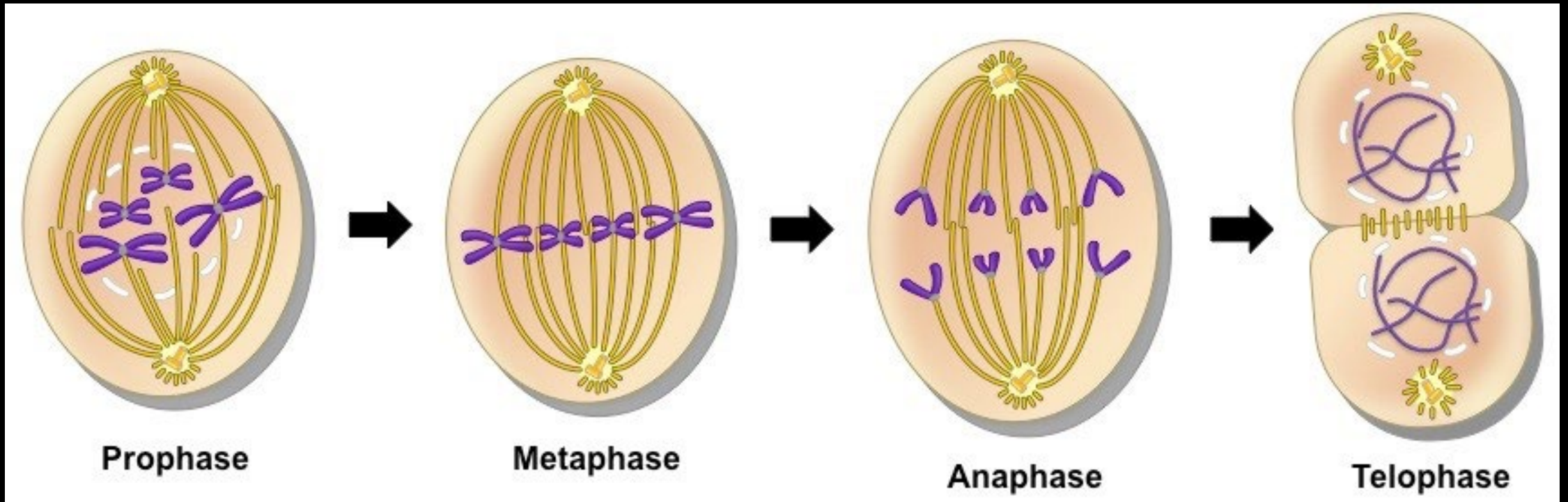


Homologous
chromosomes

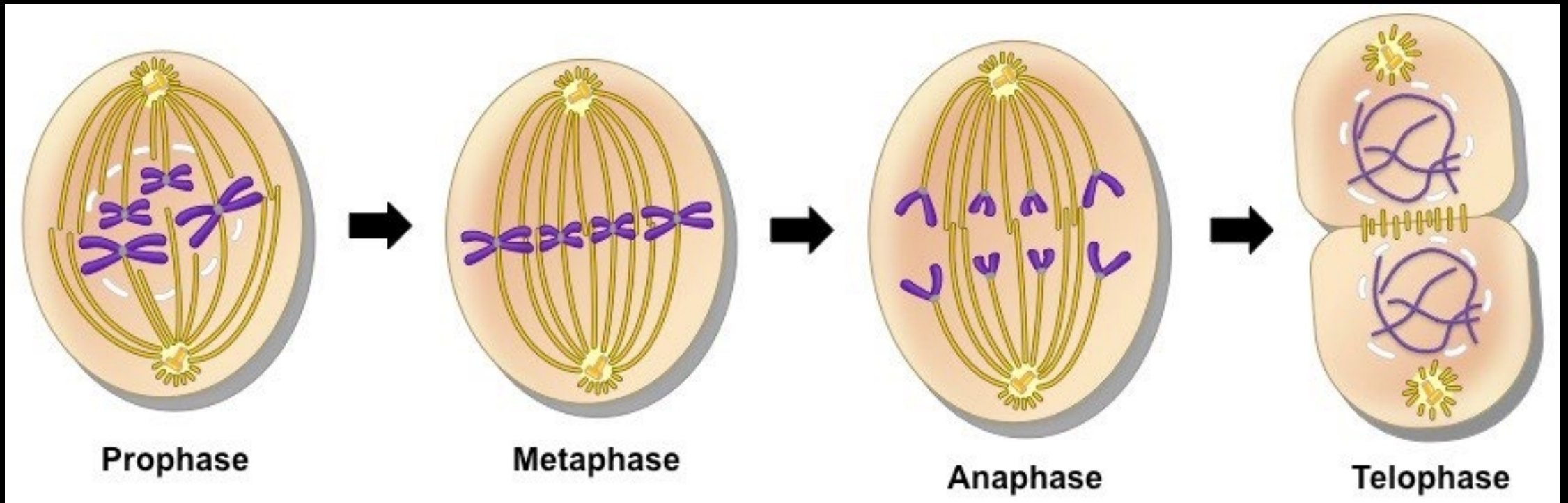


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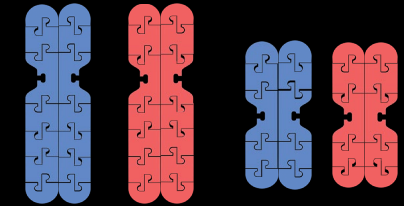
Mitosis



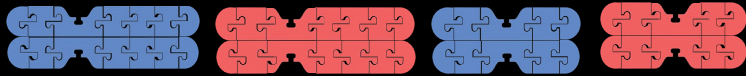
Move your chromosomes to model the process of Mitosis



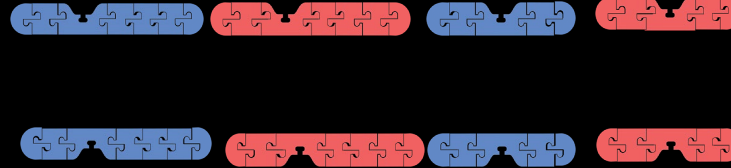
Move your chromosomes to model the process of Mitosis



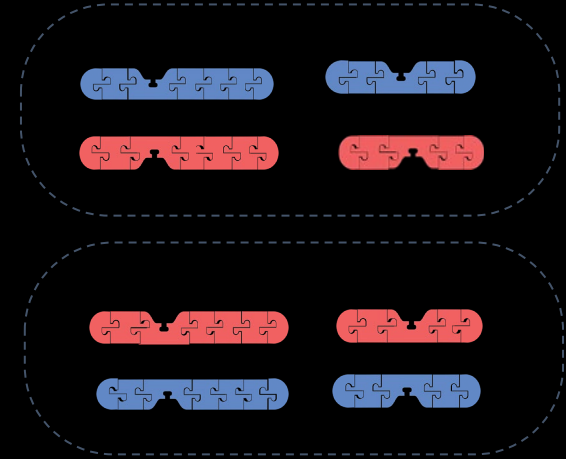
Prophase



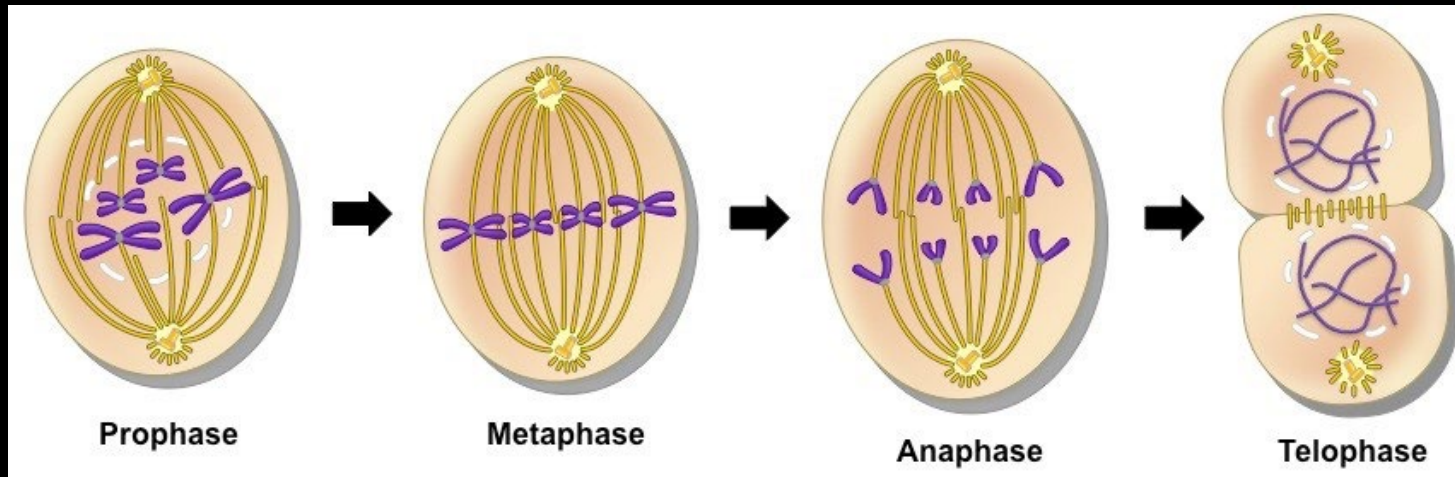
Metaphase



Anaphase



Telophase





Discuss:



- How do the daughter cells compare to the original parent cell?
- How many chromosomes were in each parent cell?
- How many *chromatids* were in the cell during prophase?
- How many chromosomes are in each daughter cell?

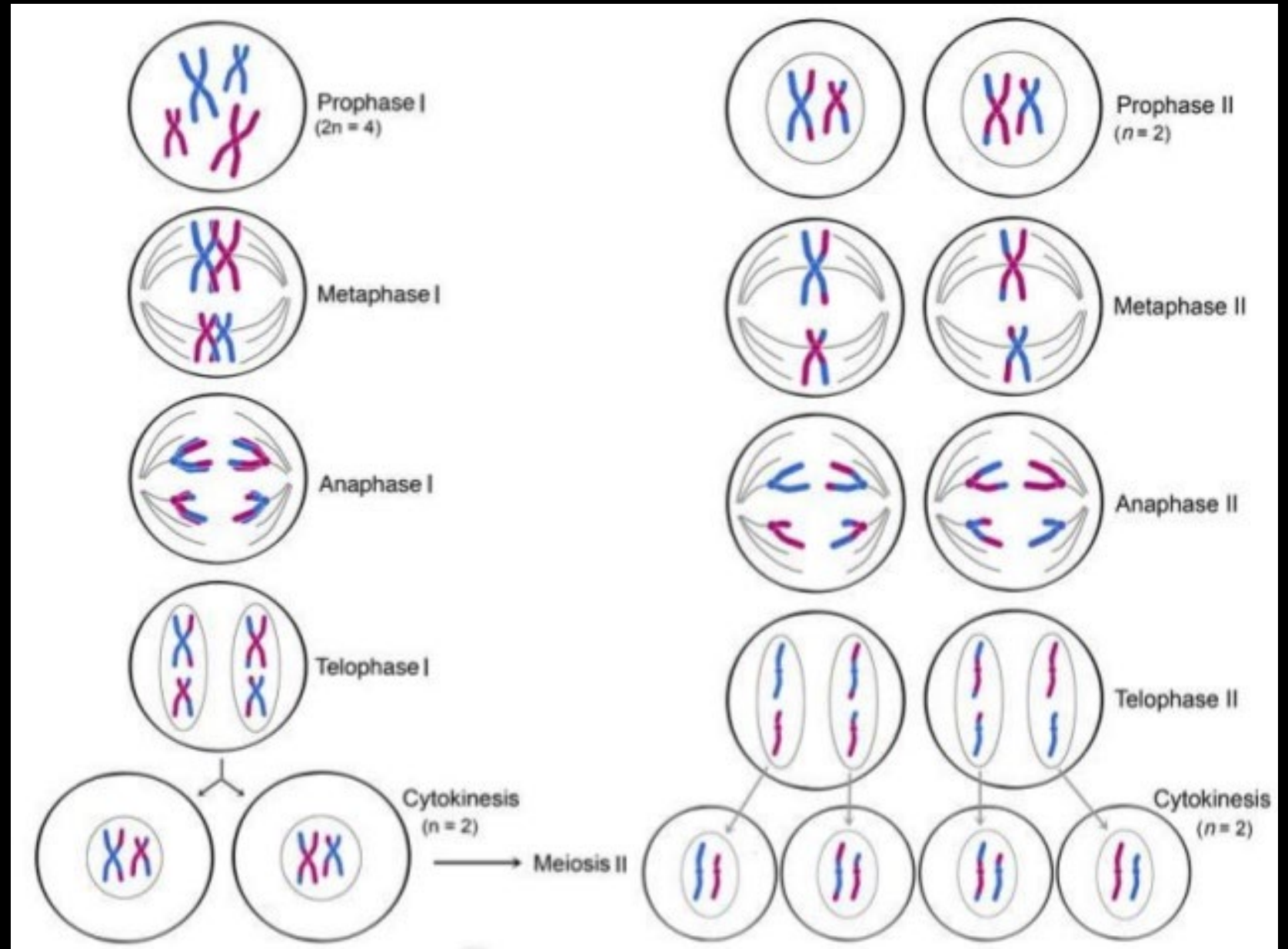


Chat Time

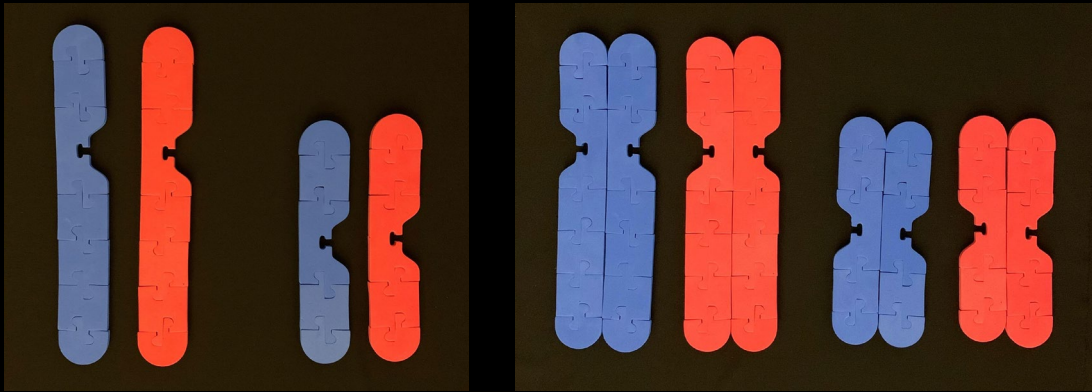
How might this activity be used in your classroom?

In what ways could modeling this process be helpful for students?

Meiosis

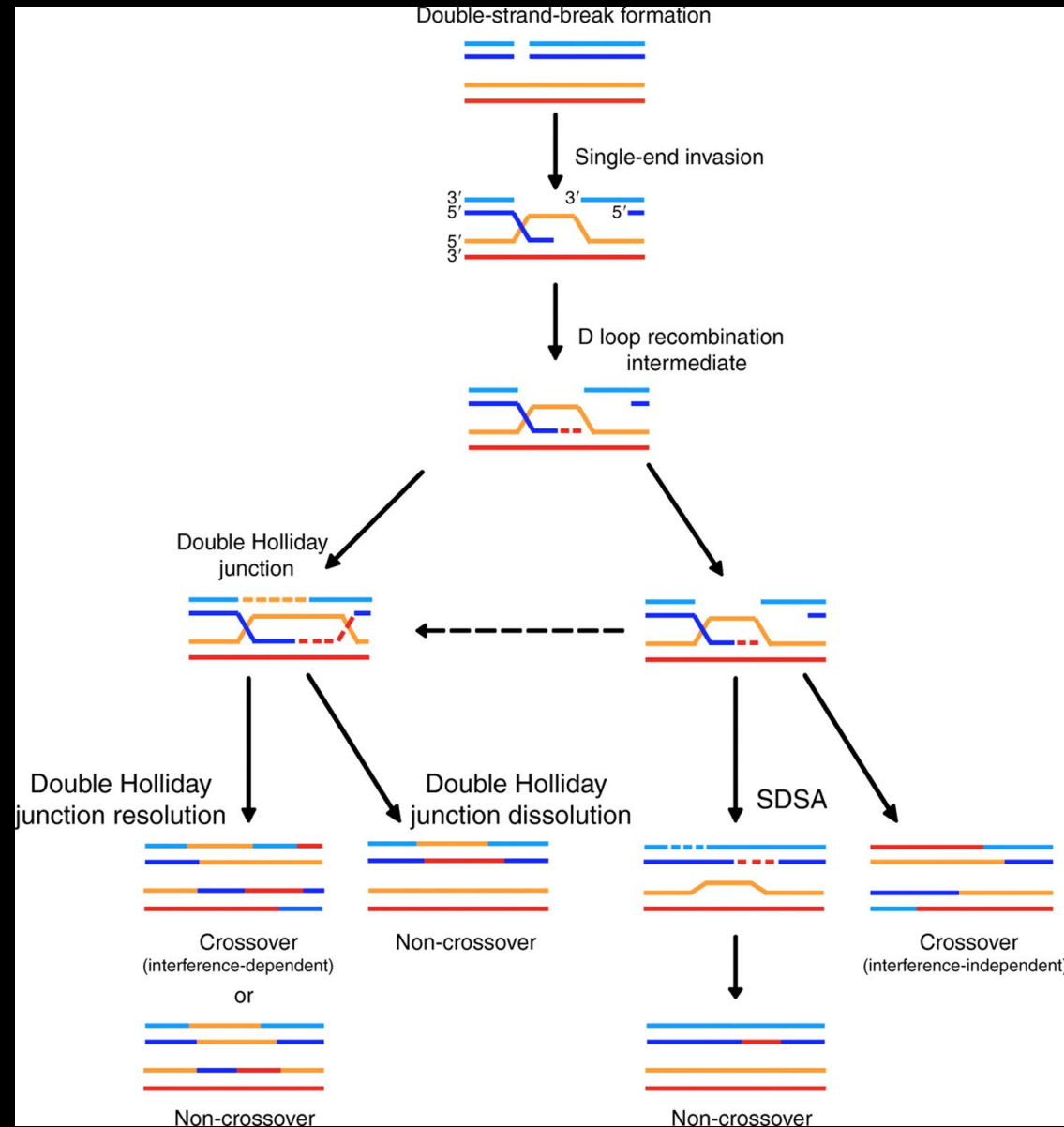


Prophase I – Crossing Over



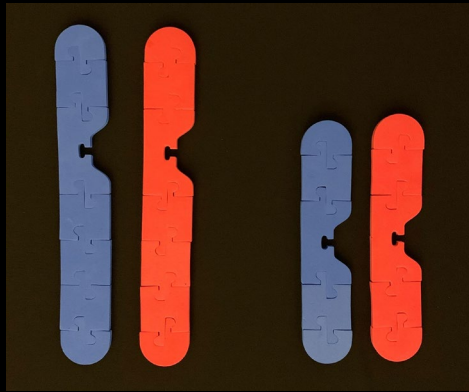
G₁ Phase

S Phase
(& G₂ Phase)

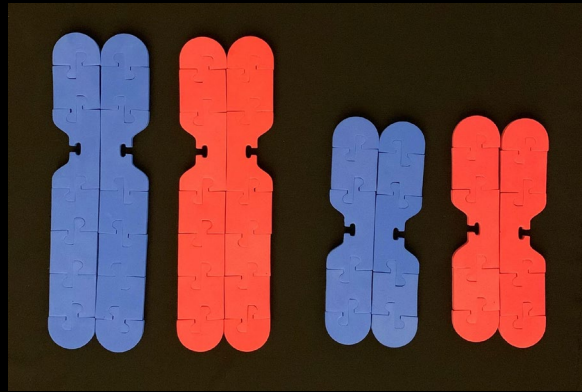


Youds, JL & Boulton, SJ. (2011). The choice in meiosis - defining the factors that influence crossover or non-crossover formation. *Journal of Cell Science* 2011 124: 501-513; doi: 10.1242/jcs.074427.

Prophase I – Crossing Over

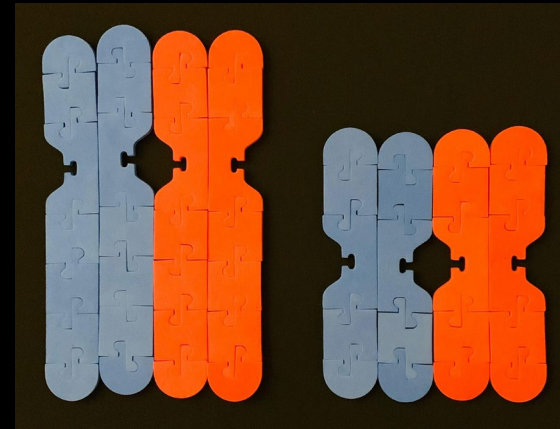


G₁ Phase

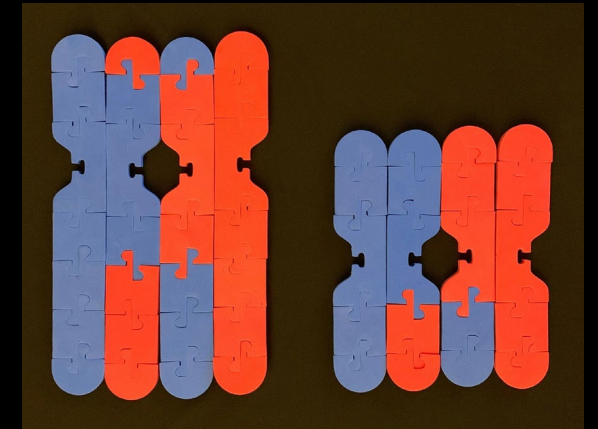


**S Phase
(& G₂ Phase)**

Meiosis: Prophase I

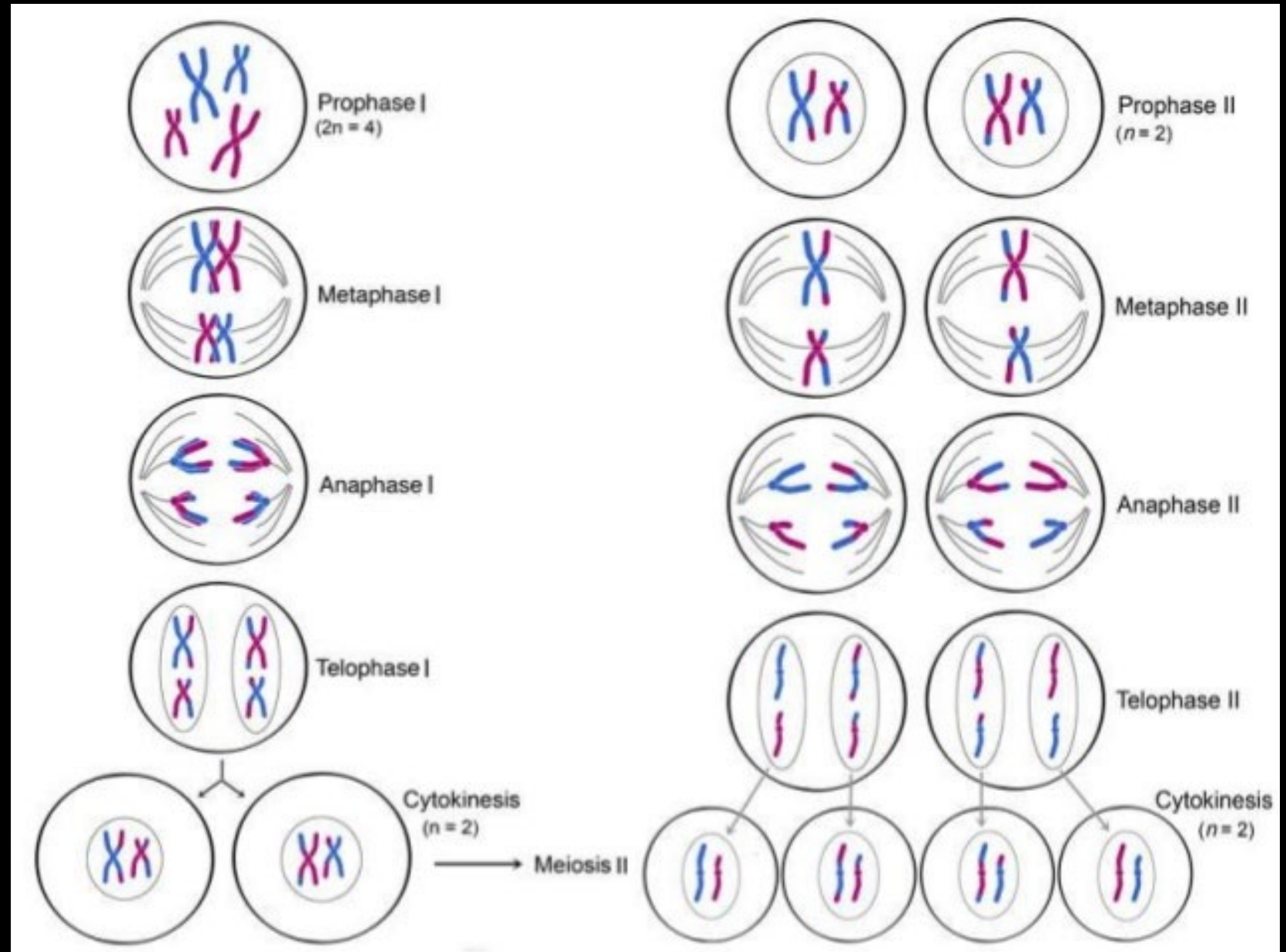


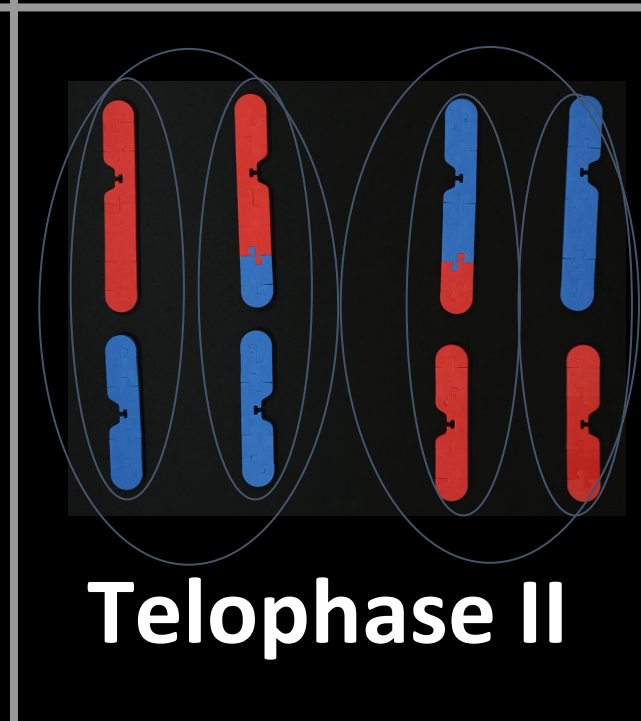
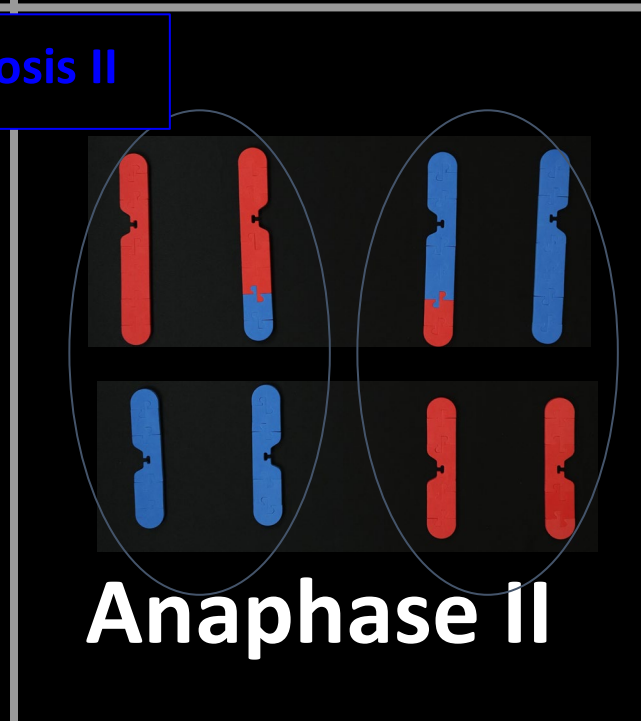
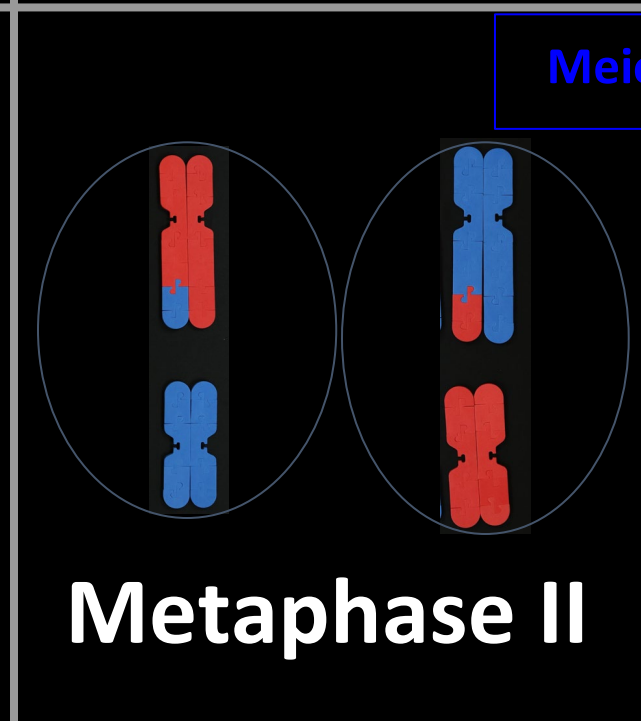
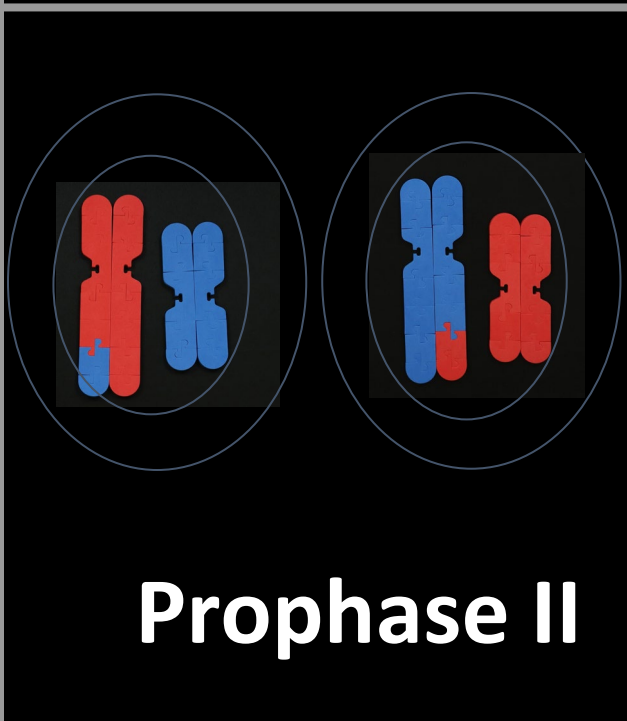
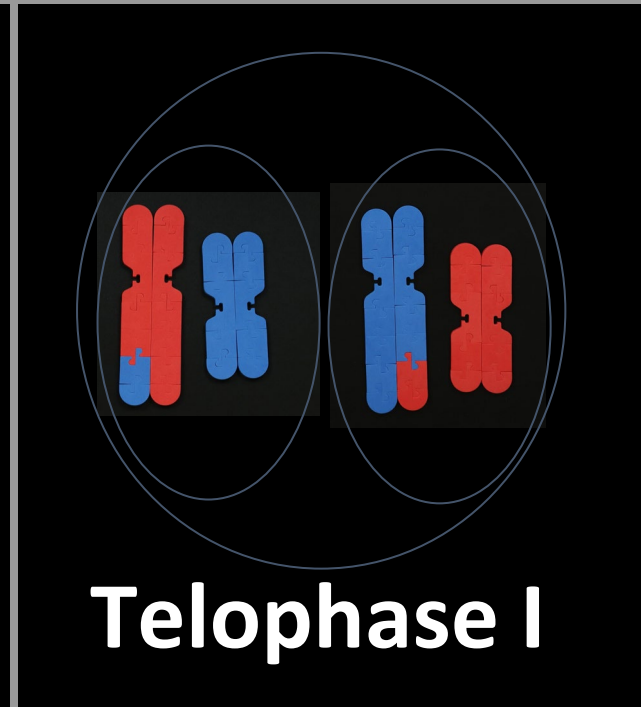
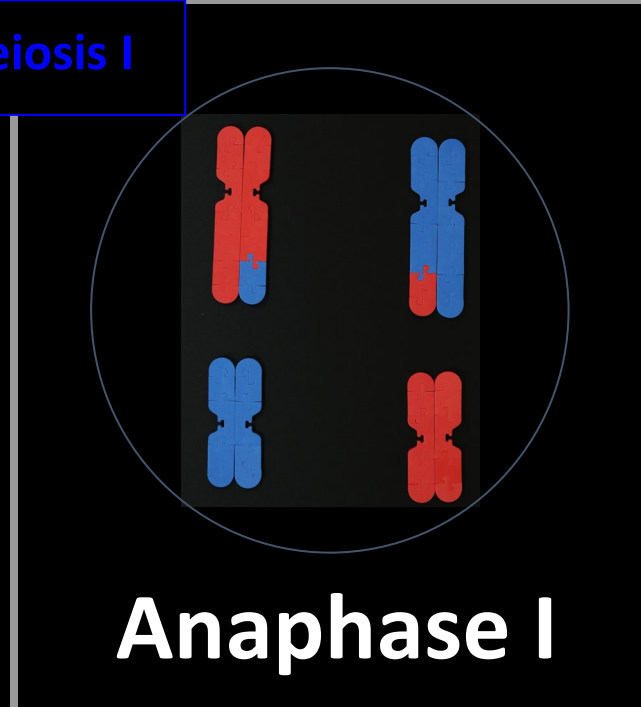
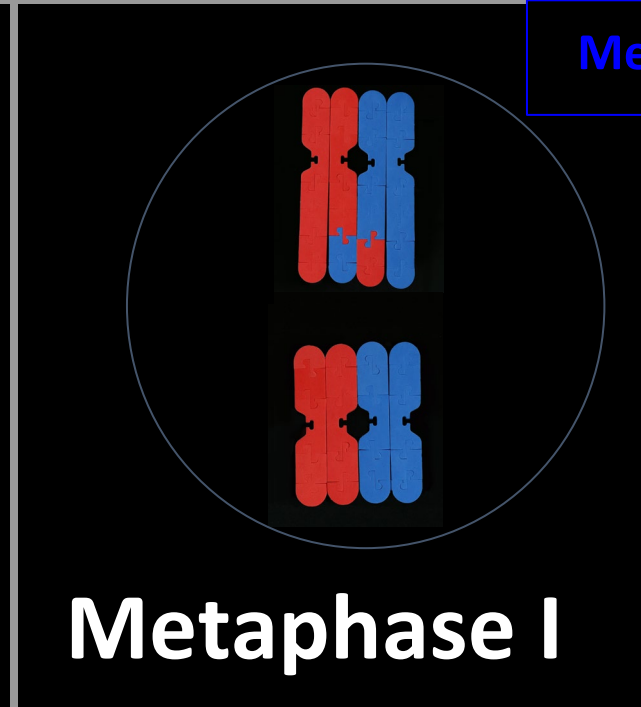
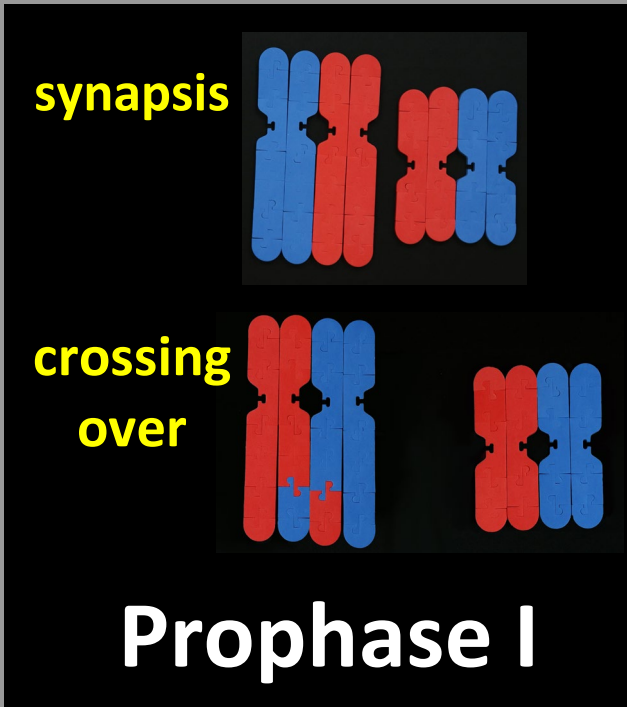
synapsis
(tetrads form)



crossing over
(1-3 crossover
events per
chromosome)

Move your chromosomes to model 2 divisions: Meiosis I and Meiosis II







Discuss:



- In meiosis, how do the daughter cells compare to the original parent cell?
- How many chromosomes were in the parent cell?
- How many chromosomes are in each daughter cell?
- List all the ways in which mitosis and meiosis are similar.
- List all the ways in which mitosis and meiosis are different.

Sources of Genetic Variation

Think back to the ways in which DNA was being shuffled or “mixed up”.

What are the sources of genetic variation?





Chat Time

**How might this activity be used
in your classroom?**

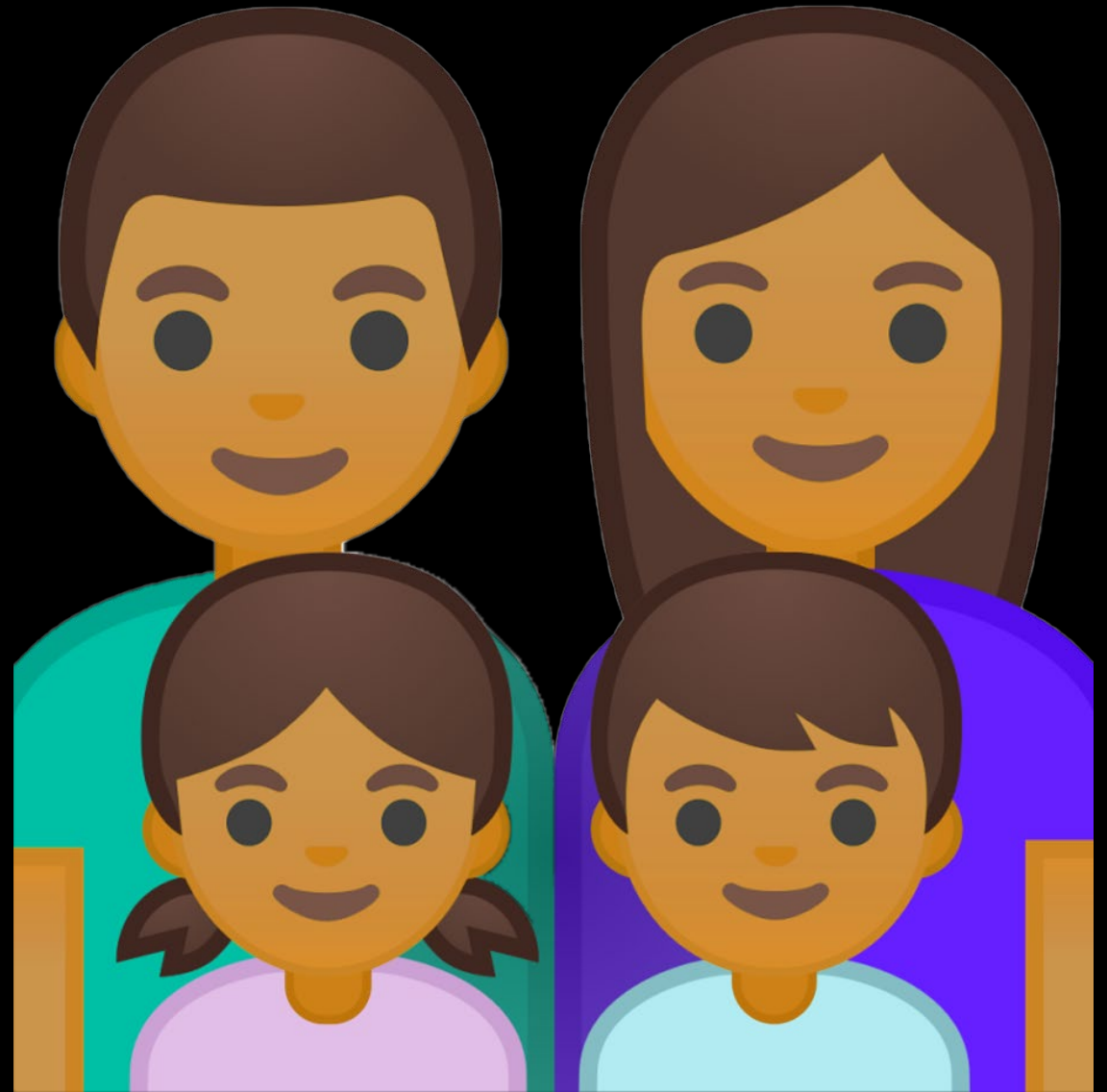
**In what ways could modeling this
process be helpful for students?**



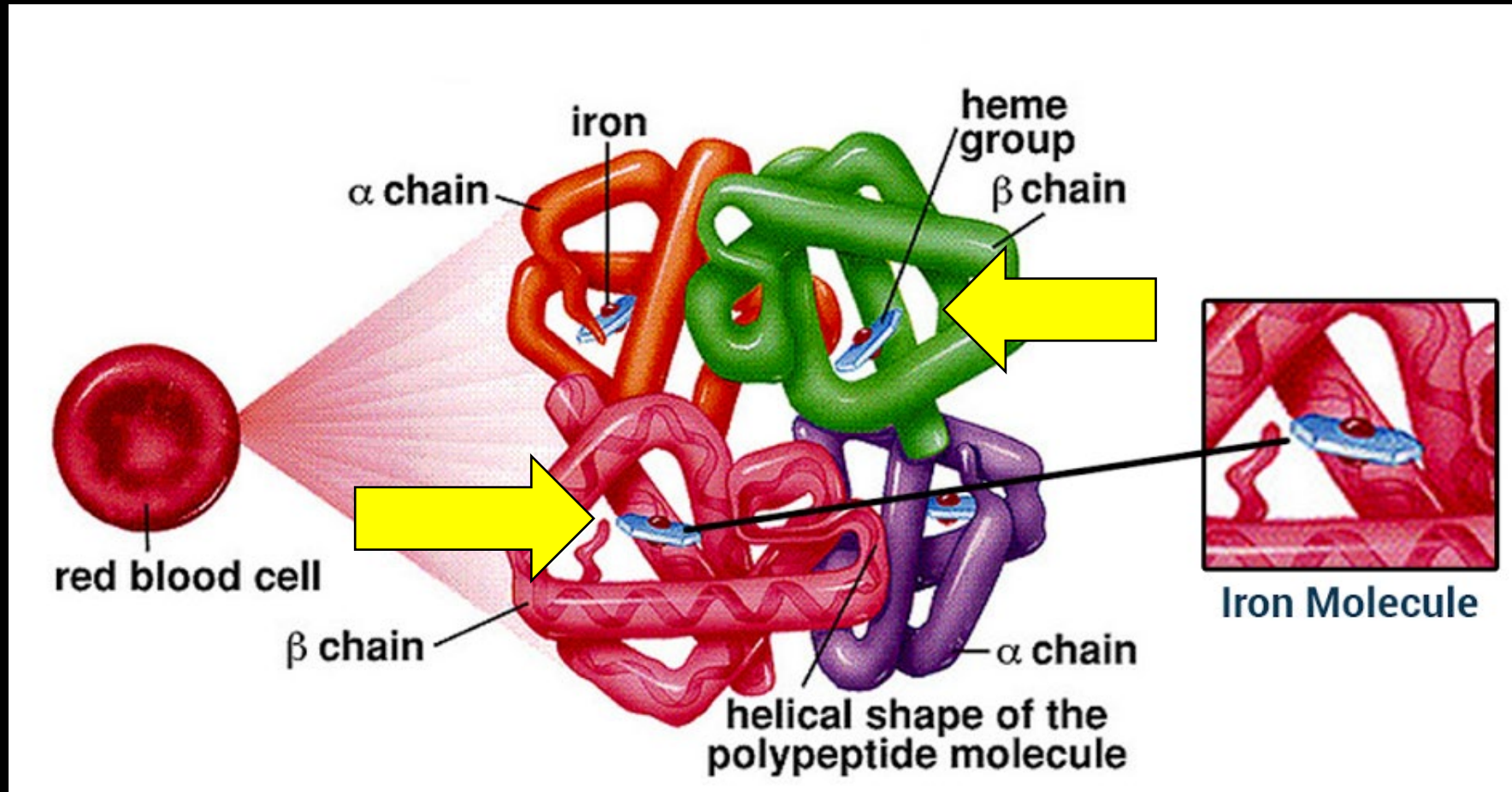
Genetic Counselor Role



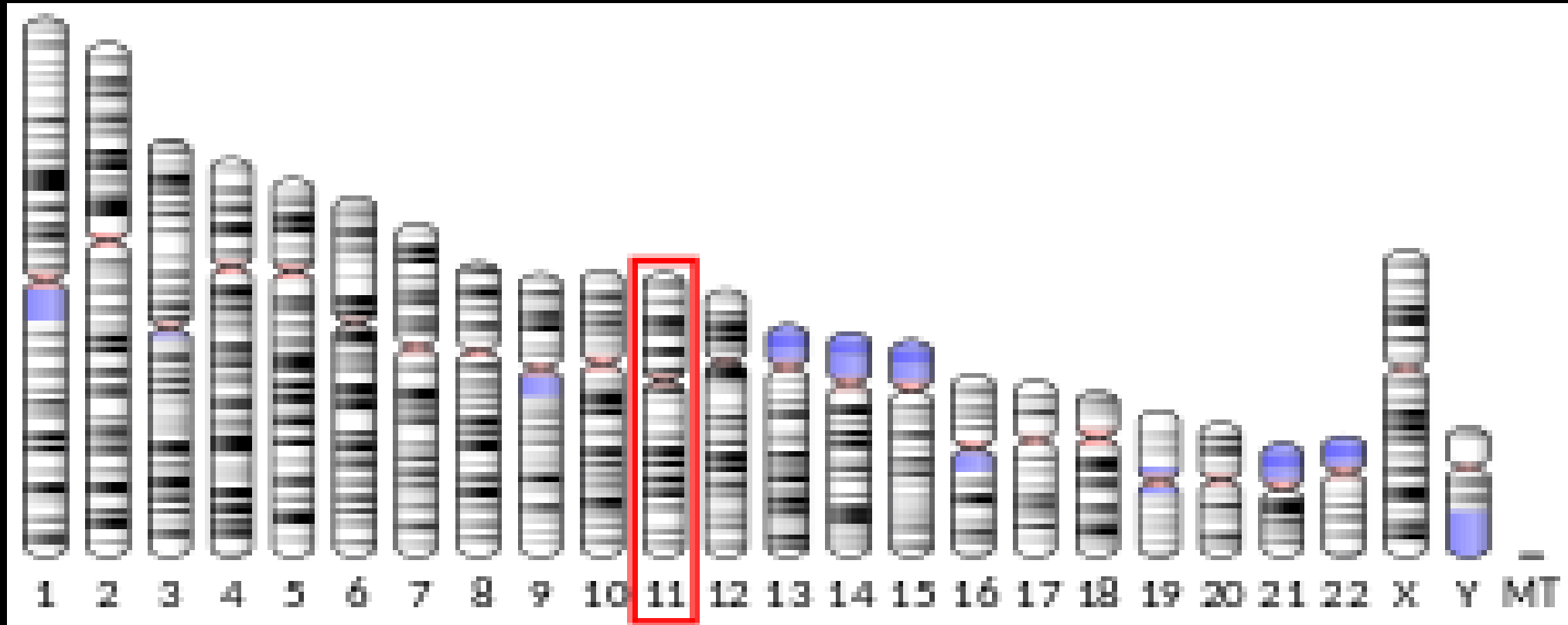
Meet the Smiths



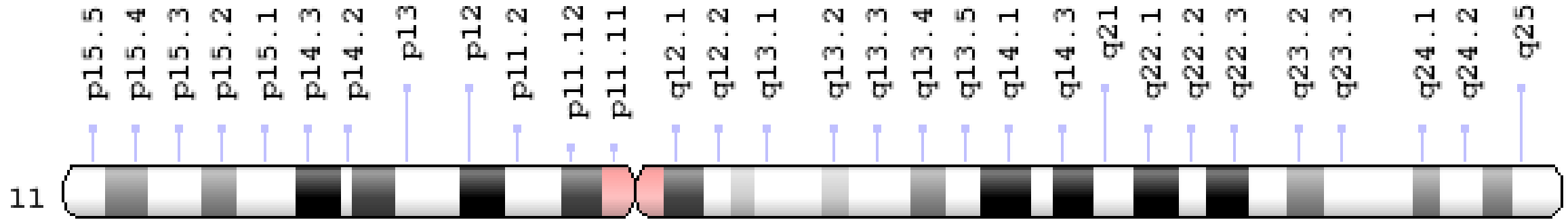
HBB Gene --> Beta-globin protein



Where is the HBB gene located?

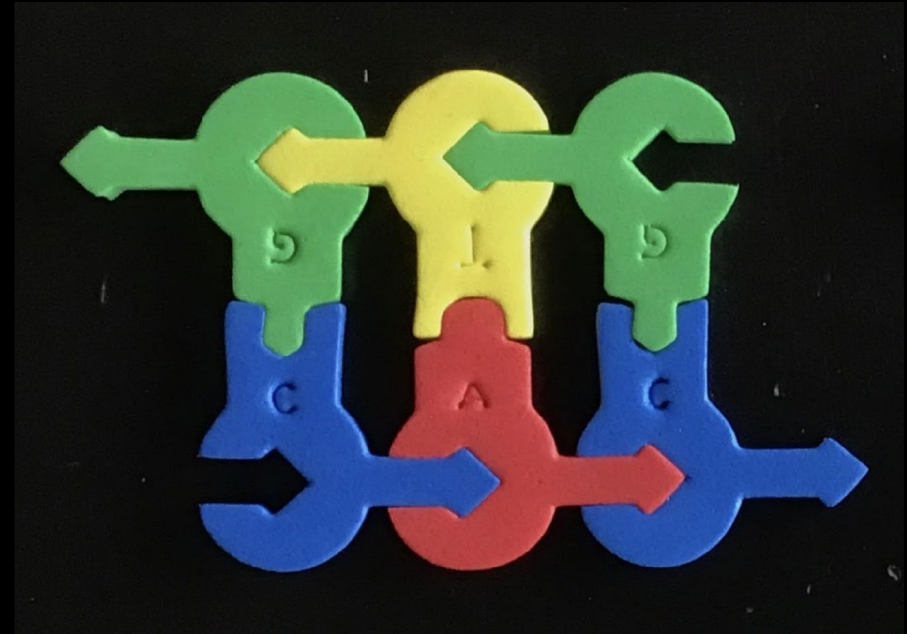
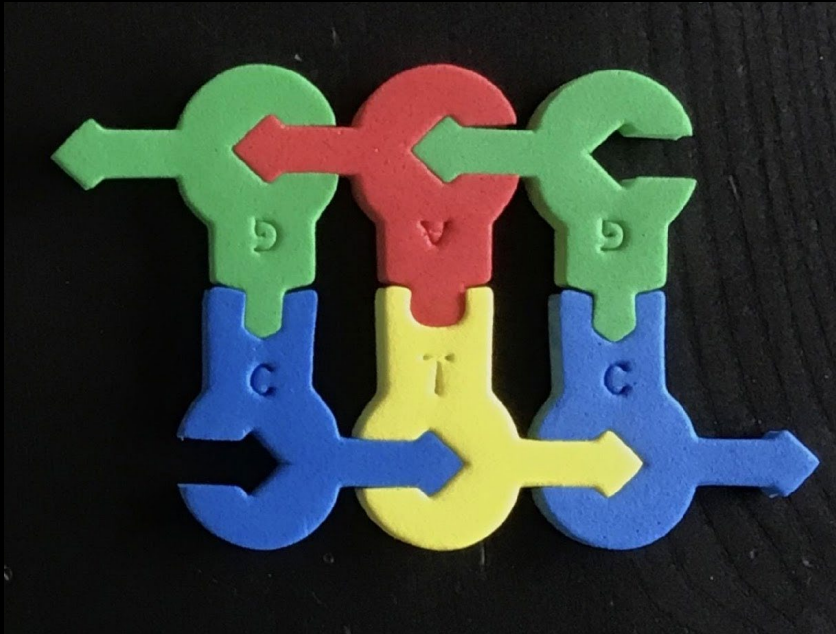


Chromosome 11



HBB Gene

HBB variants (alleles):

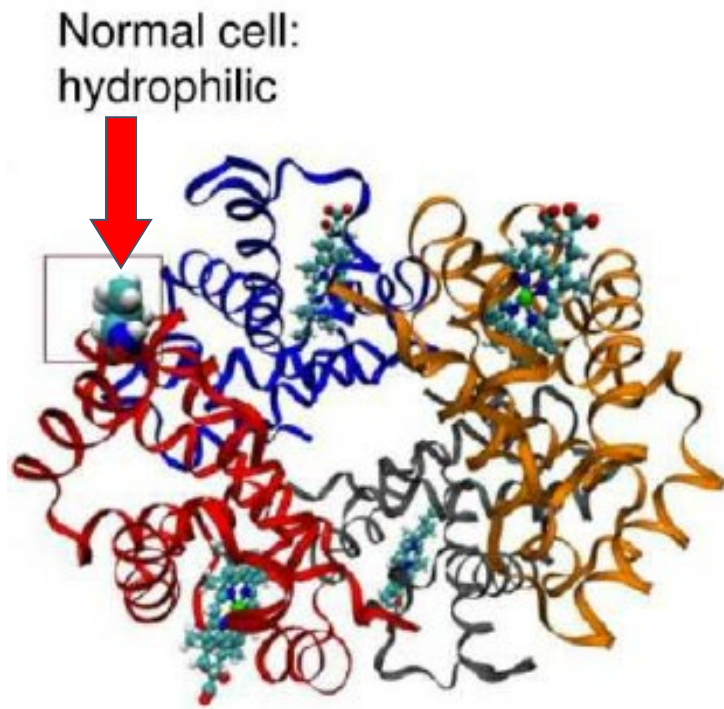


What's the difference?

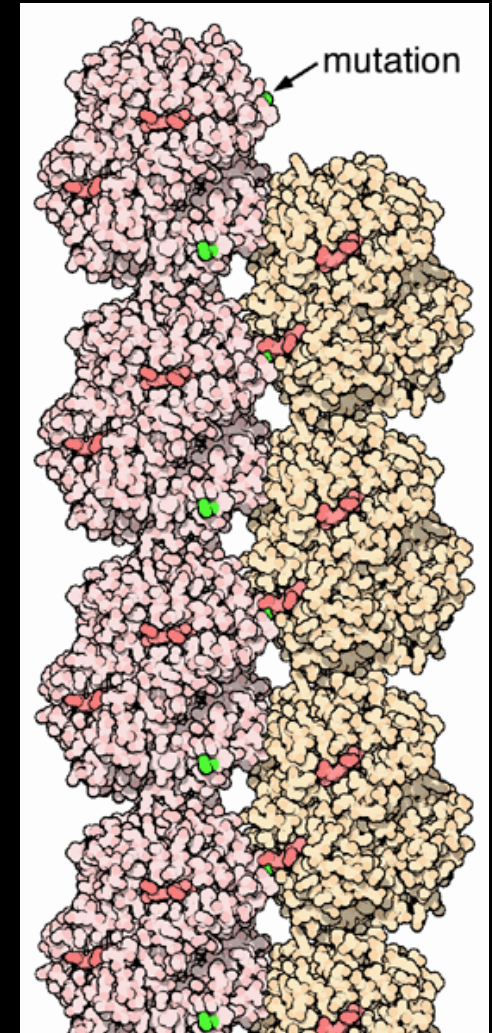
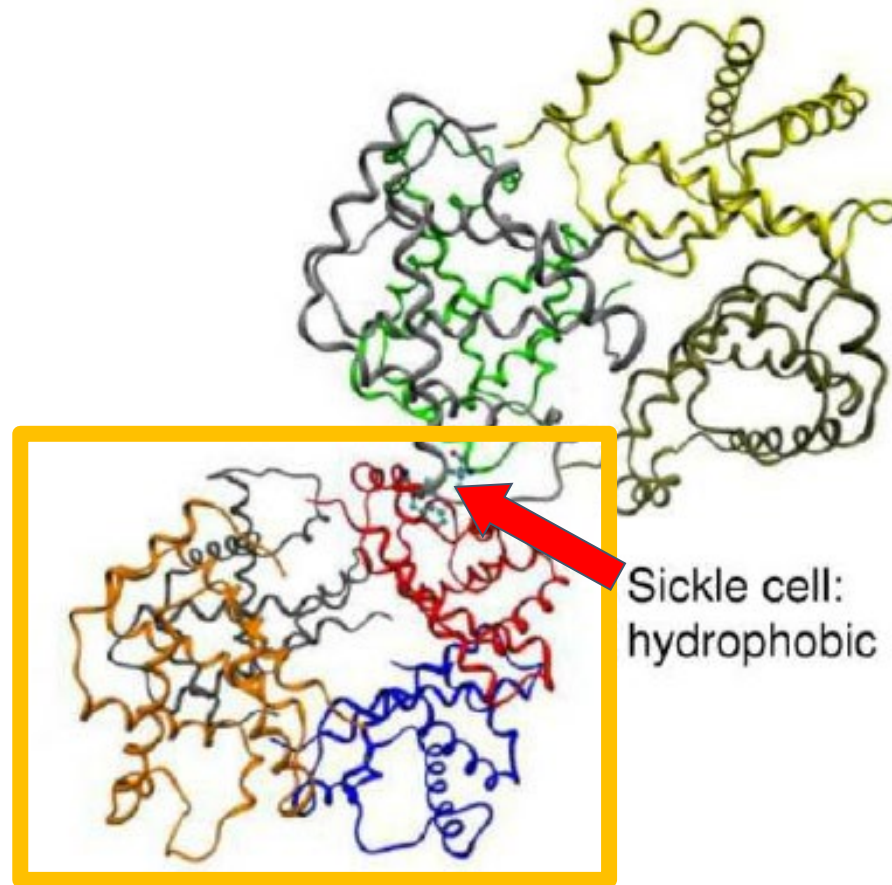
Change in DNA = Mutation

	Normal	Missense Mutation
Partial DNA Sequence of Beta Globin Gene:	CCTGAGGAG GGACTCTCTC	CCTGTGGAG GGAACCTCTC
Partial RNA Sequence:	CCUGAGGAG	CCUGUGGAG
Partial Amino Acid Sequence for Beta Globin:	Pro—Glu—Glu	Pro—Val—Glu

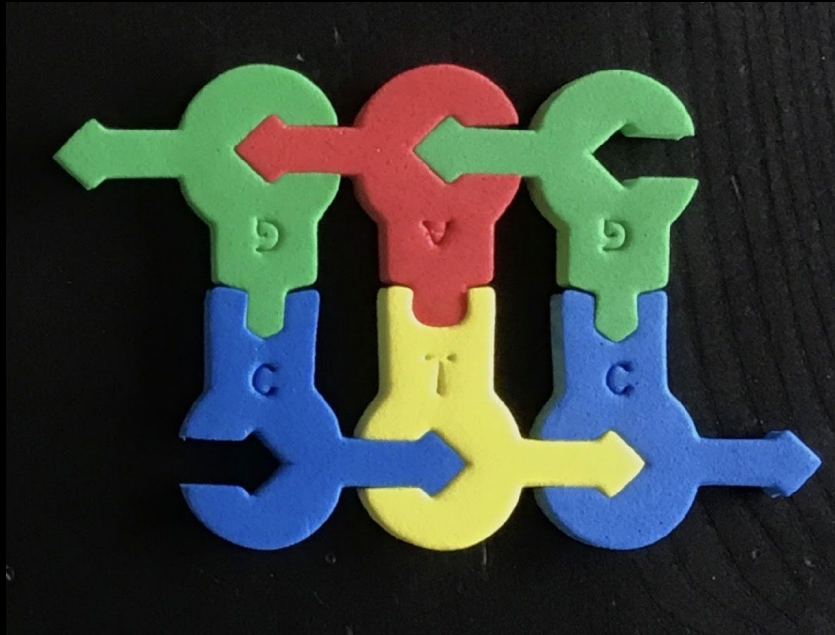
Normal Hemoglobin



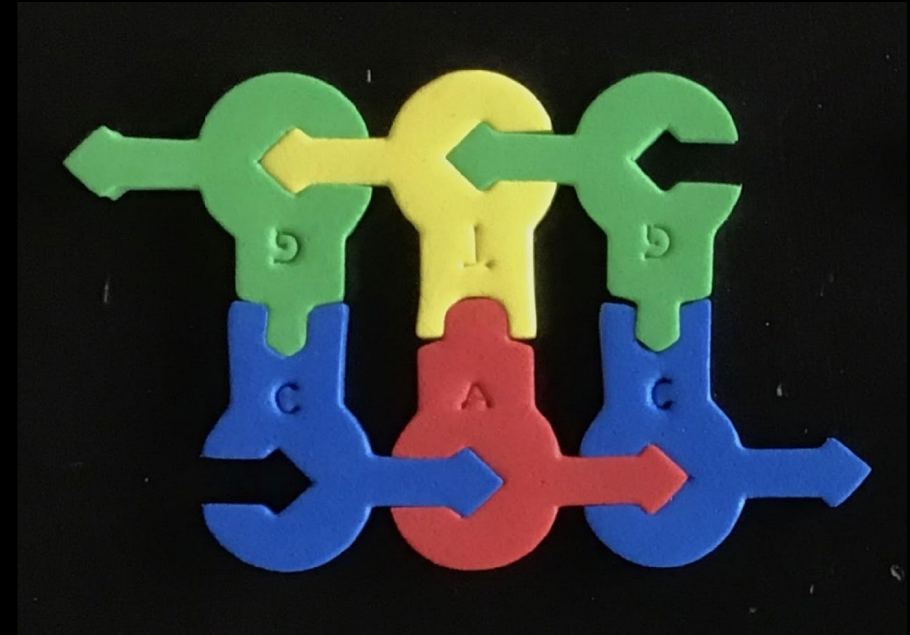
Abnormal Hemoglobin



Build these HBB Variants (Alleles)



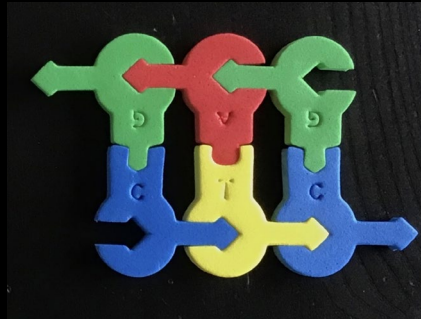
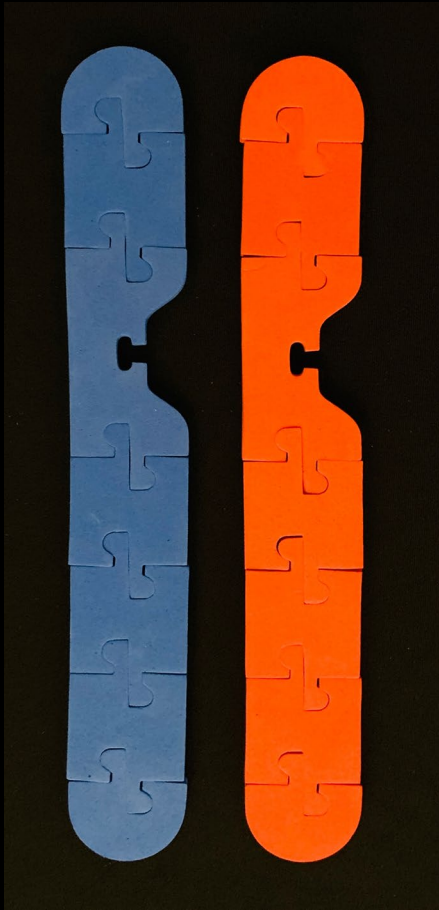
**Normal
Beta-Globin Protein
(Hemoglobin-A)**



**Abnormal
Beta-Globin Protein
(Hemoglobin-S)**

HBB Genotypes

What are the possible allele combinations that someone could inherit?



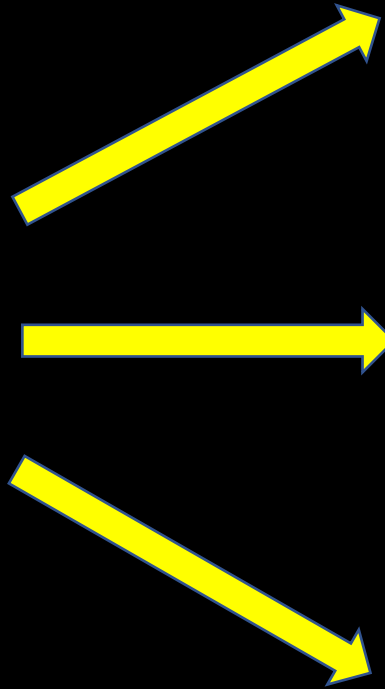
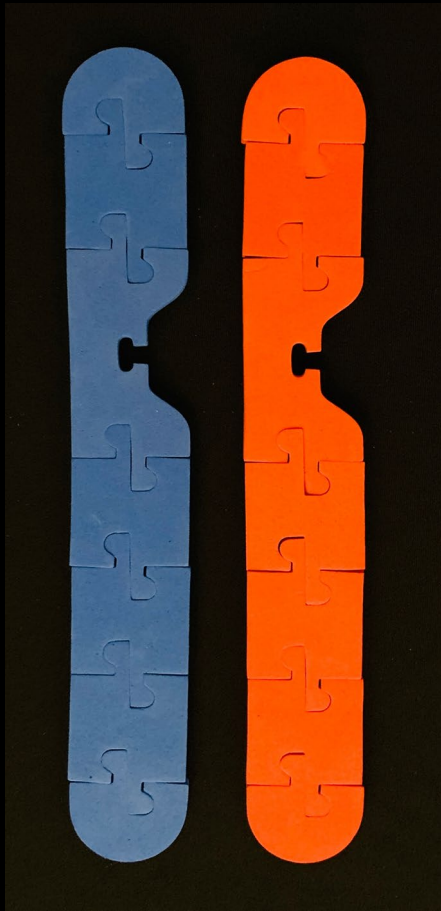
Hemoglobin-A



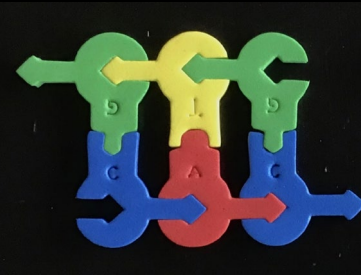
Hemoglobin-S

HBB Genotypes

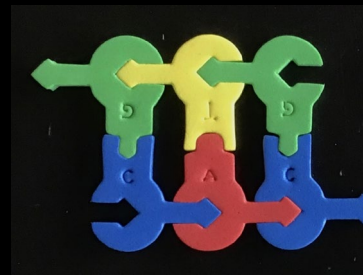
3 possible allele combinations:



$H_A H_A$ or HH

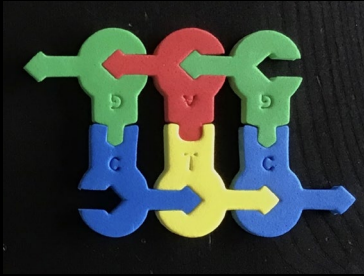


$H_A H_S$ or Hh

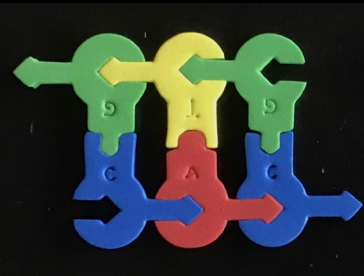


$H_S H_S$ or hh

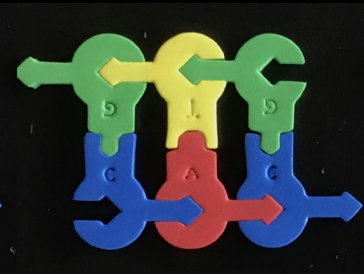
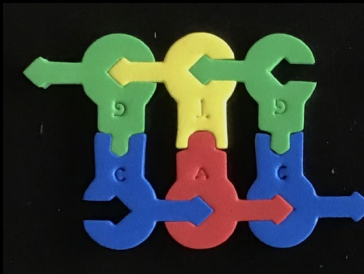
- What will be the shape(s) of the **hemoglobin molecules**?
- How do you think the shape of these different molecules will affect the *structure* and *function* of **red blood cells**?



HH = Normal Phenotype



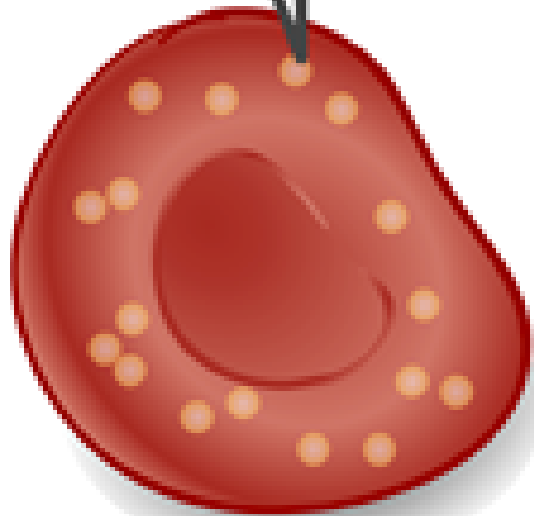
Hh = Sickle Cell Trait



Hh = Sickle Cell Disease

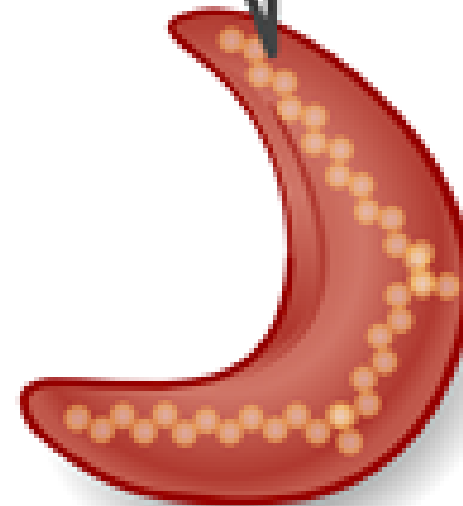
NORMAL RBC

Normal
hemoglobin
molecules

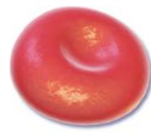


SICKLED RBC

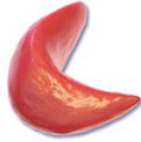
Abnormal
hemoglobin
molecules



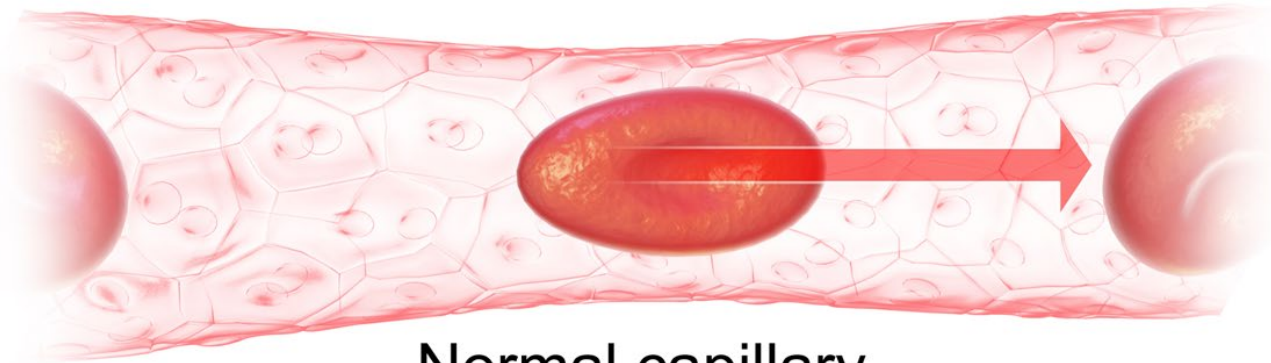
© AboutKidsHealth.ca



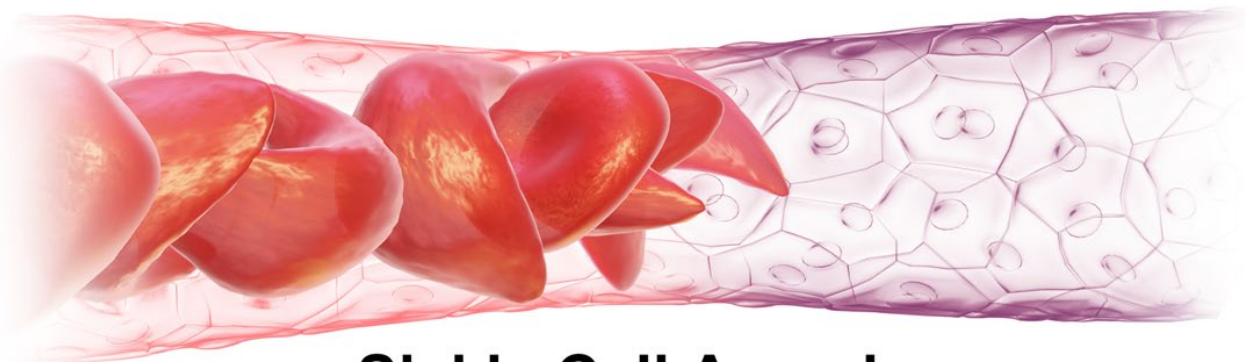
Normal red blood cell



Sickle-shaped red blood cell

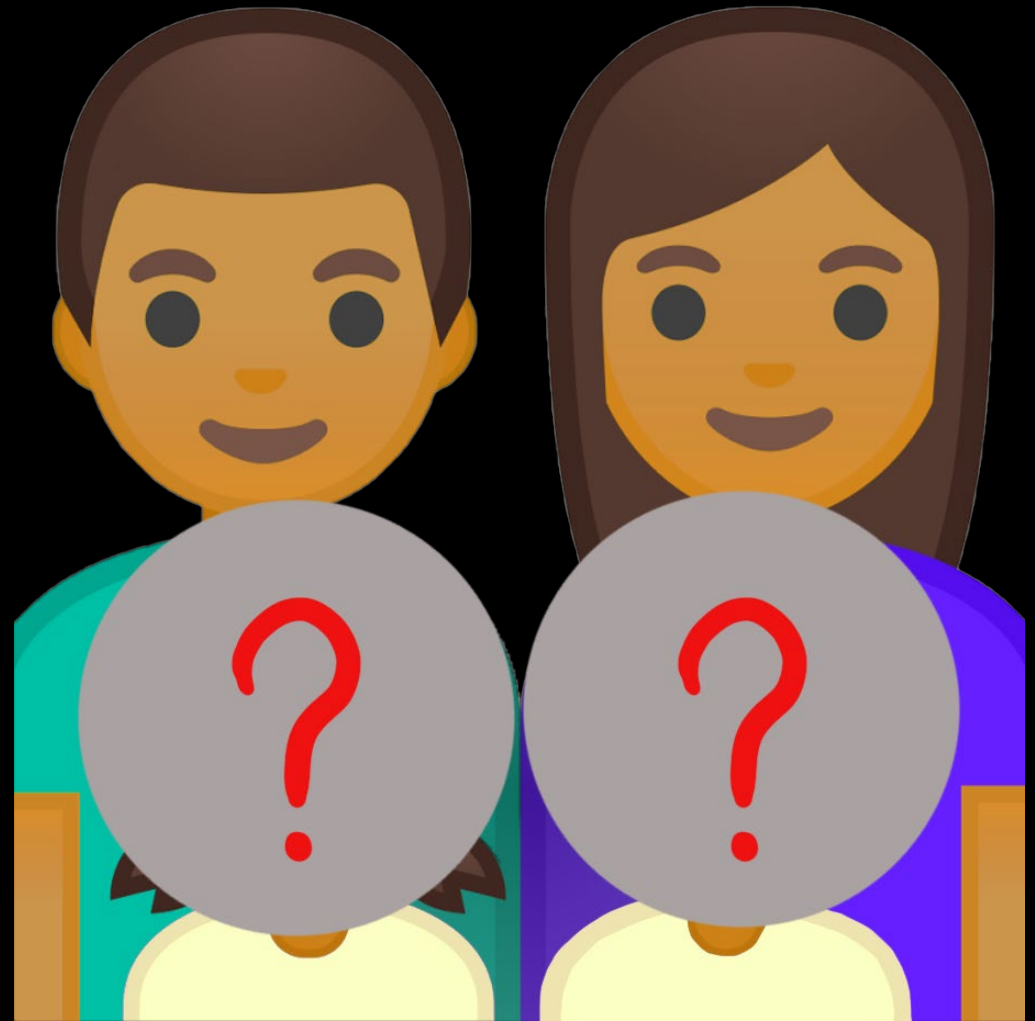


Normal capillary



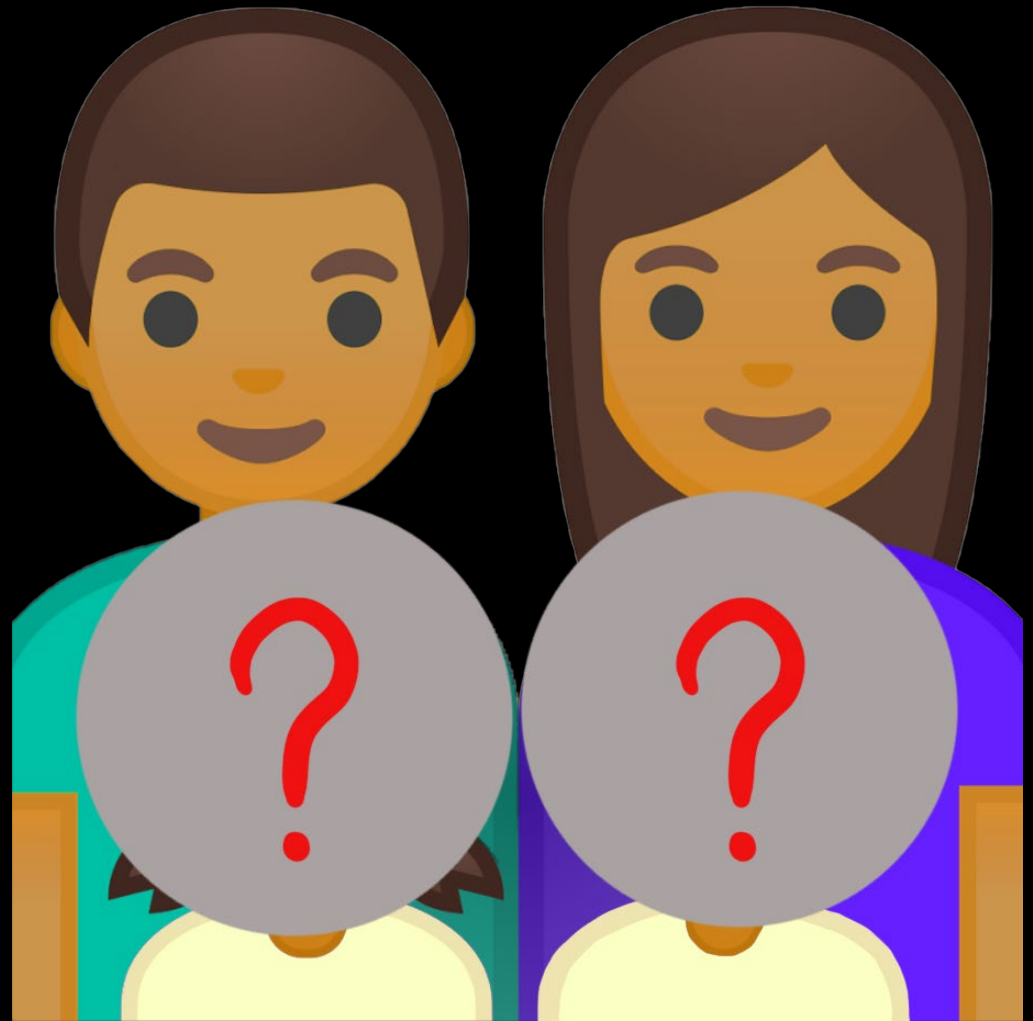
Sickle Cell Anemia

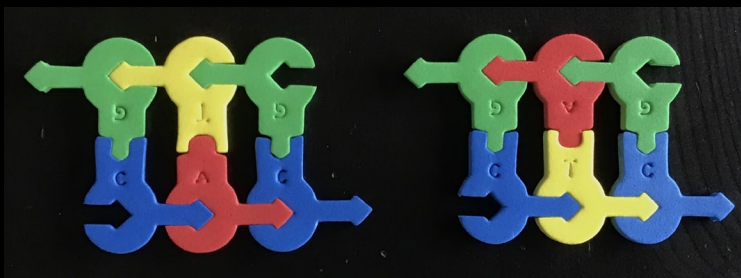
Mr. & Mrs.
Smith



Mr. Smith: Hh

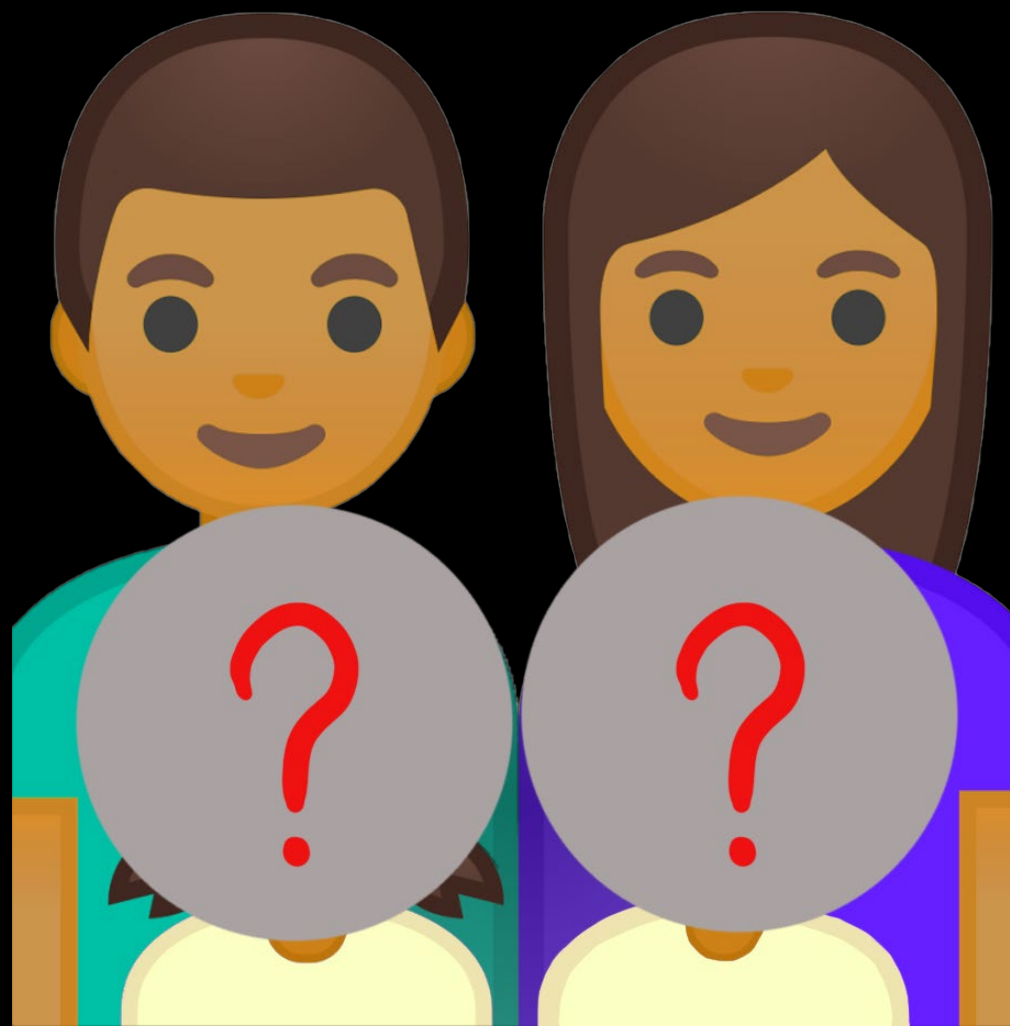
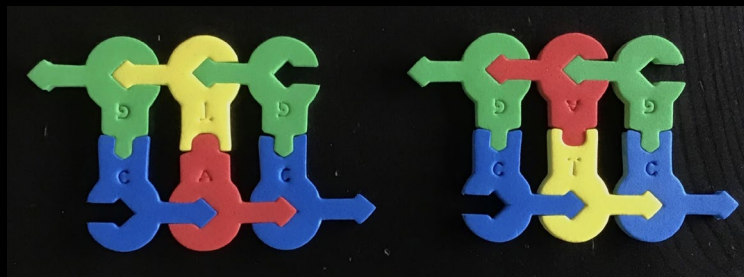
Mrs. Smith: Hh

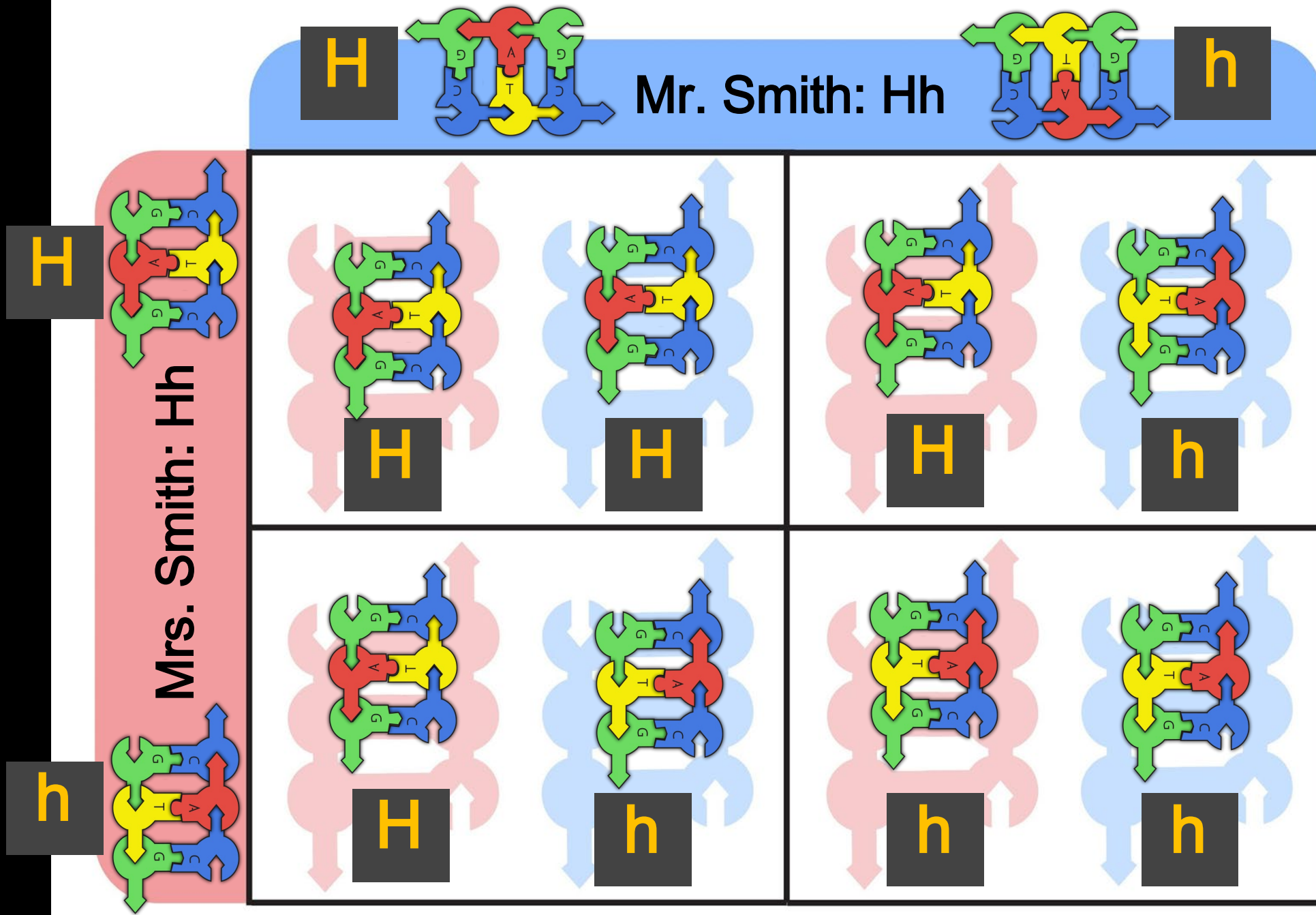




Mr. Smith: Hh

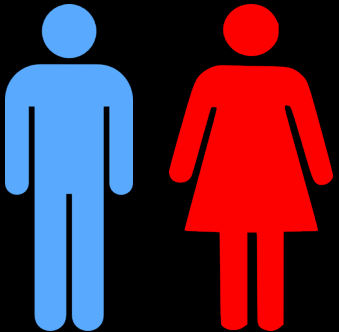
Mrs. Smith: Hh



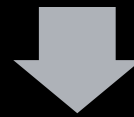




Place the genotypes onto the Punnett Square handout

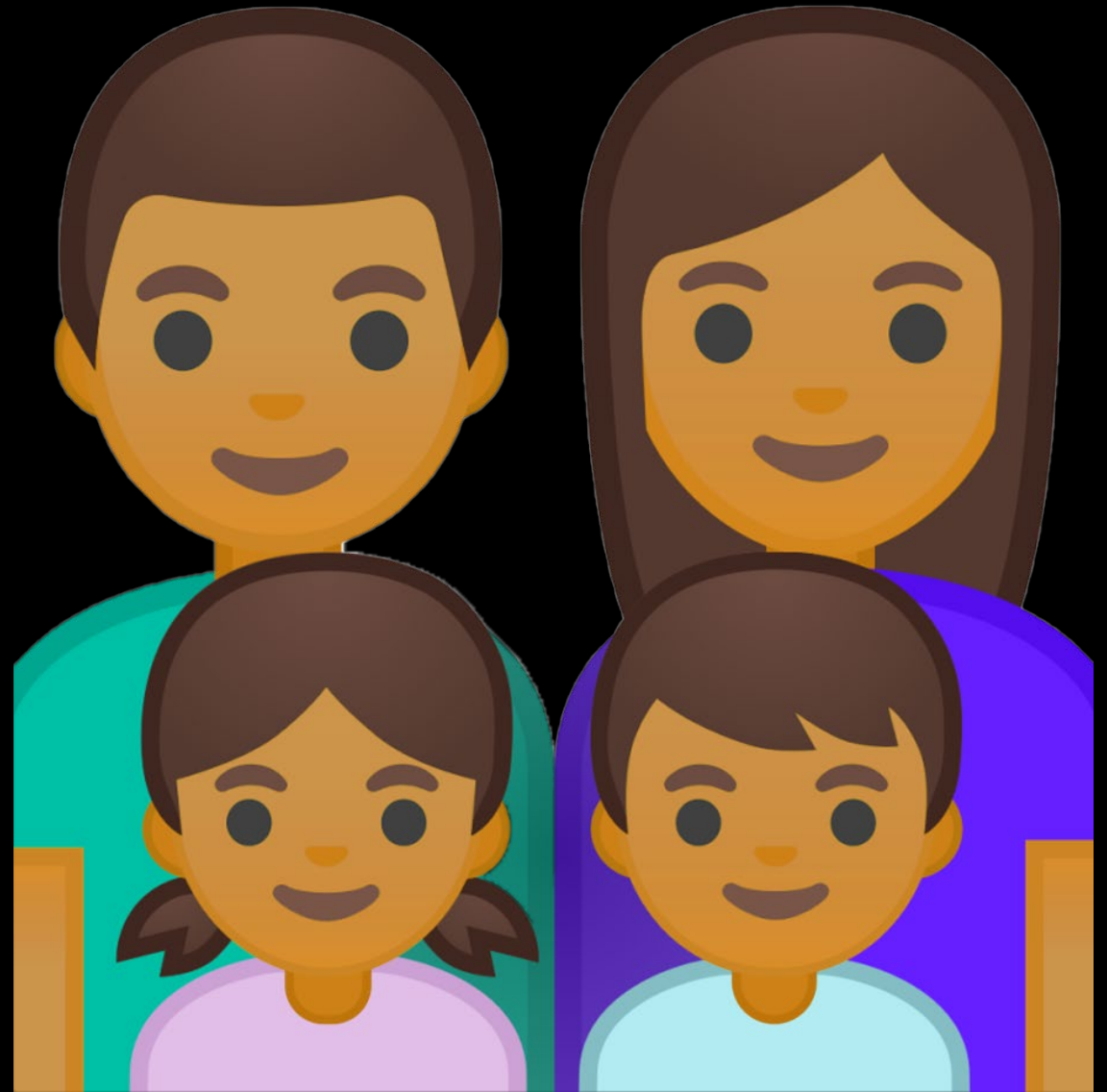


Create different combinations of genotypes by **moving** one “allele” from each parent into the offspring boxes



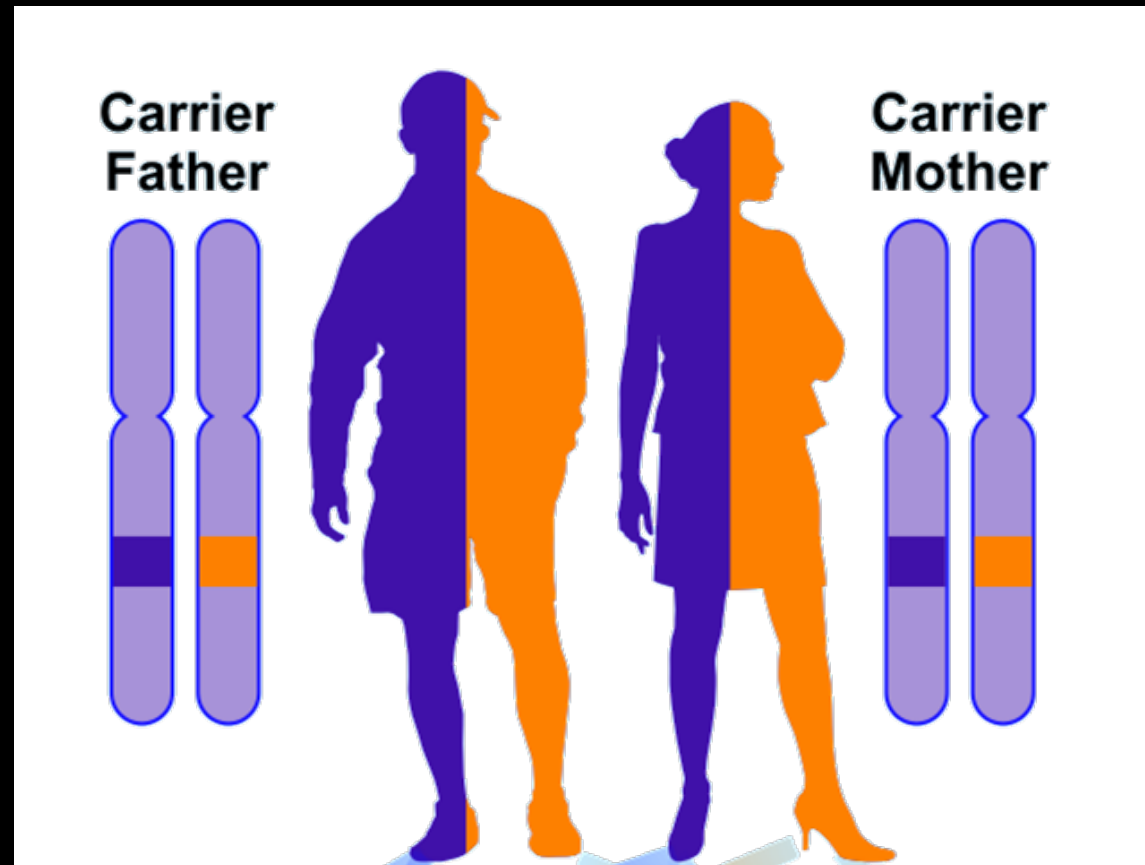
Take a photo of each offspring box to record each combination of alleles

What are the chances that the Smiths will have a child affected with sickle cell disease?

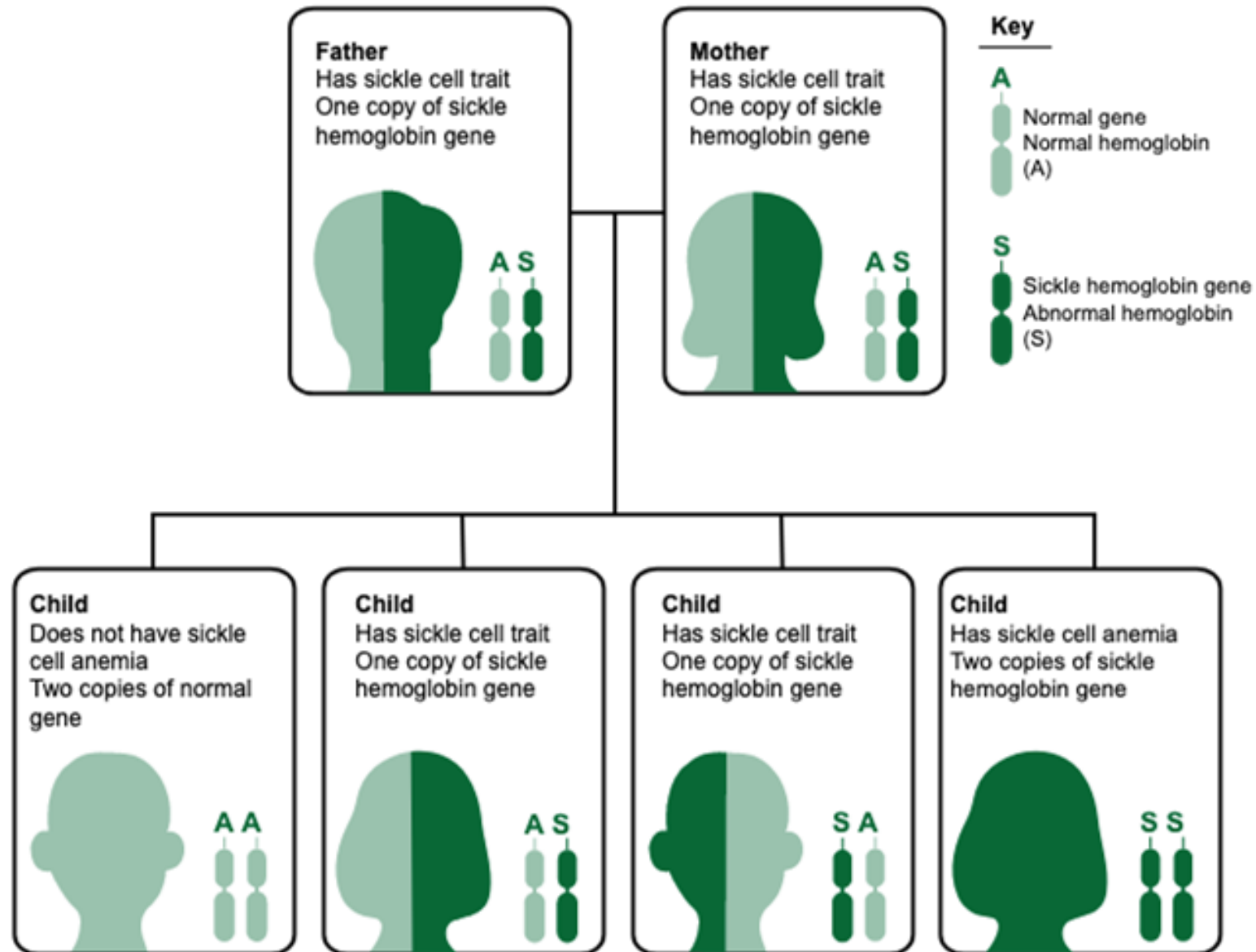


Sickle Cell Anemia is inherited as an autosomal recessive genetic disorder.

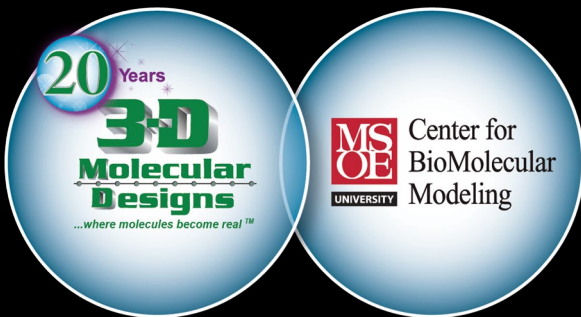
Mr. Smith: Hh



Mrs. Smith: Hh





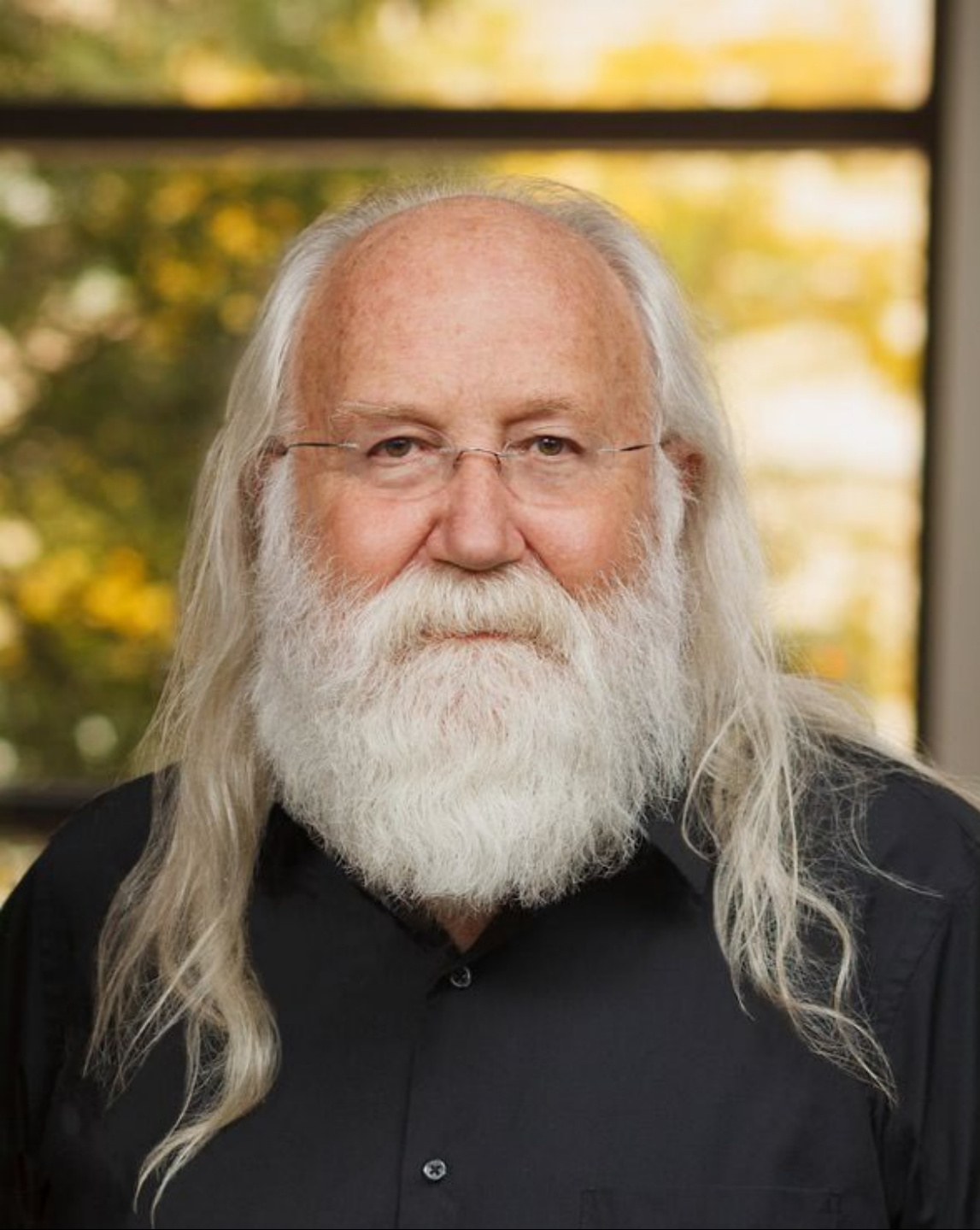


Summer Courses

- A few weeks ago, we shared some information about Modeling the Molecular World.
- Watch now to learn about two additional Summer Courses the CBM has to offer
- To learn about all of the Summer Professional Development Courses the CBM has to offer visit:

<https://cbm.msoe.edu/summerCourses>

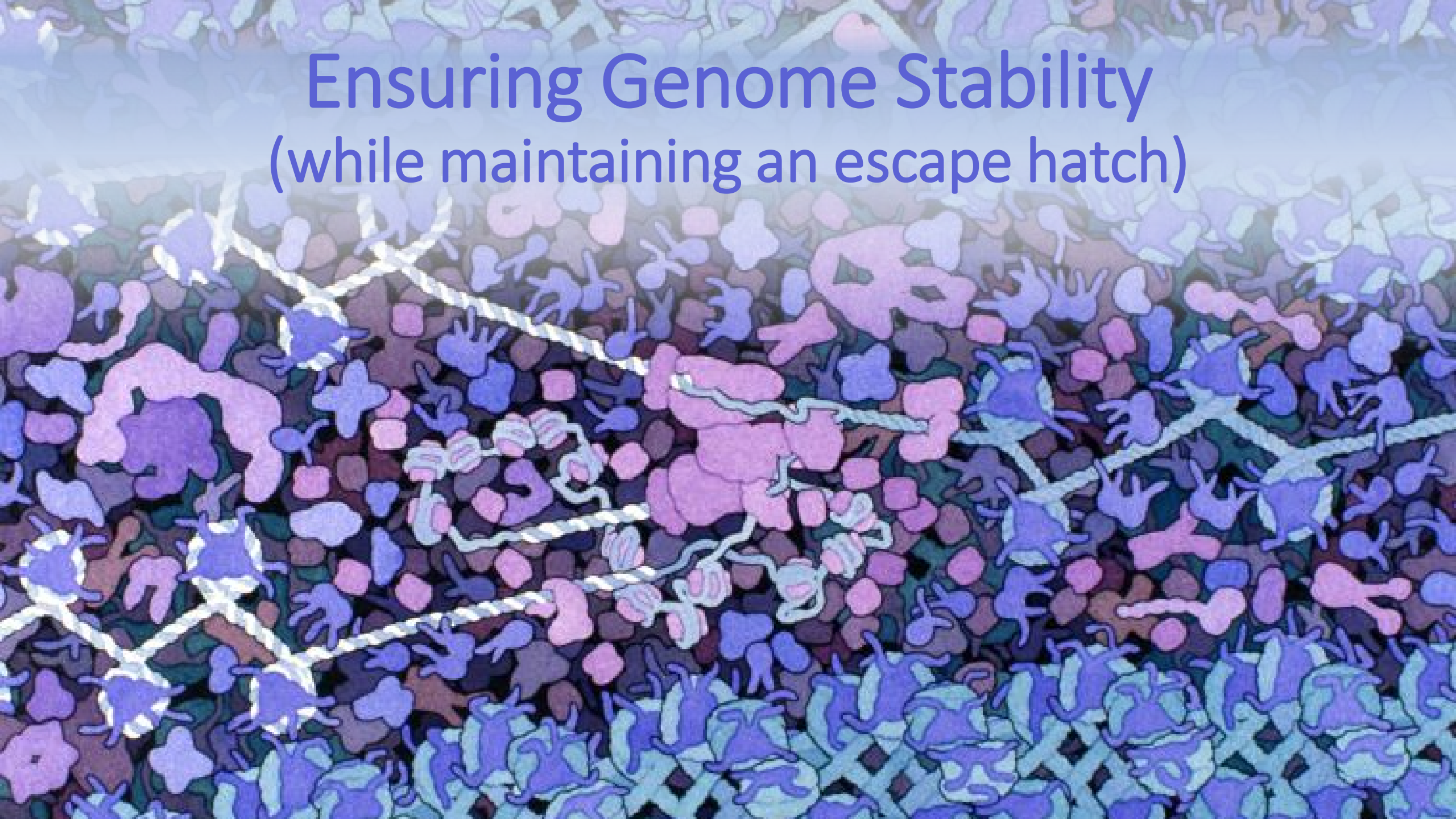


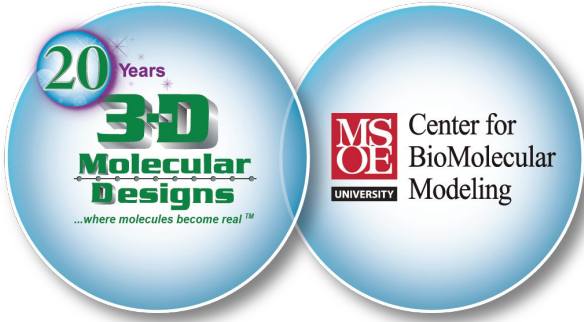


Timothy Herman, PhD

- Director of the Center for BioMolecular Modeling at MSOE
- Founding Partner of 3D Molecular Designs
- B.S. in Chemistry from the University of Nebraska
- Ph.D. in Biochemistry from Oregon State University.
- Post-doctoral studies in Molecular Biology at Harvard Medical School.

Ensuring Genome Stability (while maintaining an escape hatch)





A foundational concept of biology is

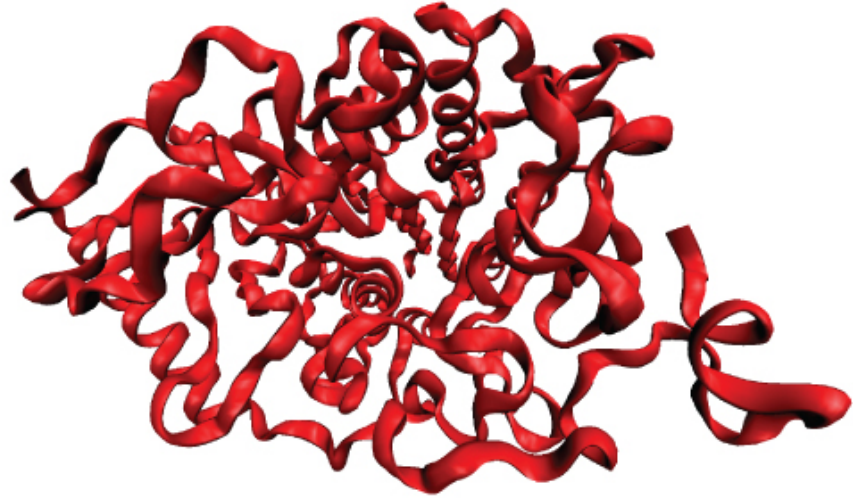
GENETICS

MOLECULAR GENETICS

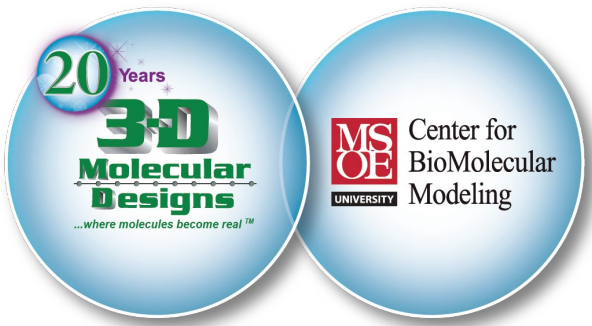
- *and the flow of genetic information from -*

DNA... to RNA... to Protein

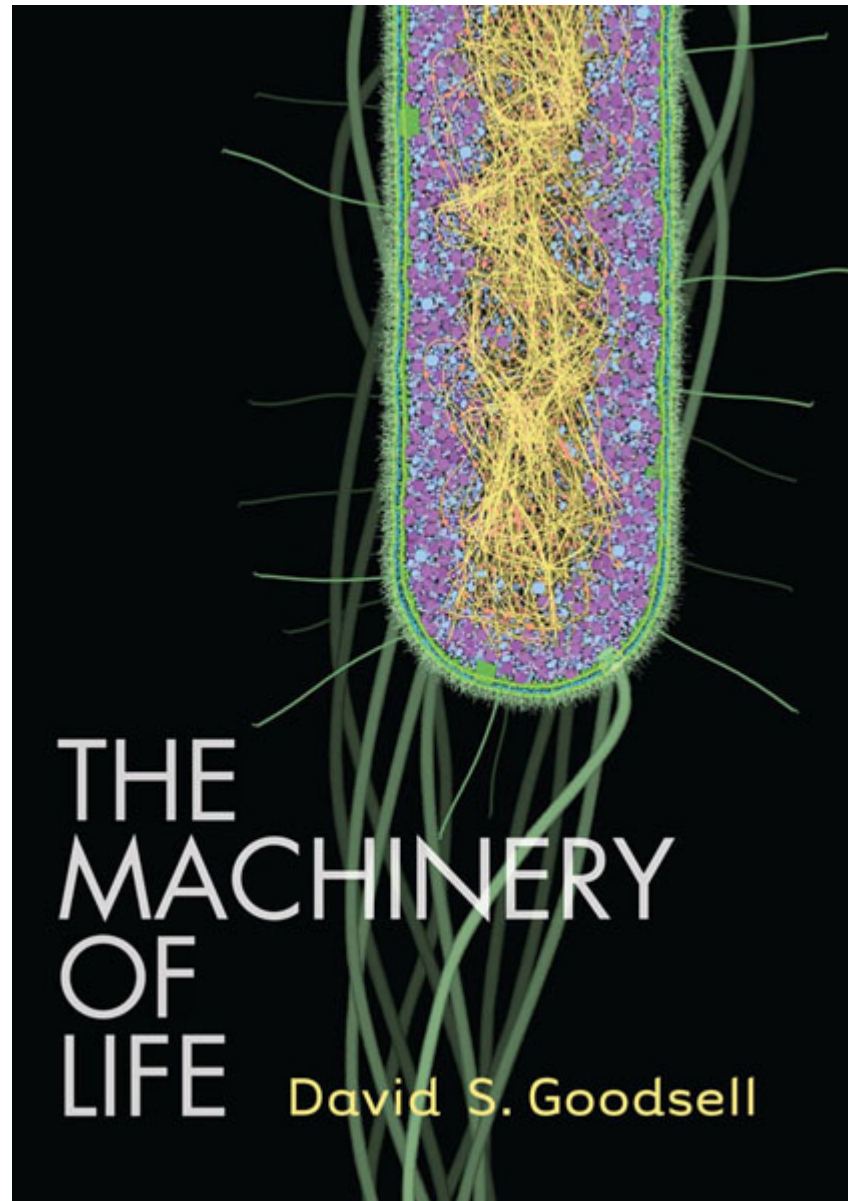
Should you teach **EPIGENETICS**?



*Life is
Complicated*
Let's deal with it. . .



*In **epigenetics**, small chemical markers -- methyl groups and acetyl groups -- are **added to both DNA and histones** to regulate the accessibility of the DNA to transcription machinery.*



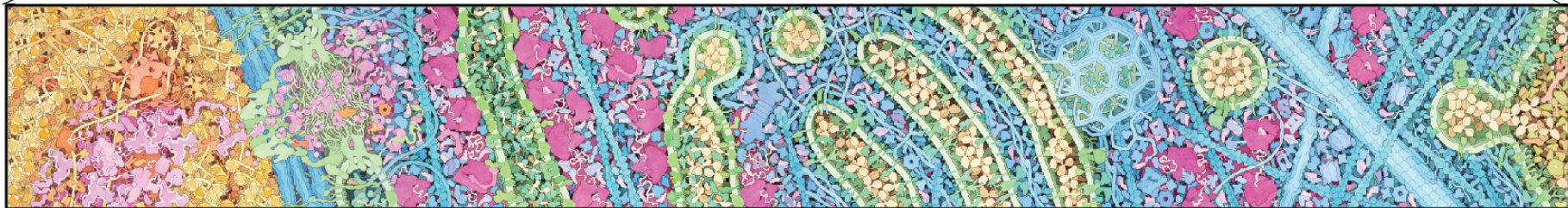
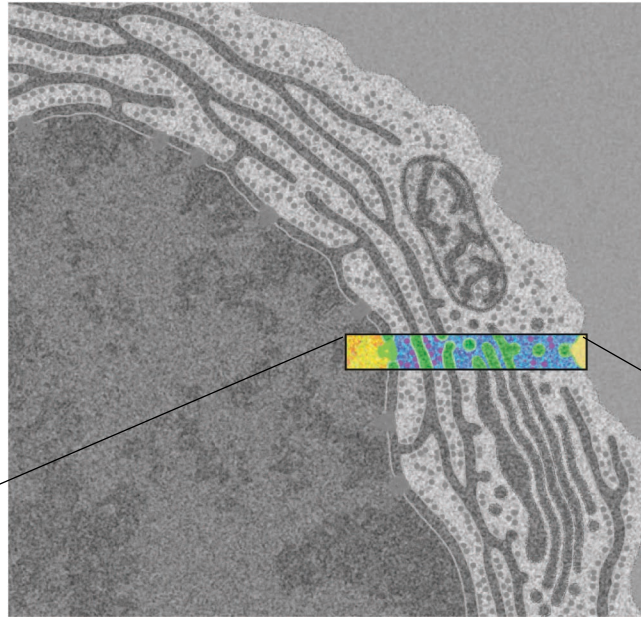
David Goodsell

Scripps Research institute

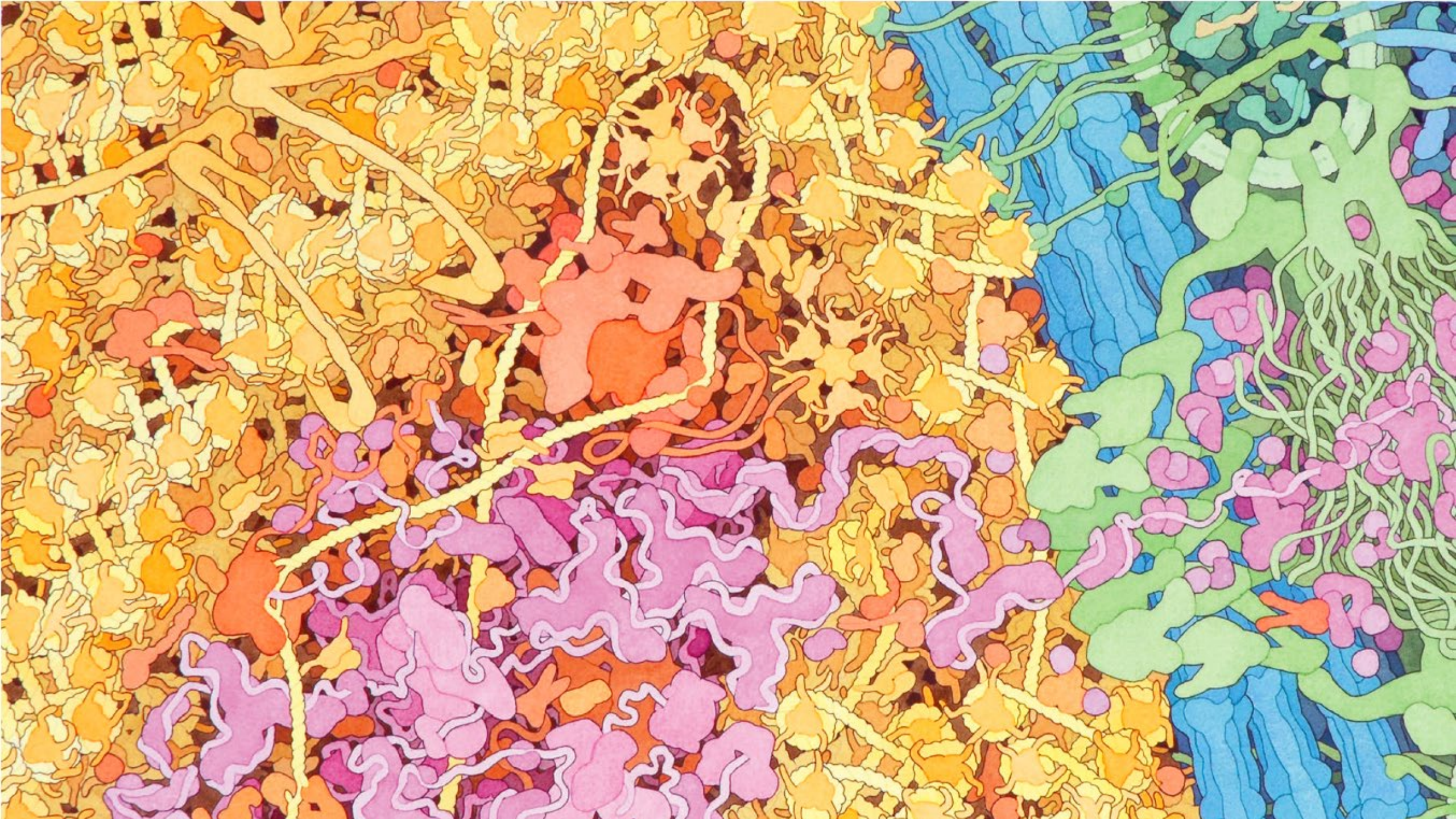
*Scientist, Author, and Artist
of all things small.*

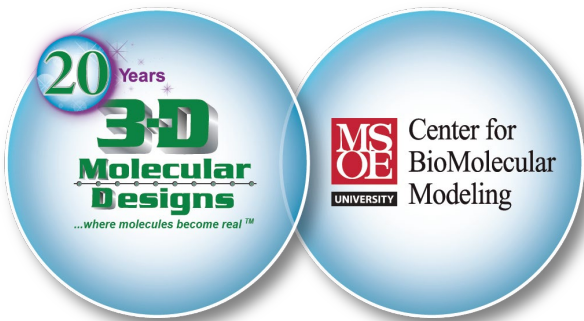


An electron micrograph of an antibody-producing B-cell



Your recent flu shot, in action.

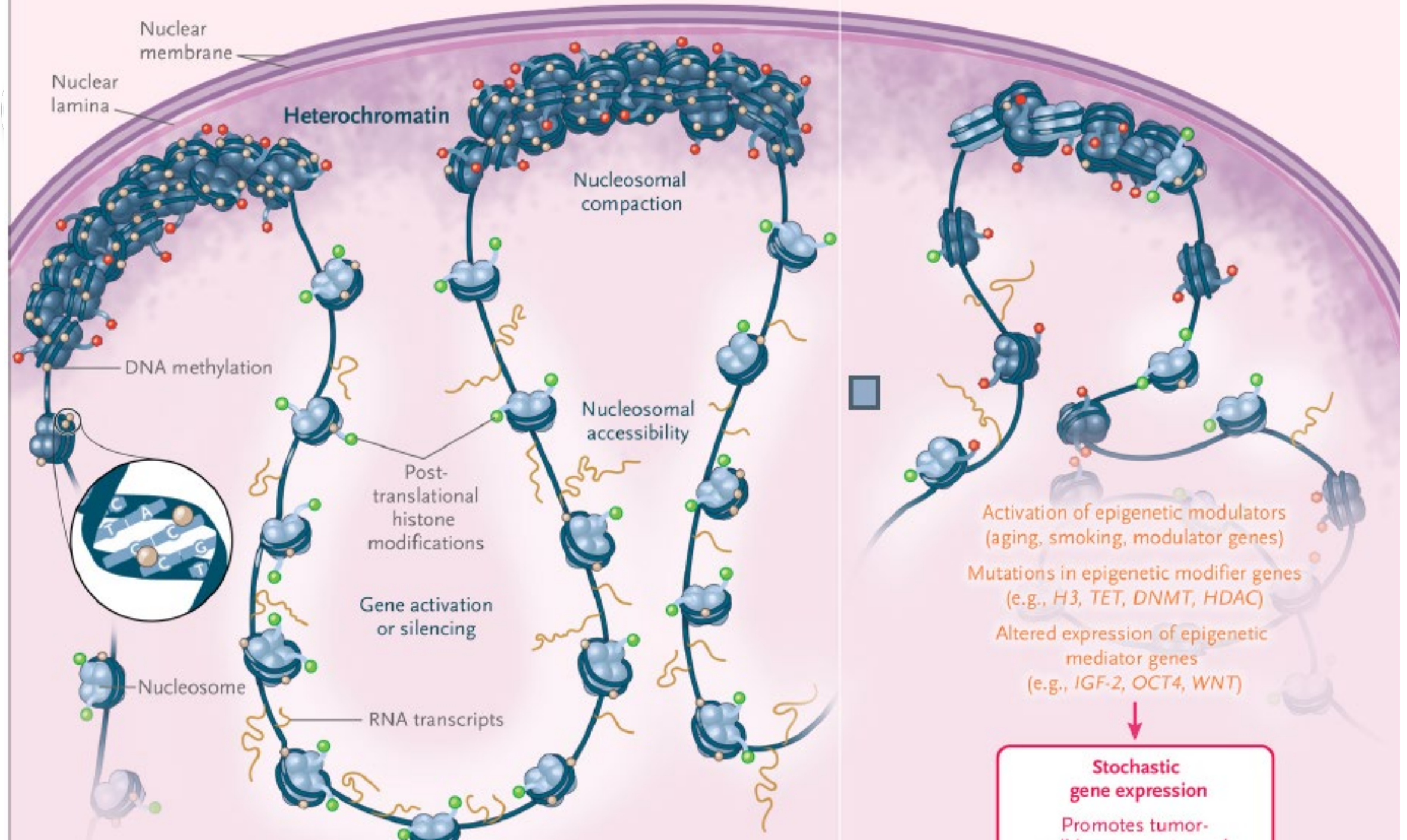


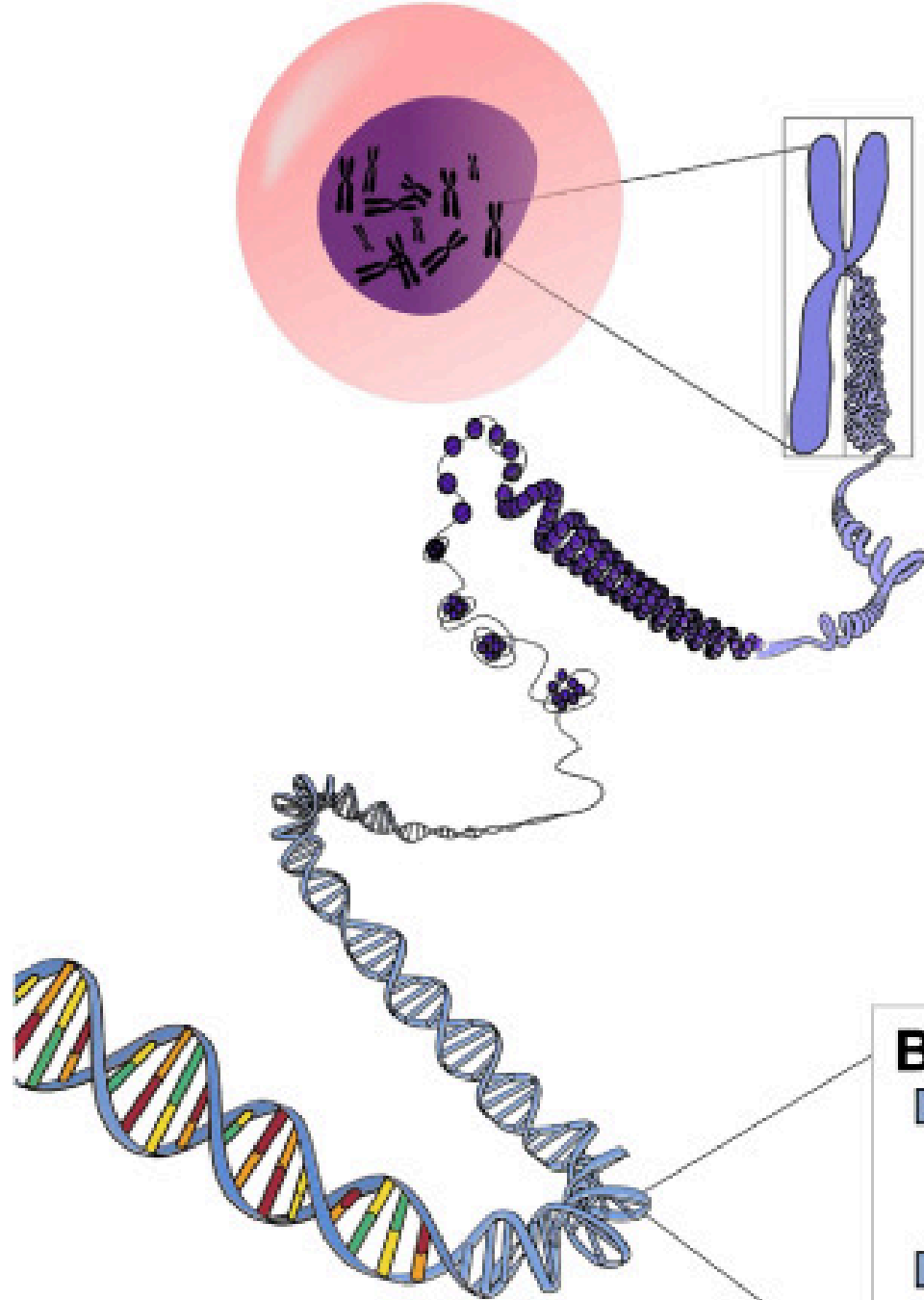


Thinking Deeper....

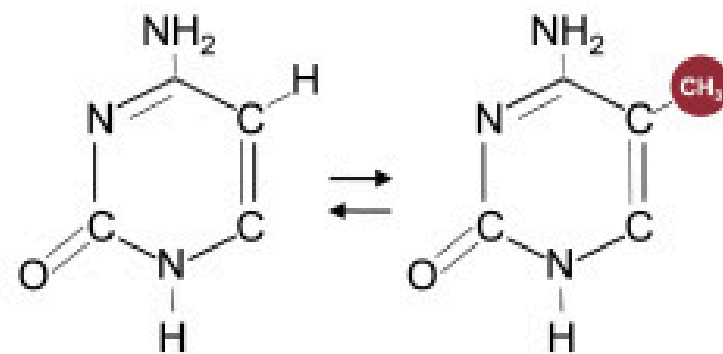
Consider the human genome – 3.2 billion base pairs of DNA, wrapped up into nucleosomes. Only 1.5% of our genome encodes protein. And only a fraction of all those protein-encoding genes are expressed in any one cell type.

When we transcribe our DNA into mRNA...
how do we find the right genes to express?
... and how do we deal the nucleosomes?



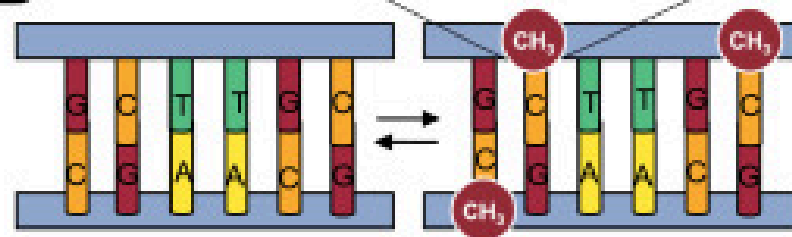


A



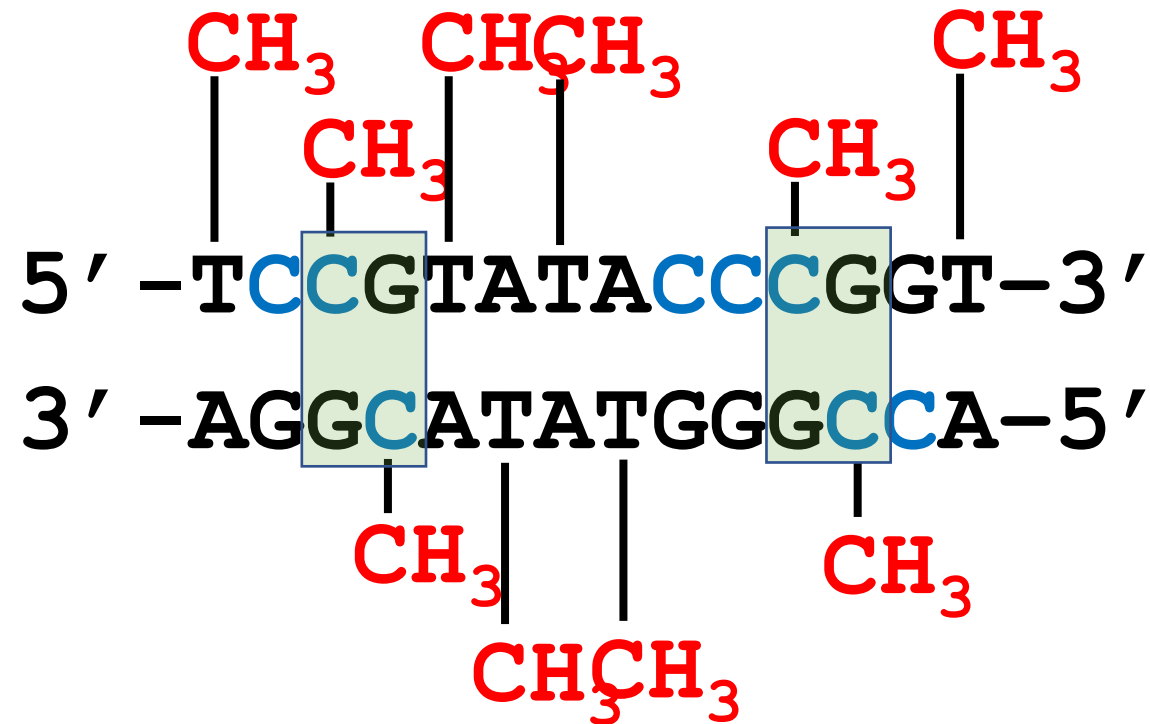
Cytosine Unmethylated $\rightleftharpoons$ Cytosine Methylated

B

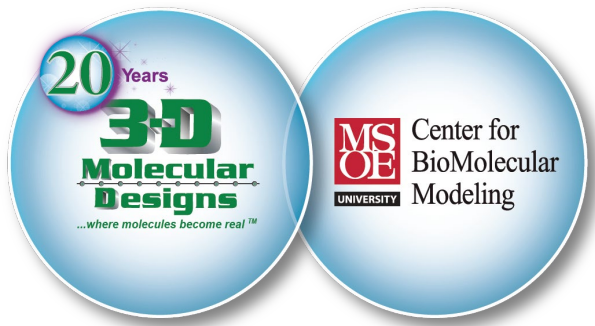


Gene Transcribed $\rightleftharpoons$ Gene Repressed

In eukaryotes,. the **cytosine** of 5'– **CpG** -3' is methylated ...at the #5 carbon



(Thymine (T) is already methylated at it #5 carbon.)

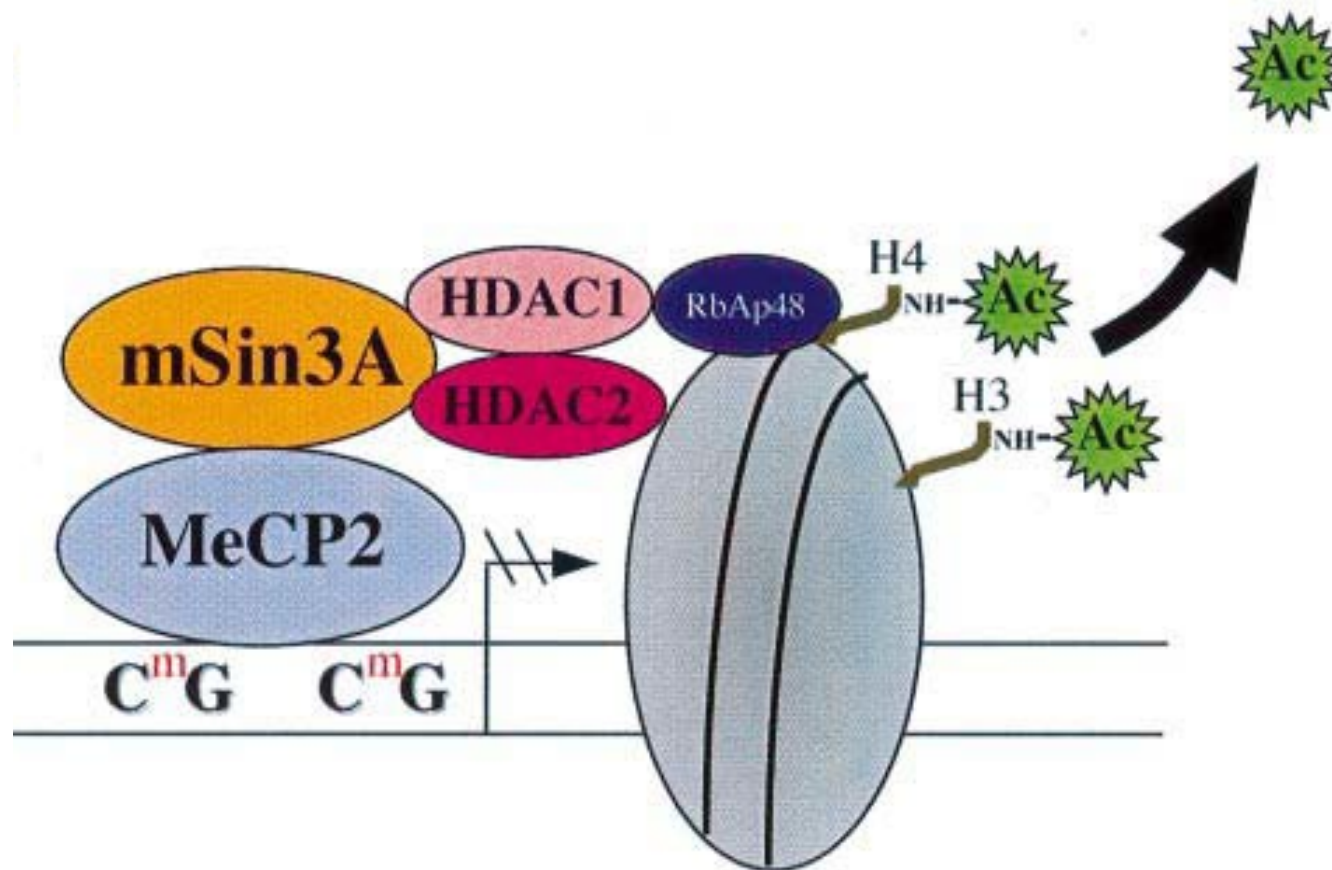


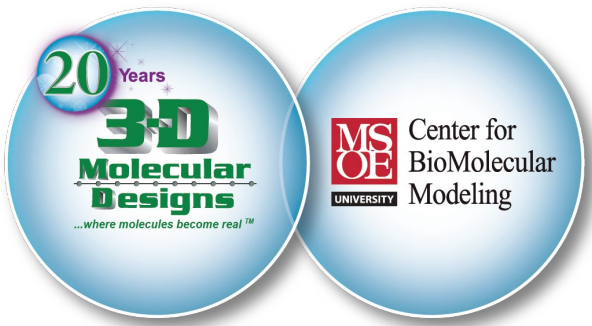
And now,

Let's explore epigenetics with models...

The EMBO Journal Vol.17 No.17 pp.4905–4908, 1998

CpG methylation, chromatin structure and gene silencing—a three-way connection



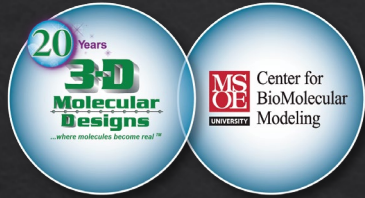


Ask me in the March 17 webinar...

*What does **CRISPR***

*have to do with **epigenetics**?*

Thank you for attending!



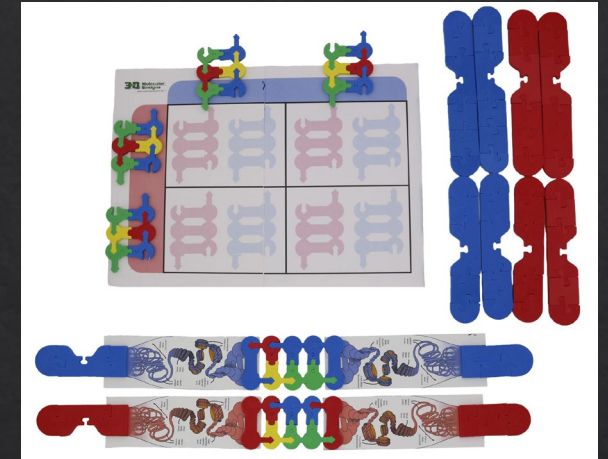
Join us on [facebook](#) for Science Sunday!

Use discount code [Webinar20](#) to receive 20% off most items in our catalog.

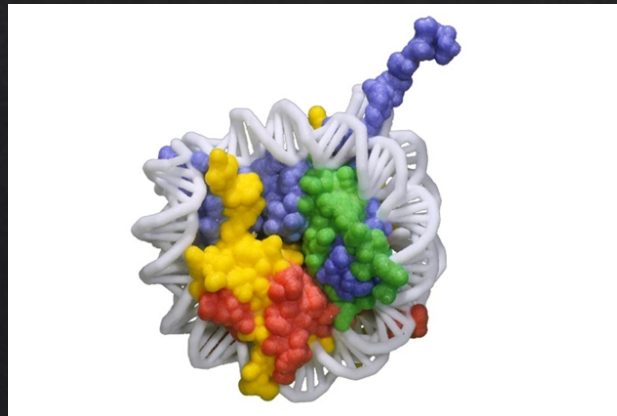
Dynamic DNA Kit©



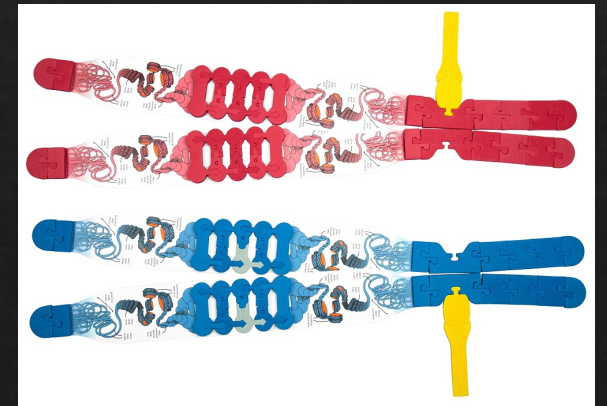
Chromosome Student Modeling Pack

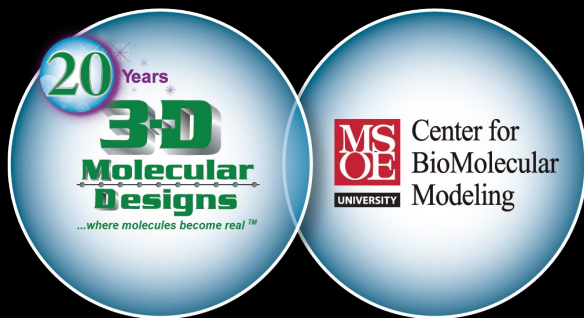


Nucleosome Mini Model

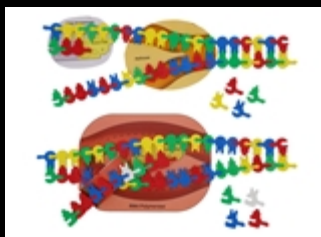


Chromosome Connections Kit©





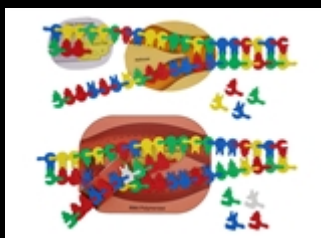
Invite your colleagues to register



Genome Editing, I

CRISPR – As an Adaptive Immune System in Bacteria

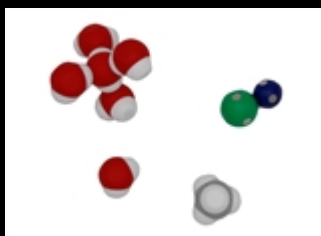
Wednesday, March 10, 2021 at 6:00 PM Central



Genome Editing II

CRISPR Cas9 - A Powerful New Tool for Editing the Human Genome

Wednesday, March 17, 2021 at 6:00 PM Central



Celebrate World Water Day!

Engage with Water Molecules!

Monday, March 22, 2021 at 6:00 PM Central

<https://www.3dmoleculardesigns.com/Webinars4.htm>