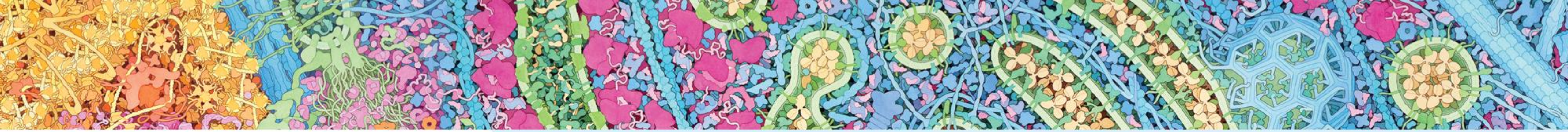

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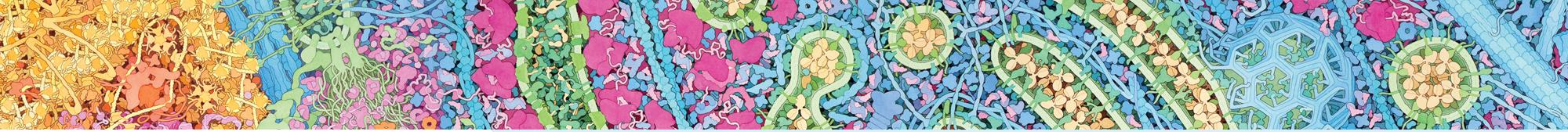
From Code to Creation: The Central Dogma Essentials

Ruth Hutson, MSSE



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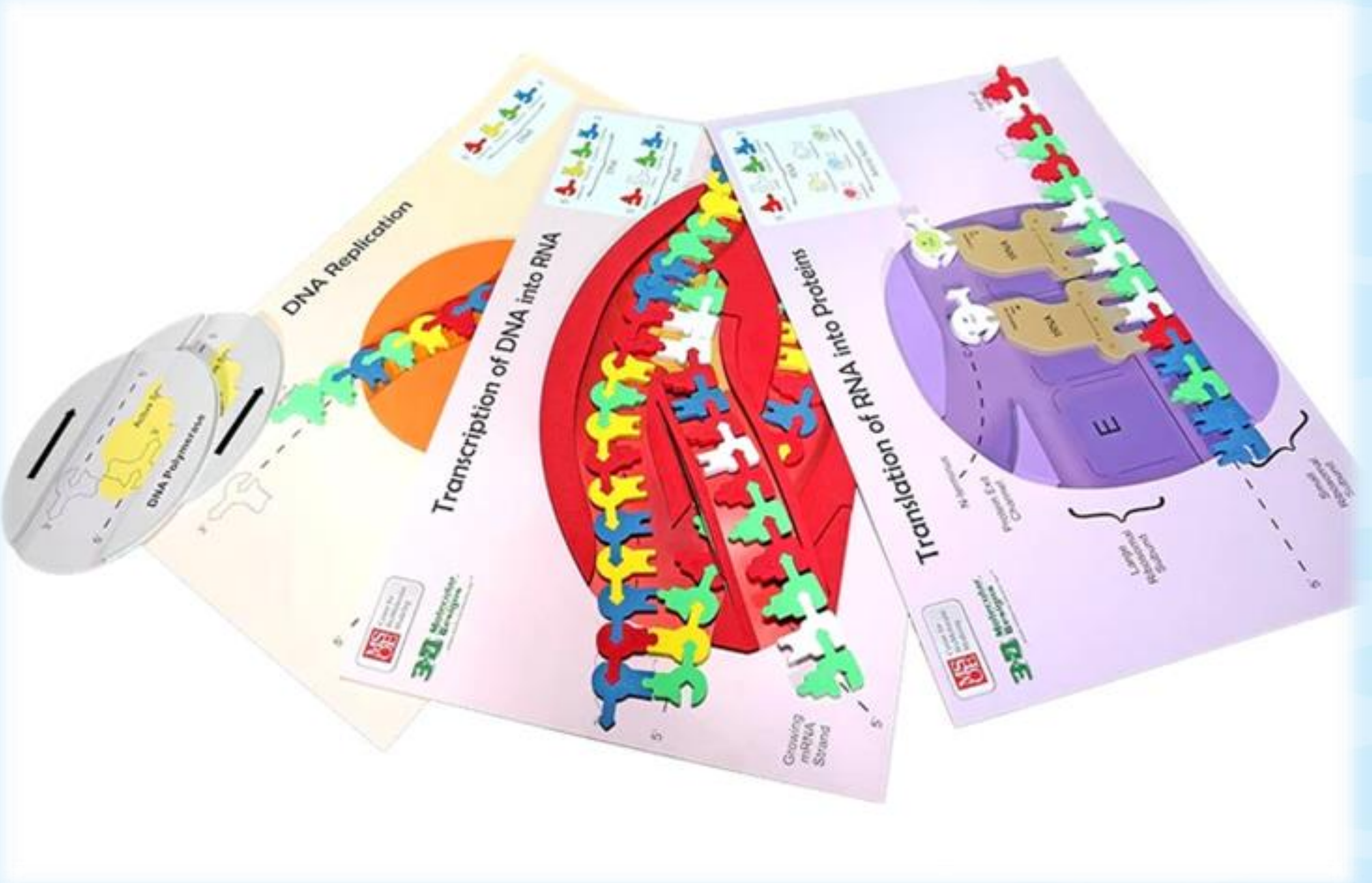


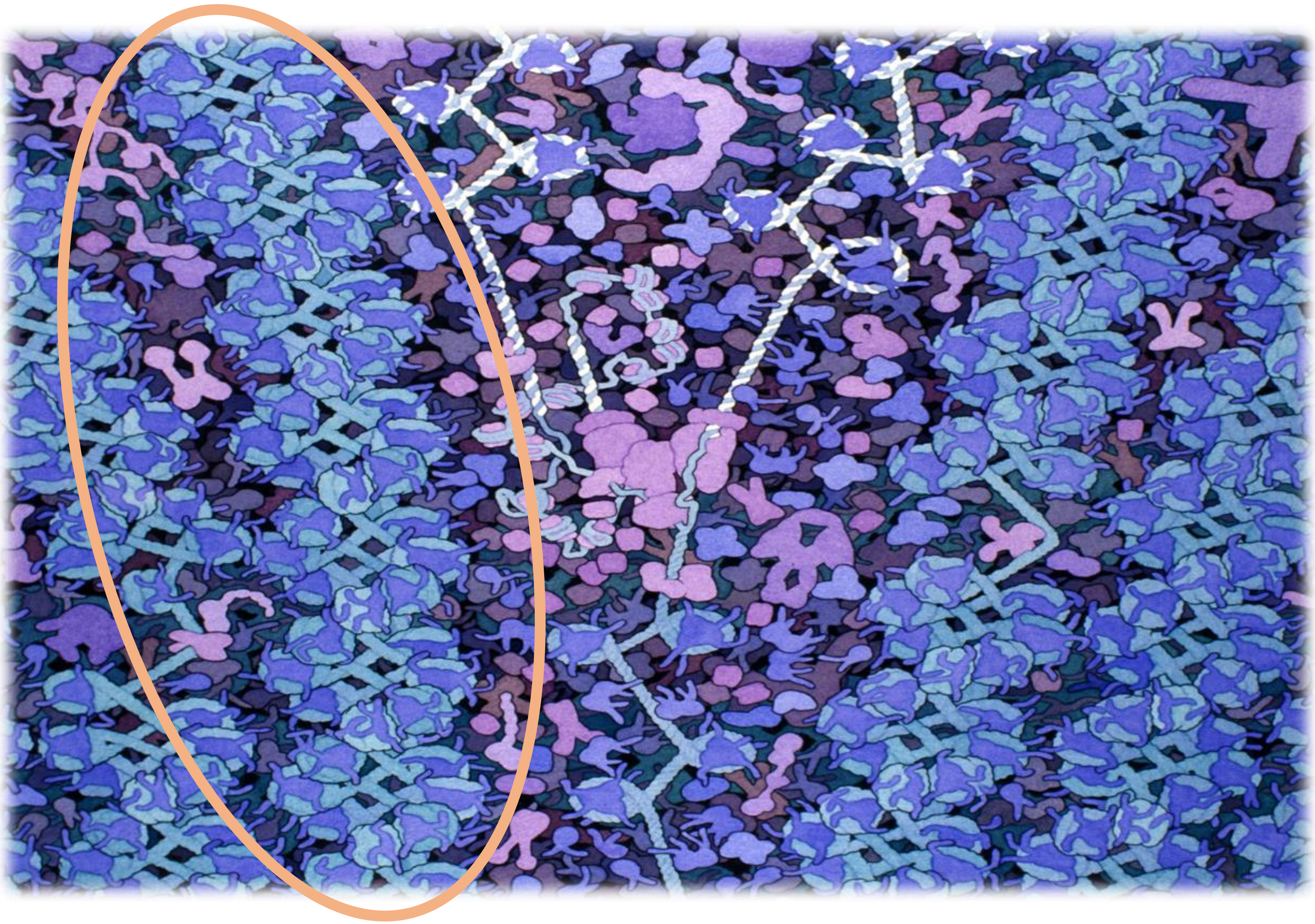
Workshop Outcomes

- Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential function of life through systems of specialized cells by explaining the purpose and purpose of replication, transcription, and translation using models of DNA and RNA.

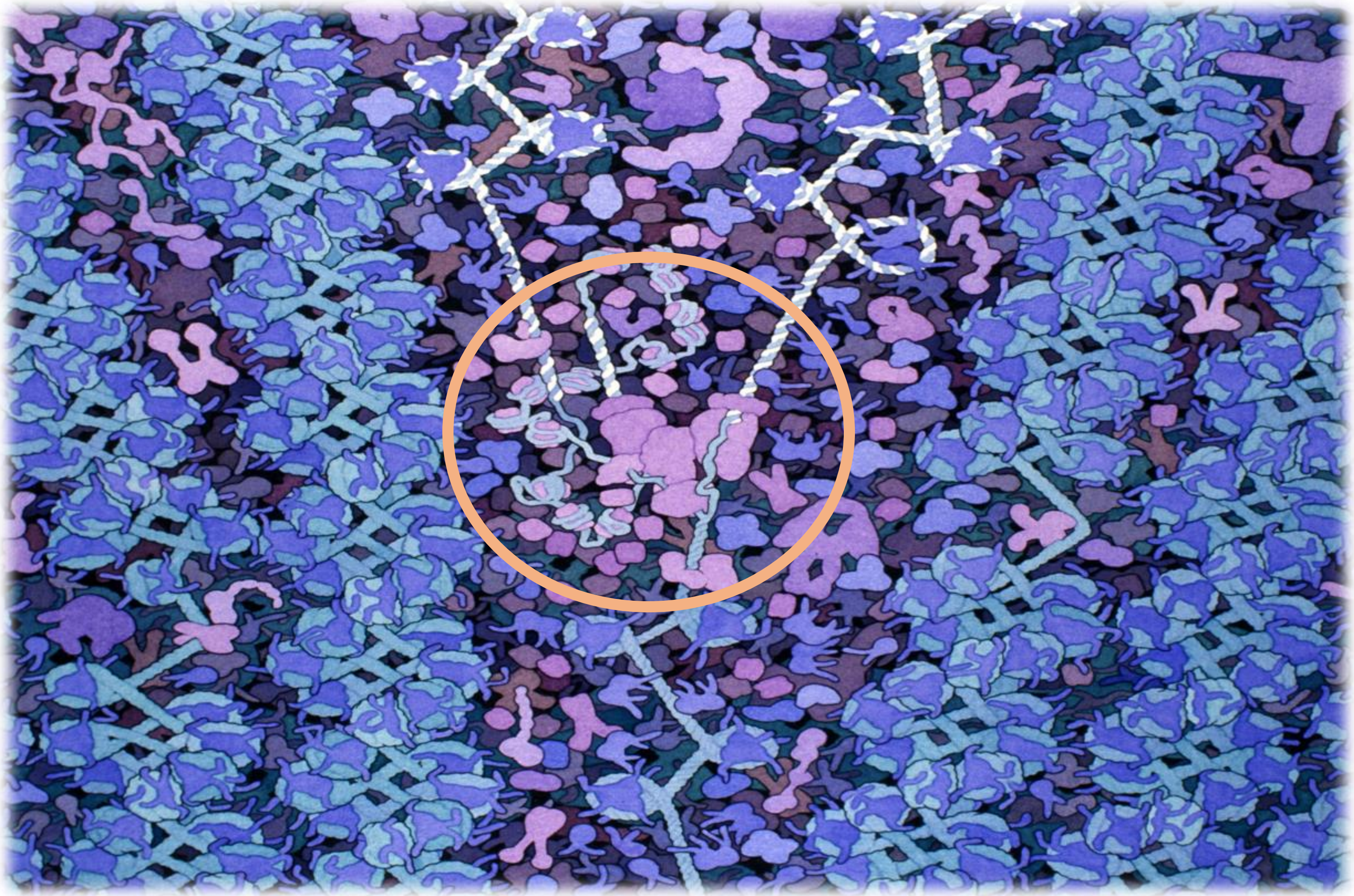
- Examine patterns within and between side chains of amino acids.

- Model protein secondary and tertiary structure based on the primary structure of amino acid sequence.

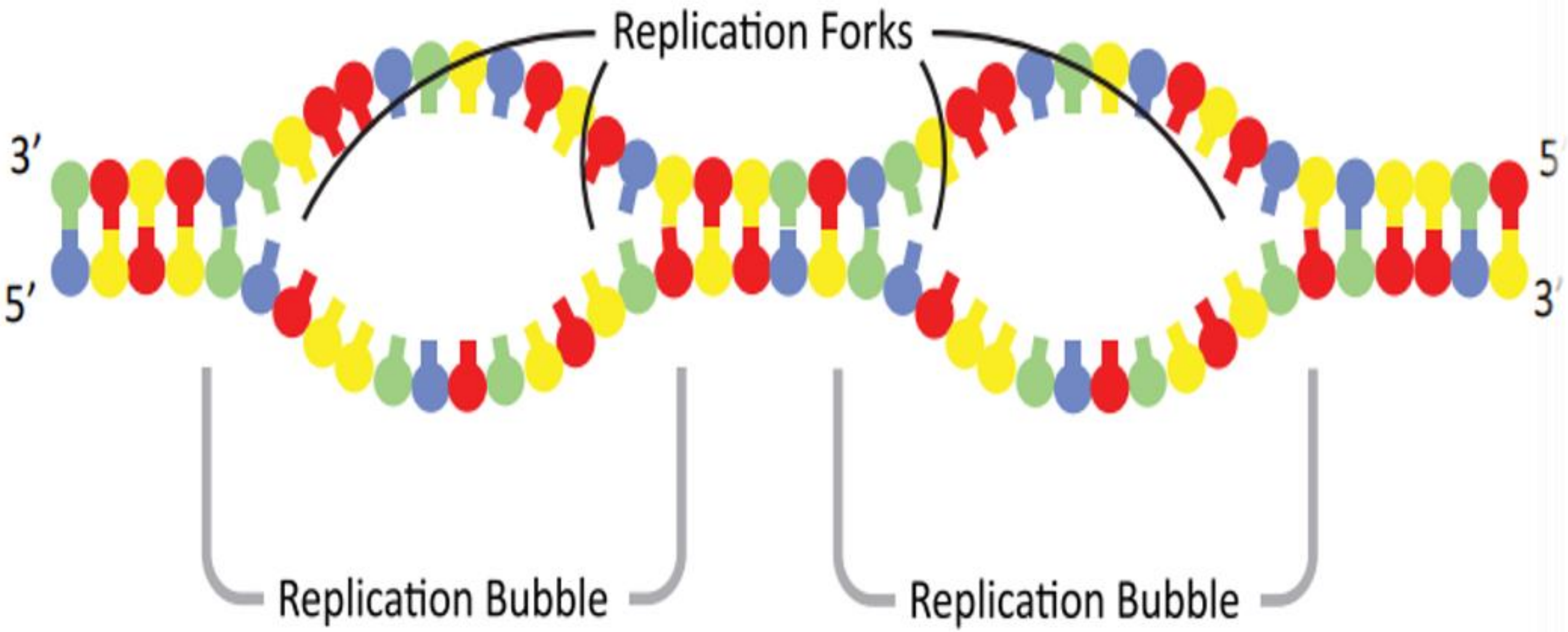
Replication in the Eukaryotic Nucleus



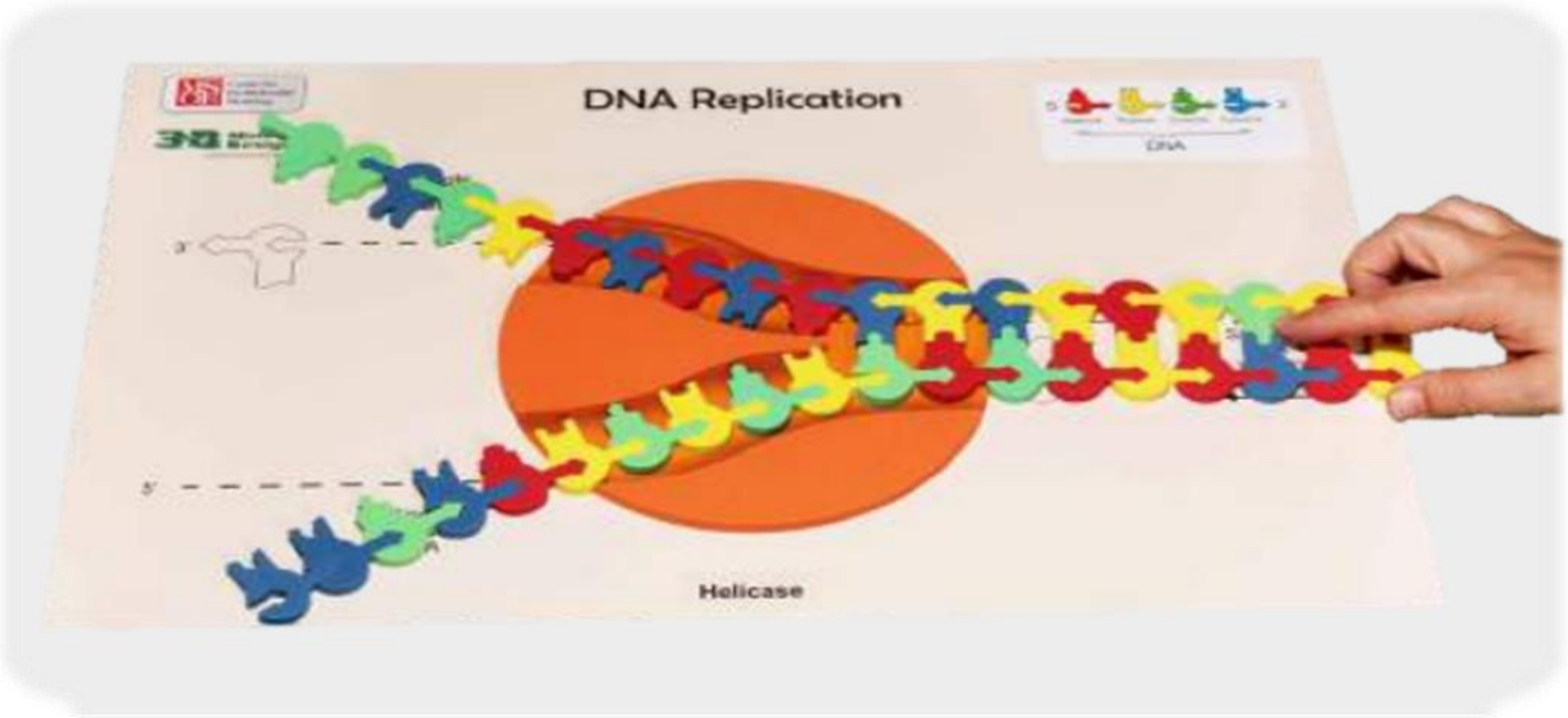
Replication in the Eukaryotic Nucleus



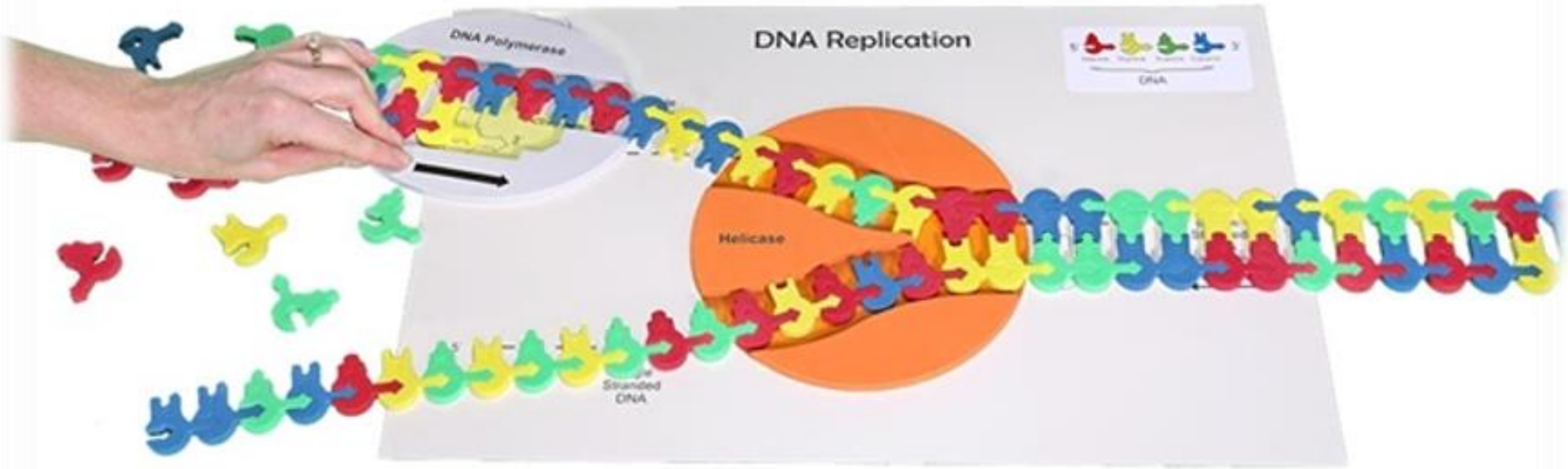
Replication Forks



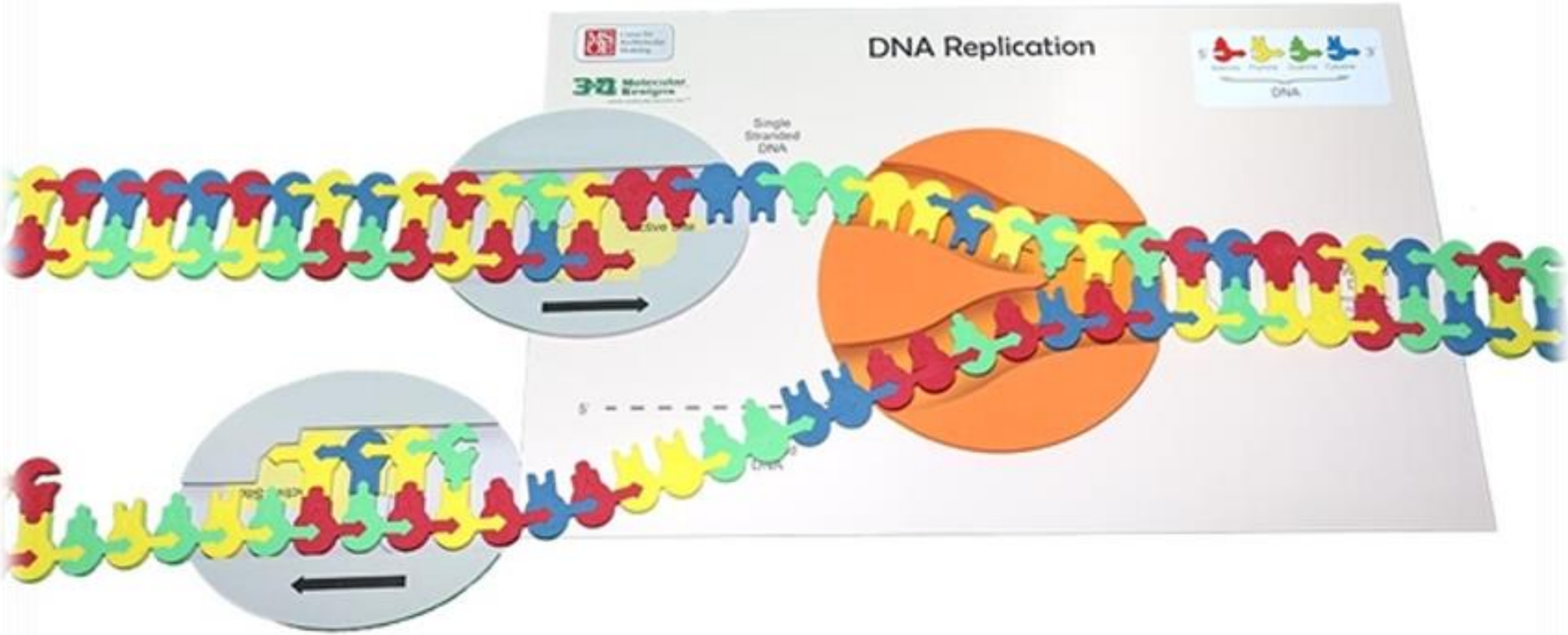
Replication



Continuous Replication



Discontinuous Replication

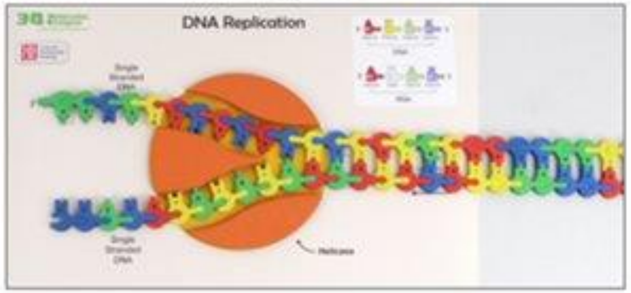


Comparing Leading and Lagging Strands

Template

Non-template

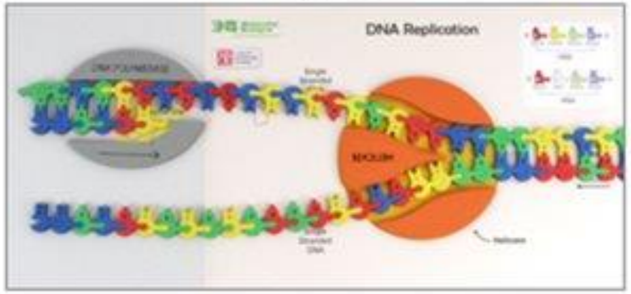
Diagram 1



Helicase unwinds the DNA at the replication fork

Helicases are enzymes that untwist the double helix and separate the two strands.

Diagram 2



DNA polymerase catalyzes the synthesis of new DNA

Leading Strand: New DNA can elongate only in the 5' → 3' direction. The DNA strand that is made **continuously** is referred to as the leading strand. DNA polymerase moves toward the replication fork.

Diagram 3

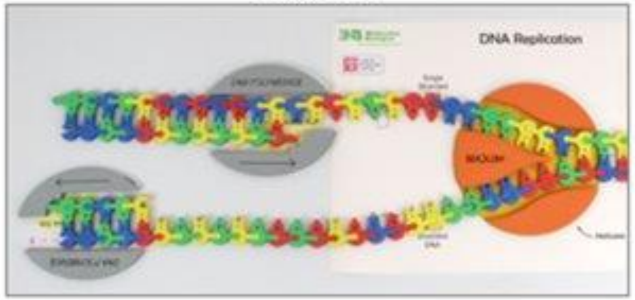
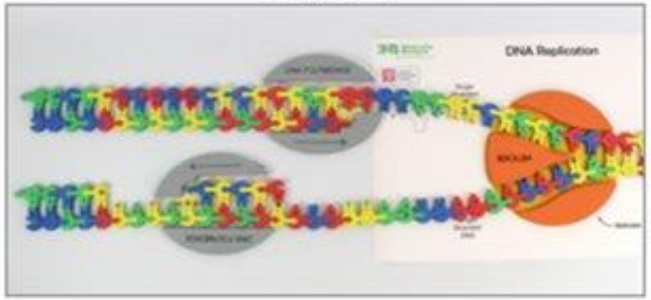
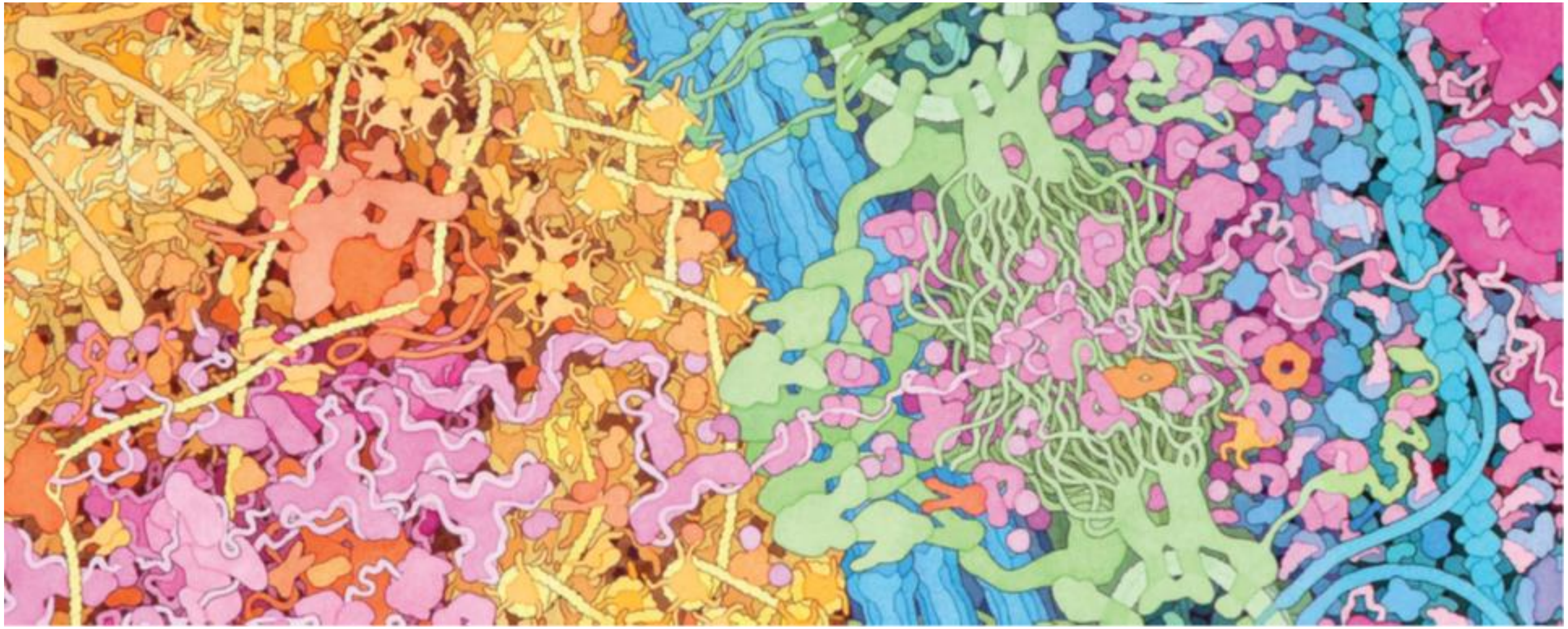


Diagram 4



Lagging Strand: DNA polymerase must move away from the fork instead of toward the fork as it did in the leading strand in order to maintain 5' → 3' DNA synthesis (diagram 3). The lagging strand is synthesized in a series of **discontinuous** fragments referred to as Okazaki fragments (diagram 4).

A Brief Tour Through the Cell



This image is an excerpt from Tour of a Human Cell by David Goodsell, as shown in 3D Molecular Designs' Tour of a Human Cell© poster and David Goodsell's book, ***The Machinery of Life***

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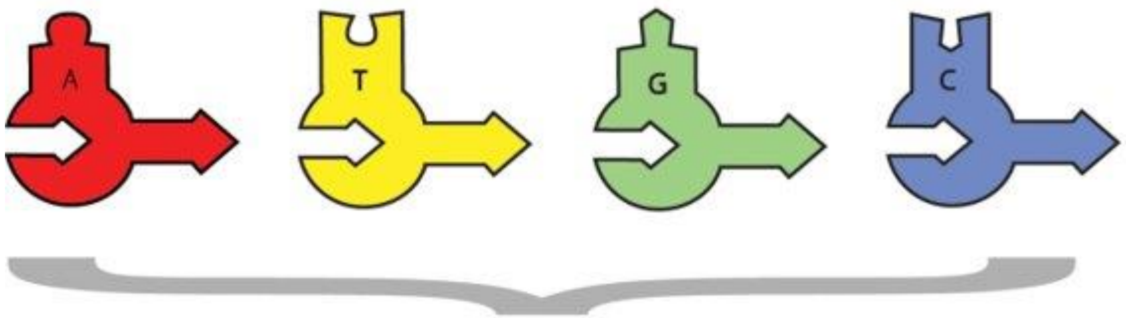
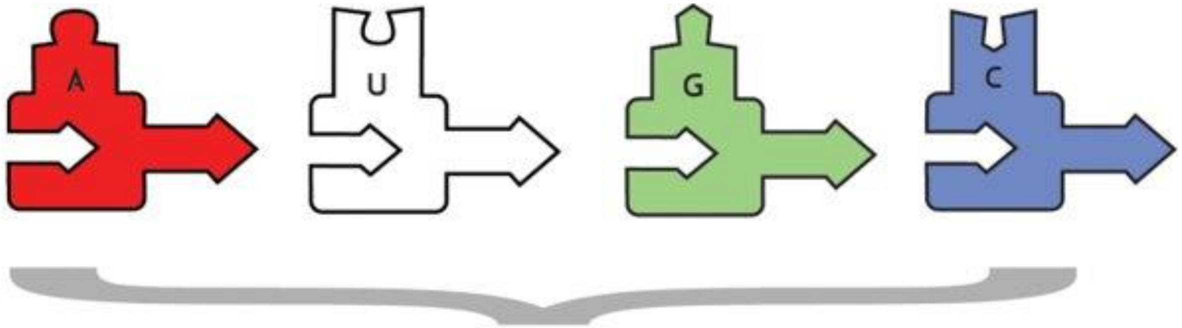
Transcription

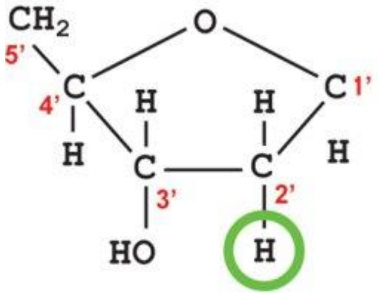


DNA

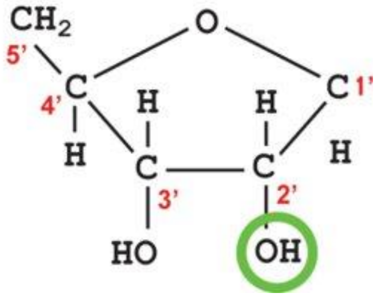


RNA

Deoxyribose
found in DNA

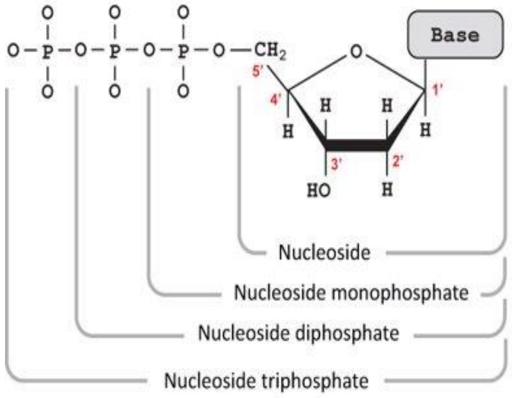


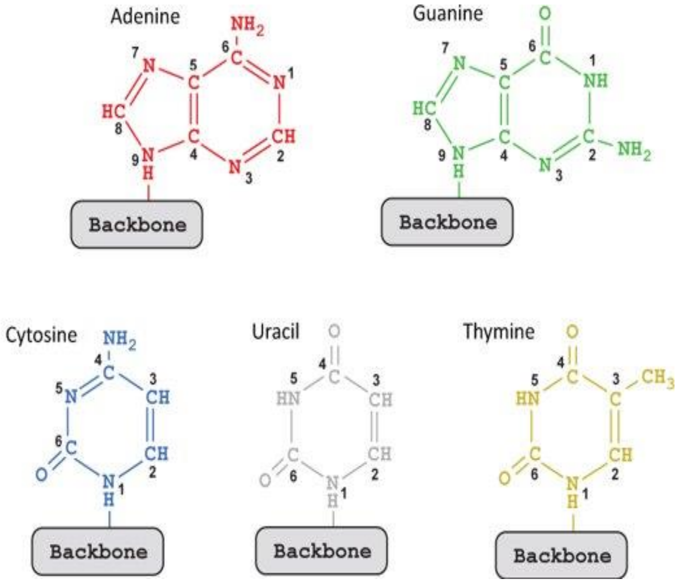
Ribose
found in RNA

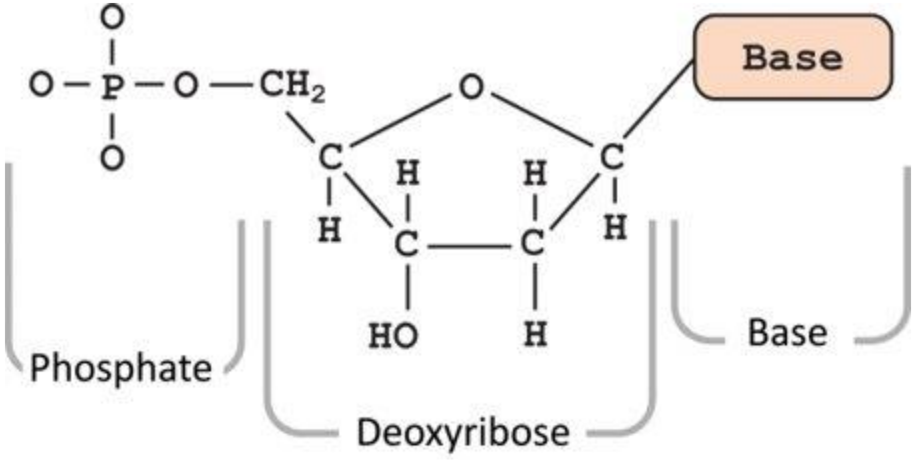


Notice:
The DNA pieces are different than the RNA pieces.

Transcription



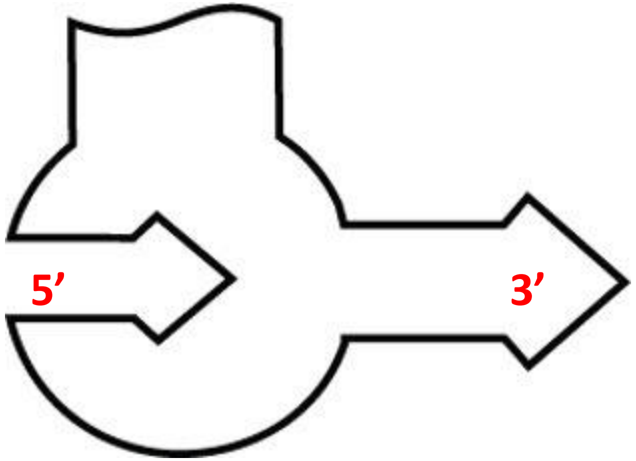




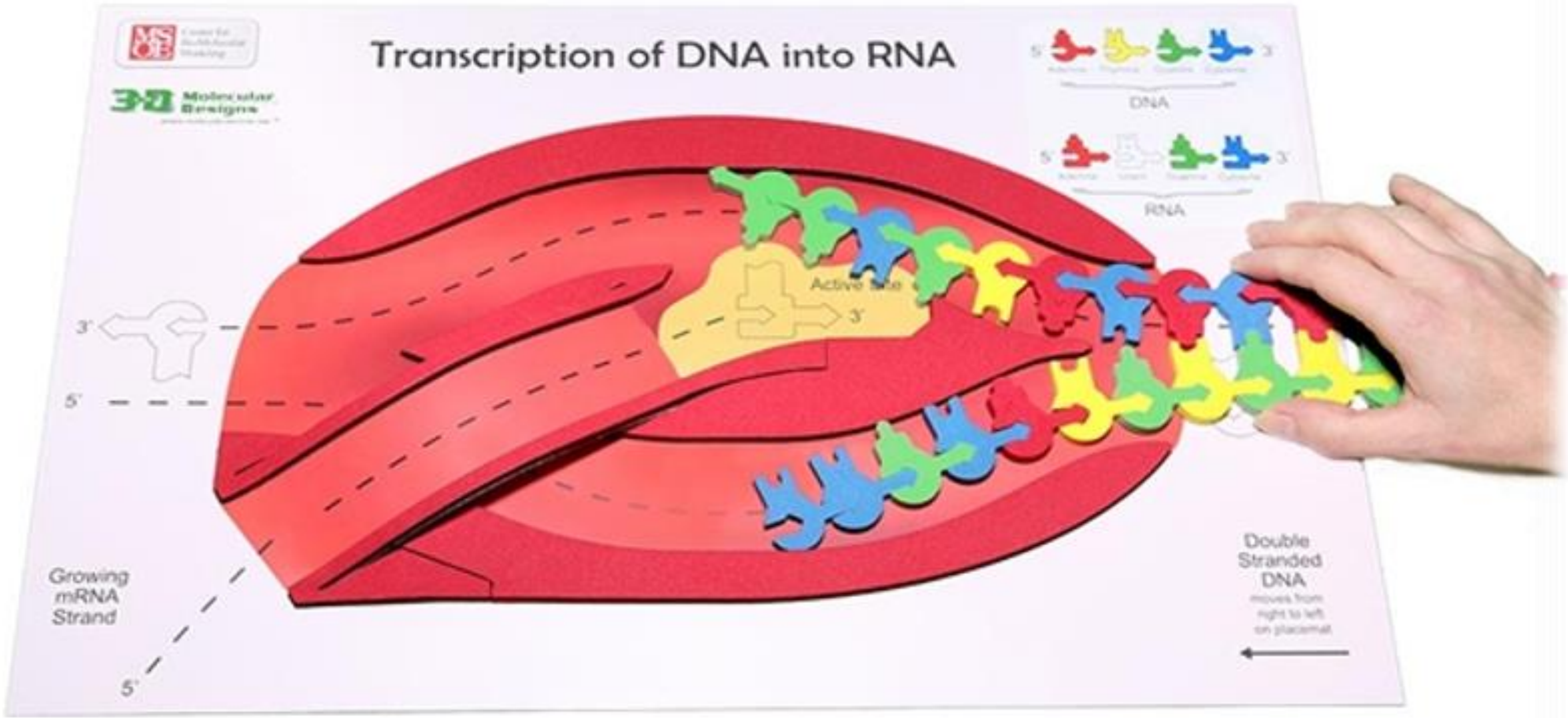
Helpful Hints:

Take care when loading the DNA in the RNA polymerase.

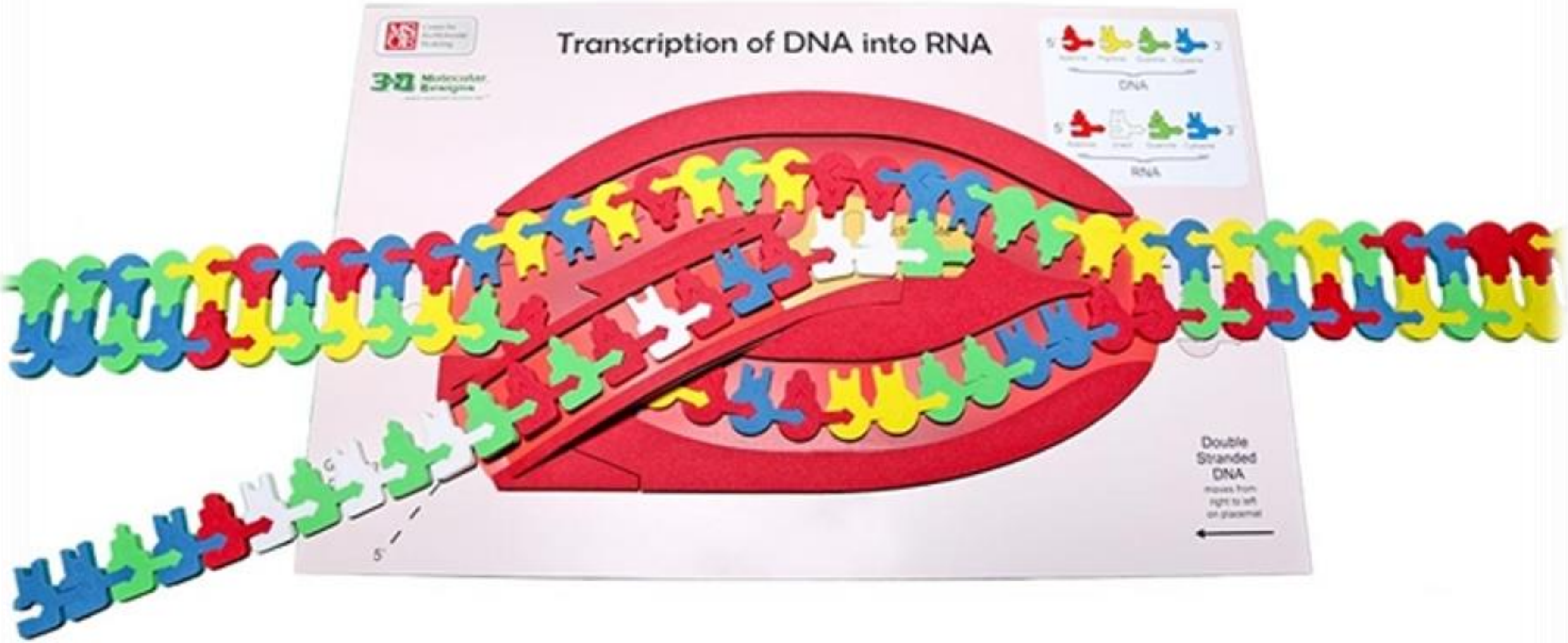
Remember RNA is synthesized from the 5’ to the 3’ end.



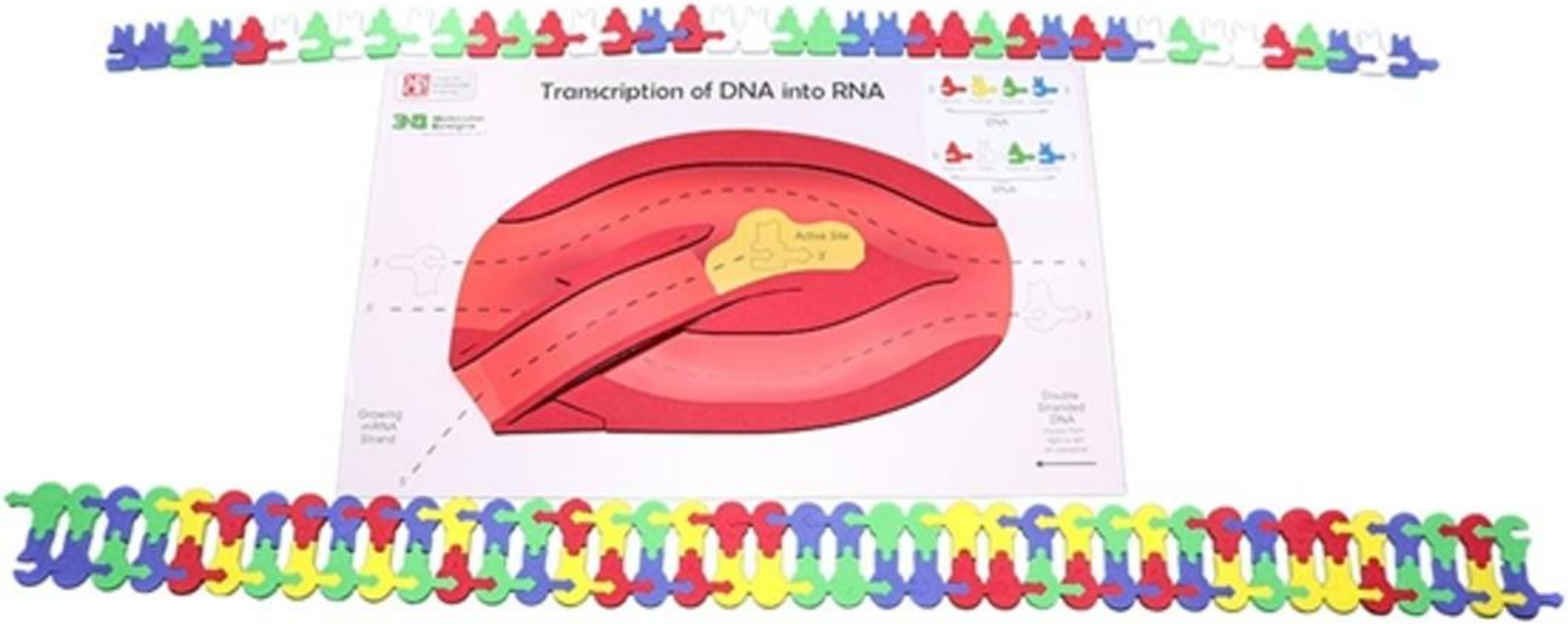
Transcription: Initiation

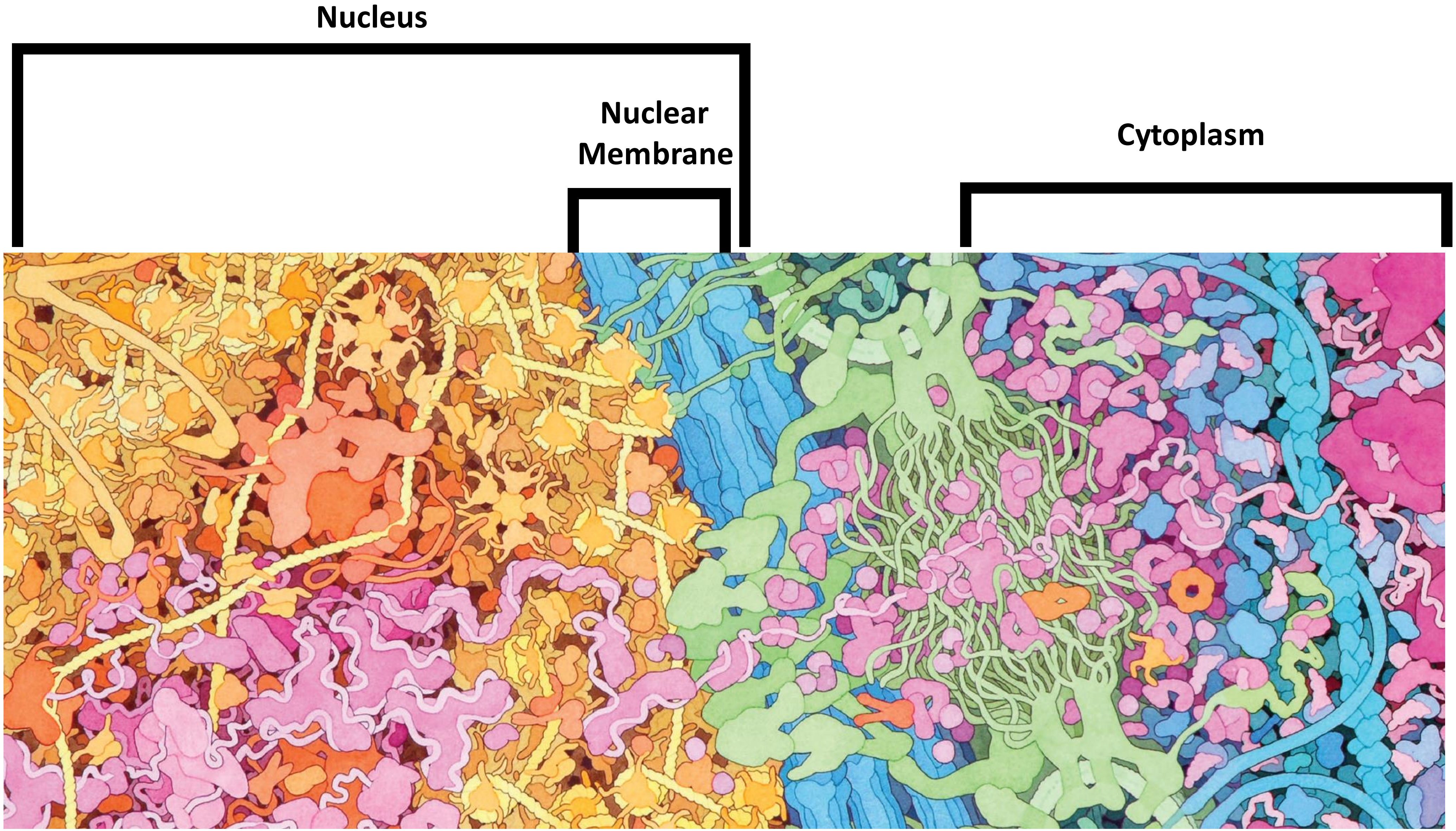


Transcription: Elongation



Transcription: Termination





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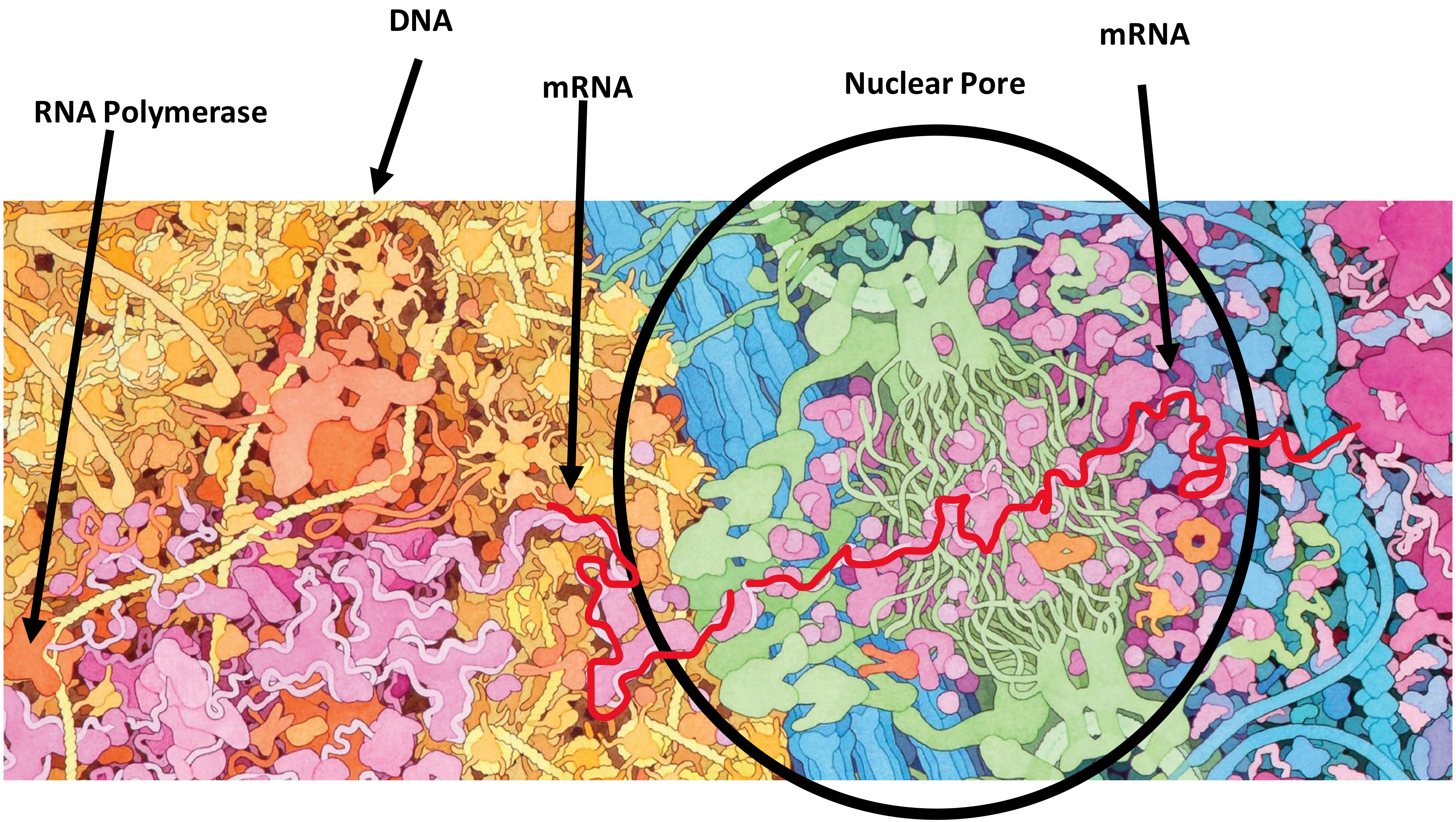
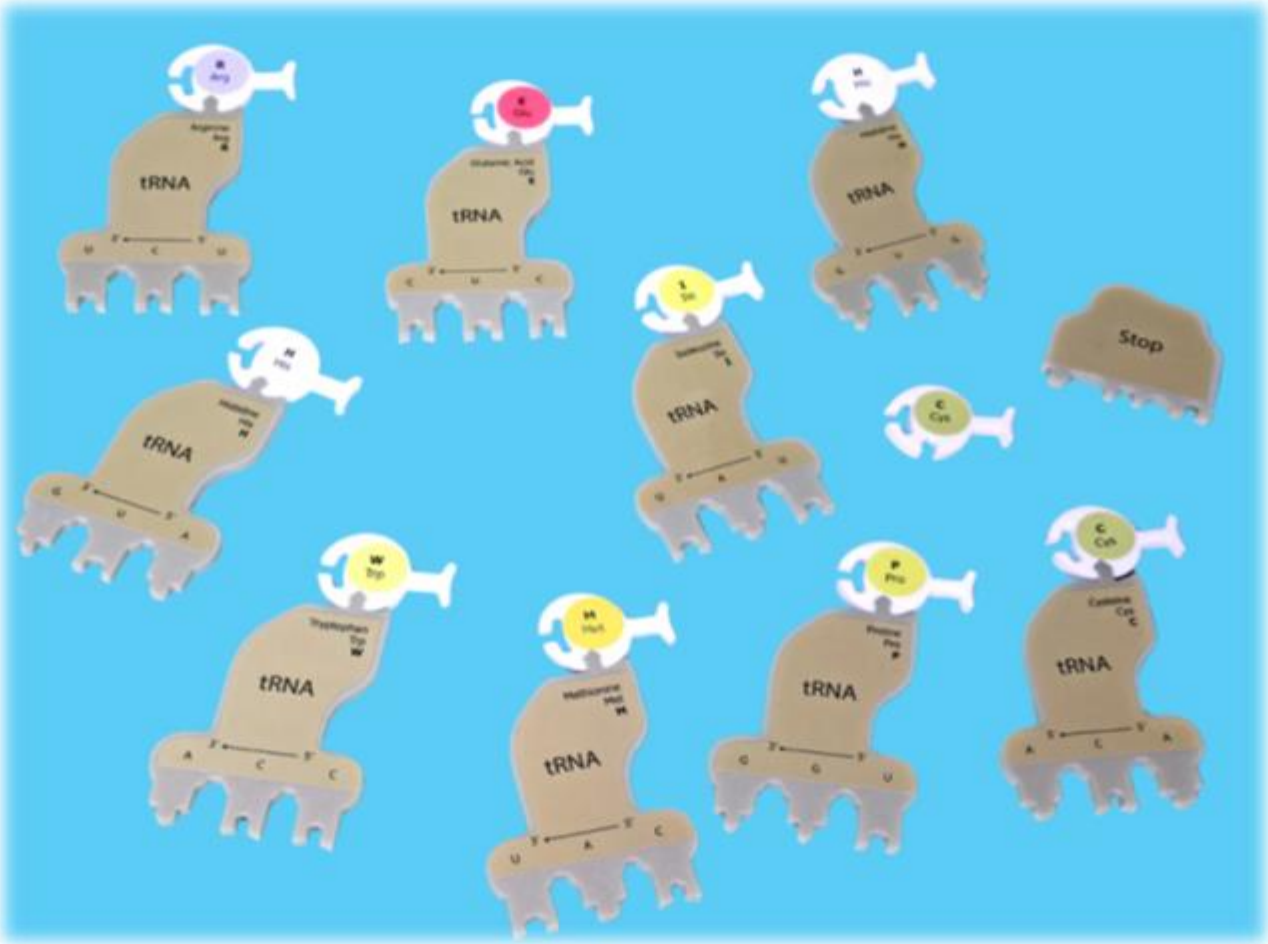


This image is an excerpt from Tour of a Human Cell by David Goodsell, as shown in 3D Molecular Designs' Tour of a Human Cell© poster and David Goodsell's book, ***The Machinery of Life.***

Pair the tRNA with the amino acids



The Genetic Codon Chart©

	U	C	A	G	
U	UUU → Phe F	UCU → Ser S	UAU → Tyr Y	UGU → Cys C	U
	UUC → Phe F	UCC → Ser S	UAC → Tyr Y	UGC → Cys C	C
	UUA → Leu L	UCA → Ser S	UAA → Stop	UGA → Stop	A
	UUG → Leu L	UCG → Ser S	UAG → Stop	UGG → Trp W	G
C	CUU → Leu L	CCU → Pro P	CAU → His H	CGU → Arg R	U
	CUC → Leu L	CCC → Pro P	CAC → His H	CGC → Arg R	C
	CUA → Leu L	CCA → Pro P	CAA → Gln Q	CGA → Arg R	A
	CUG → Leu L	CCG → Pro P	CAG → Gln Q	CGG → Arg R	G
A	AUU → Ile I	ACU → Thr T	AAU → Asn N	AGU → Ser S	U
	AUC → Ile I	ACC → Thr T	AAC → Asn N	AGC → Ser S	C
	AUA → Ile I	ACA → Thr T	AAA → Lys K	AGA → Arg R	A
	AUG → Met M	ACG → Thr T	AAG → Lys K	AGG → Arg R	G
G	GUU → Val V	GCU → Ala A	GAU → Asp D	GGU → Gly G	U
	GUC → Val V	GCC → Ala A	GAC → Asp D	GGC → Gly G	C
	GUA → Val V	GCA → Ala A	GAA → Glu E	GGA → Gly G	A
	GUG → Val V	GCG → Ala A	GAG → Glu E	GGG → Gly G	G

Amino Acid Properties

Translation Start Codon
Hydrophobic / Non-polar
Negative Charge
Cysteine
Translation Stop Codon
Hydrophilic / Polar
Positive Charge

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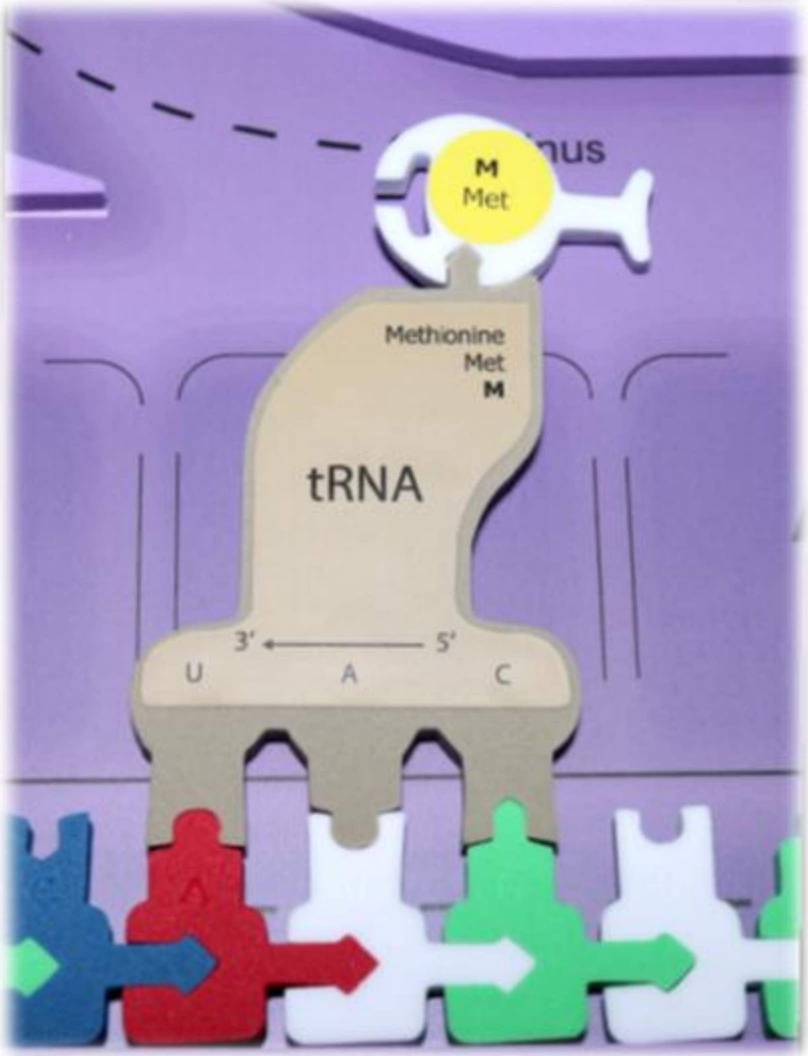
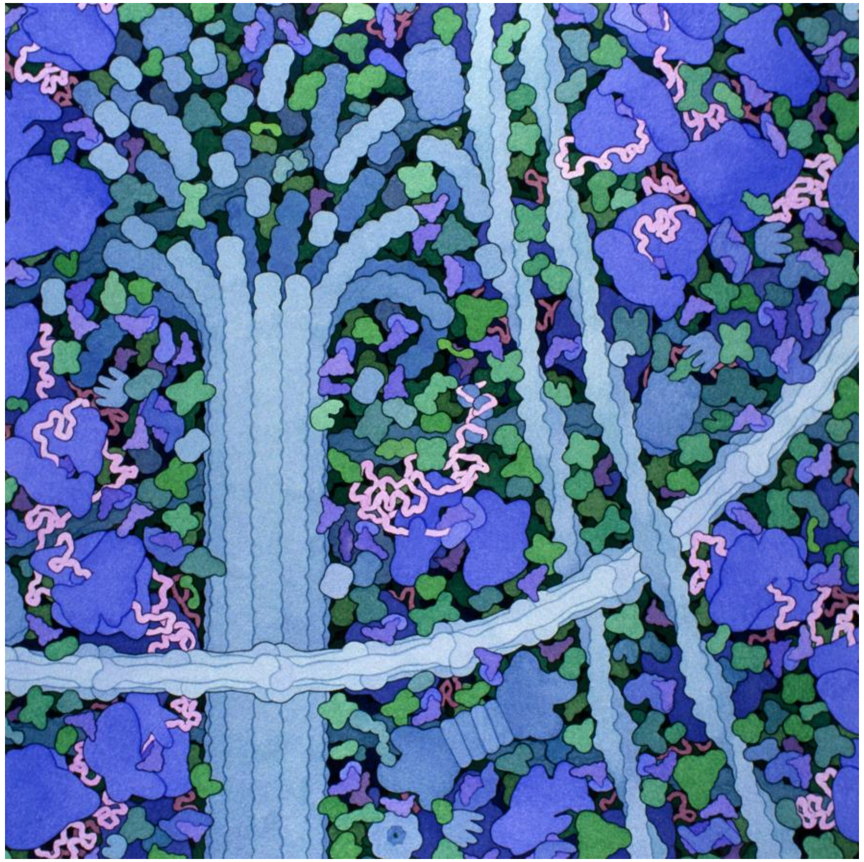
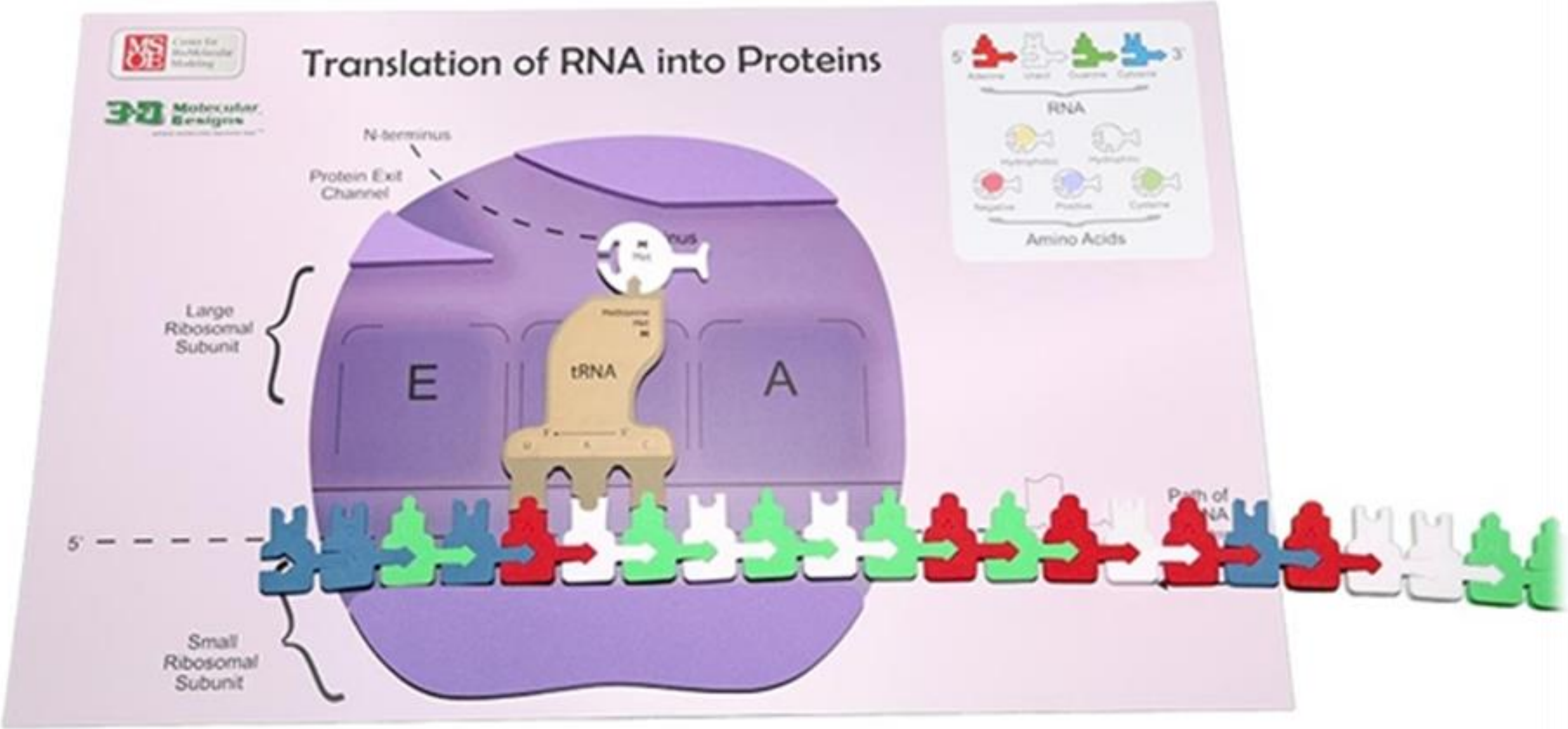
Translation



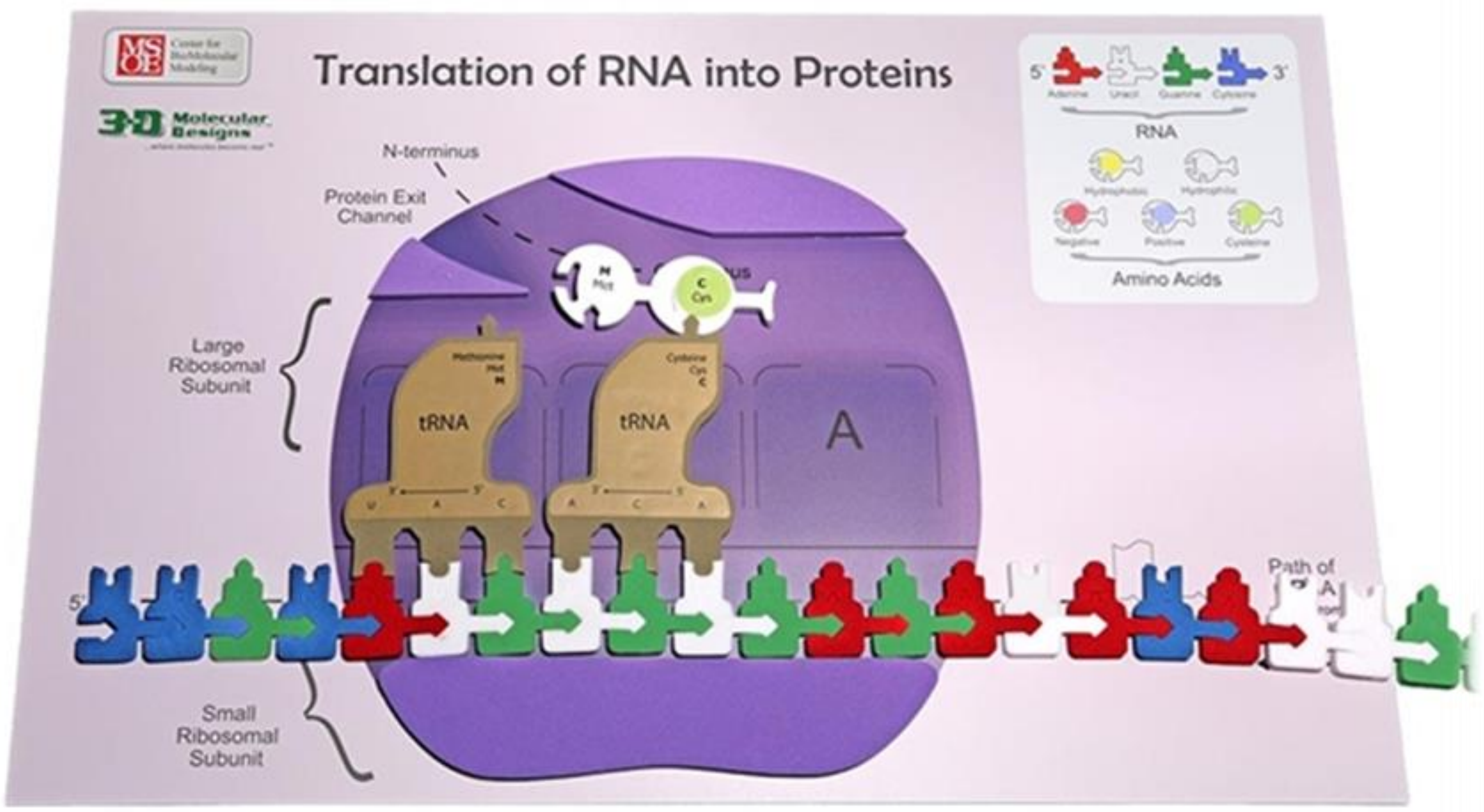


Acknowledgement: Illustration by David S. Goodsell. doi: 10.2210/rcsb_pdb/goodsell-gallery-006

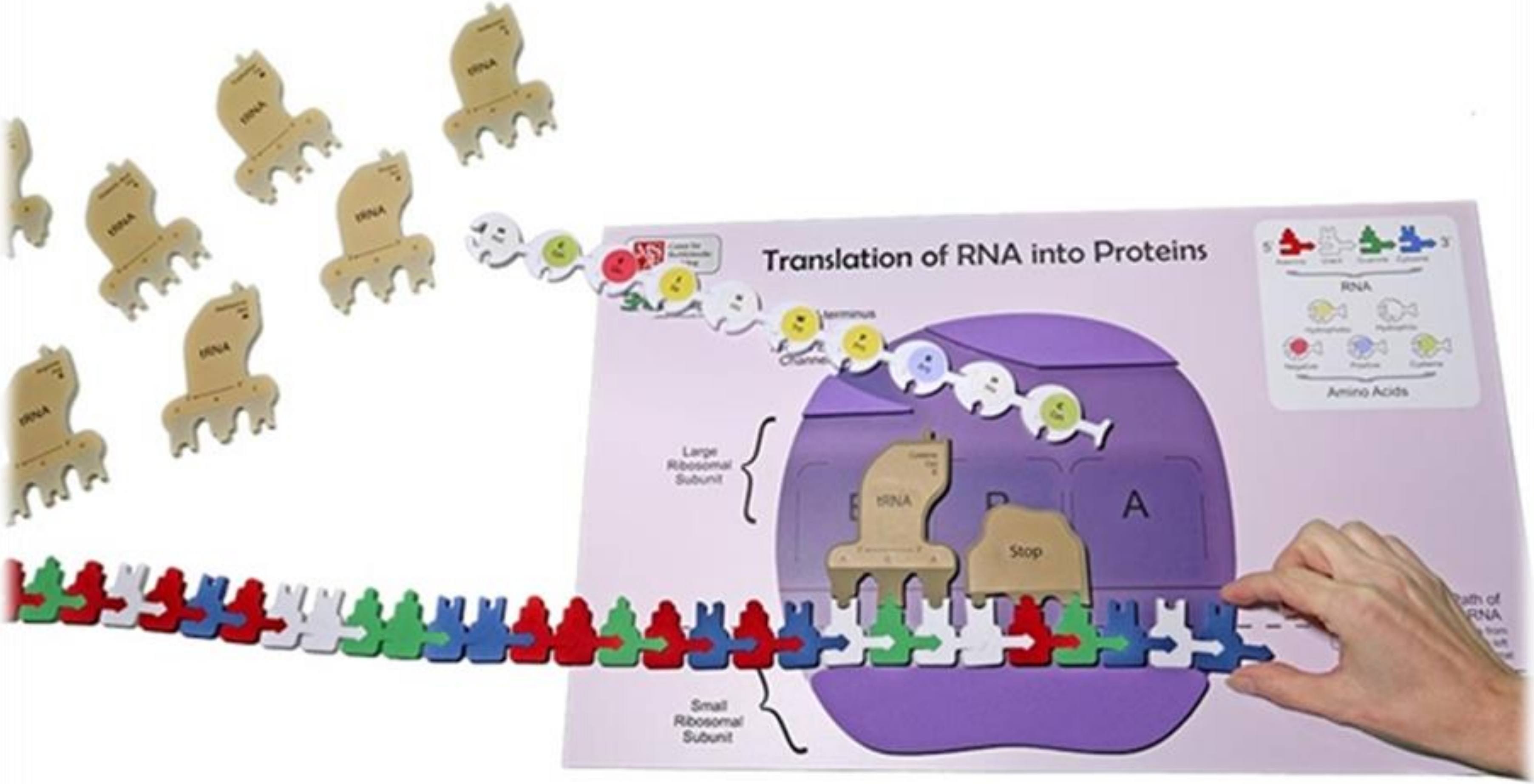
Translation: Initiation



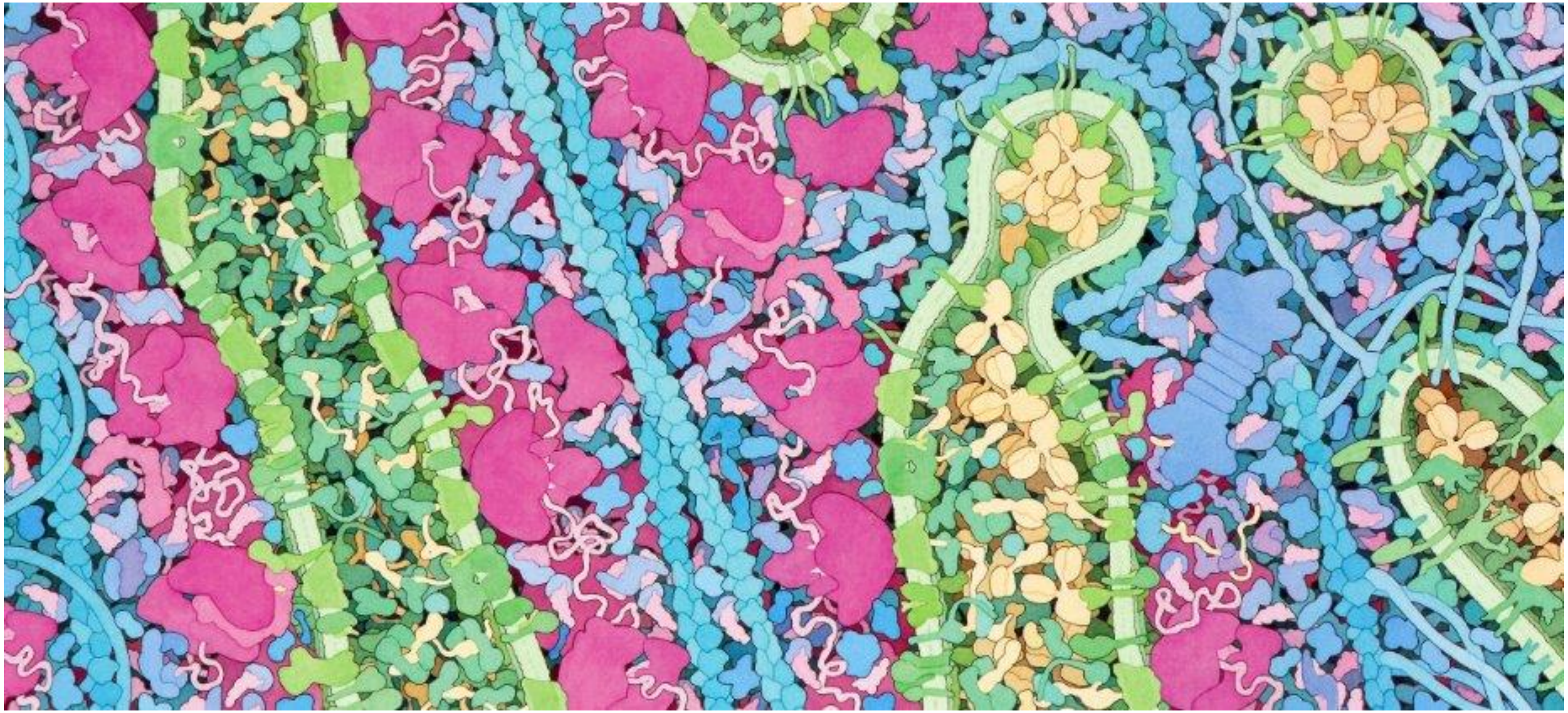
Translation: Elongation



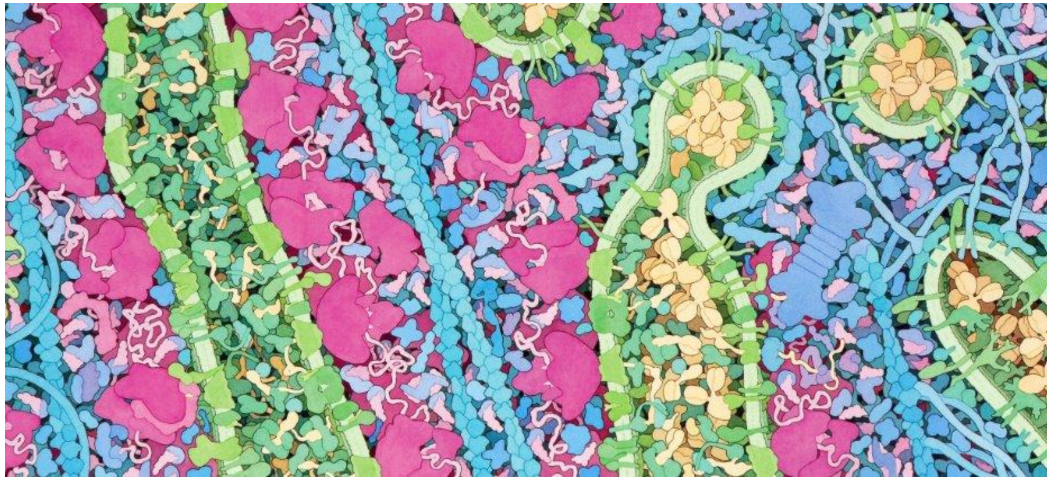
Translation: Termination



Revisit the panorama



Protein Folding in Cytoplasm or Rough ER



Protein Folding in Cytoplasm or Rough ER

KEY

Hydrophobic Side Chains are **Yellow**
Hydrophilic Side Chains are **White**
Acidic Side Chains are **Red**
Basic Side Chains are **Blue**
Cysteine Side Chains are **Green**

SIX HYDROPHOBIC

THREE HYDROPHILIC

TWO ACIDIC

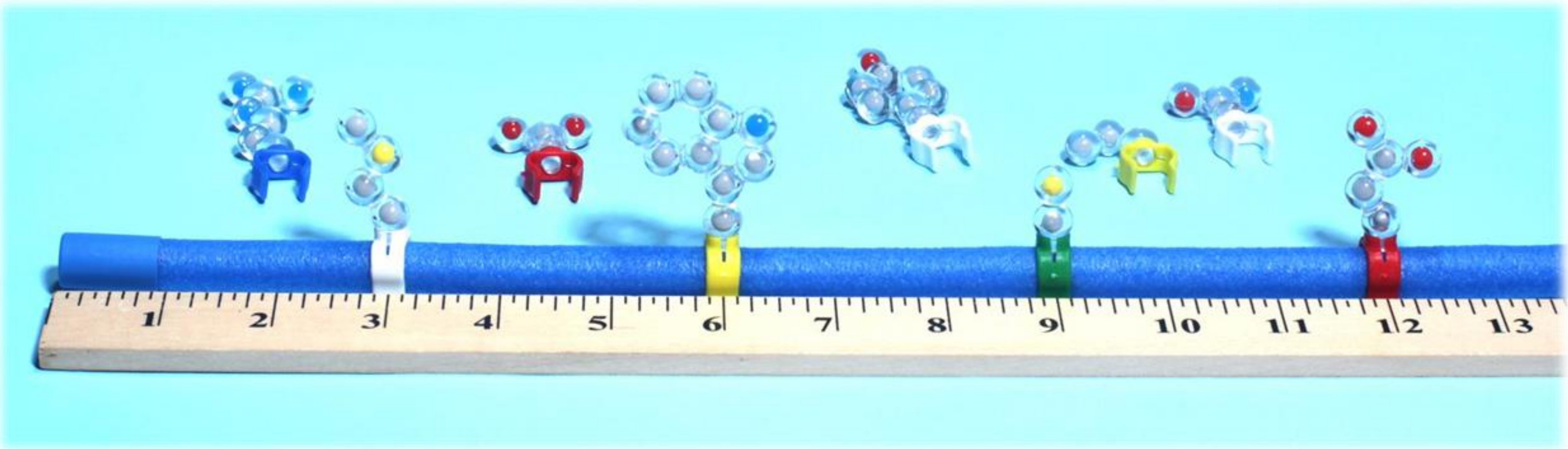
TWO BASIC

TWO CYSTEINE

A TOTAL OF FIFTEEN SIDE CHAINS

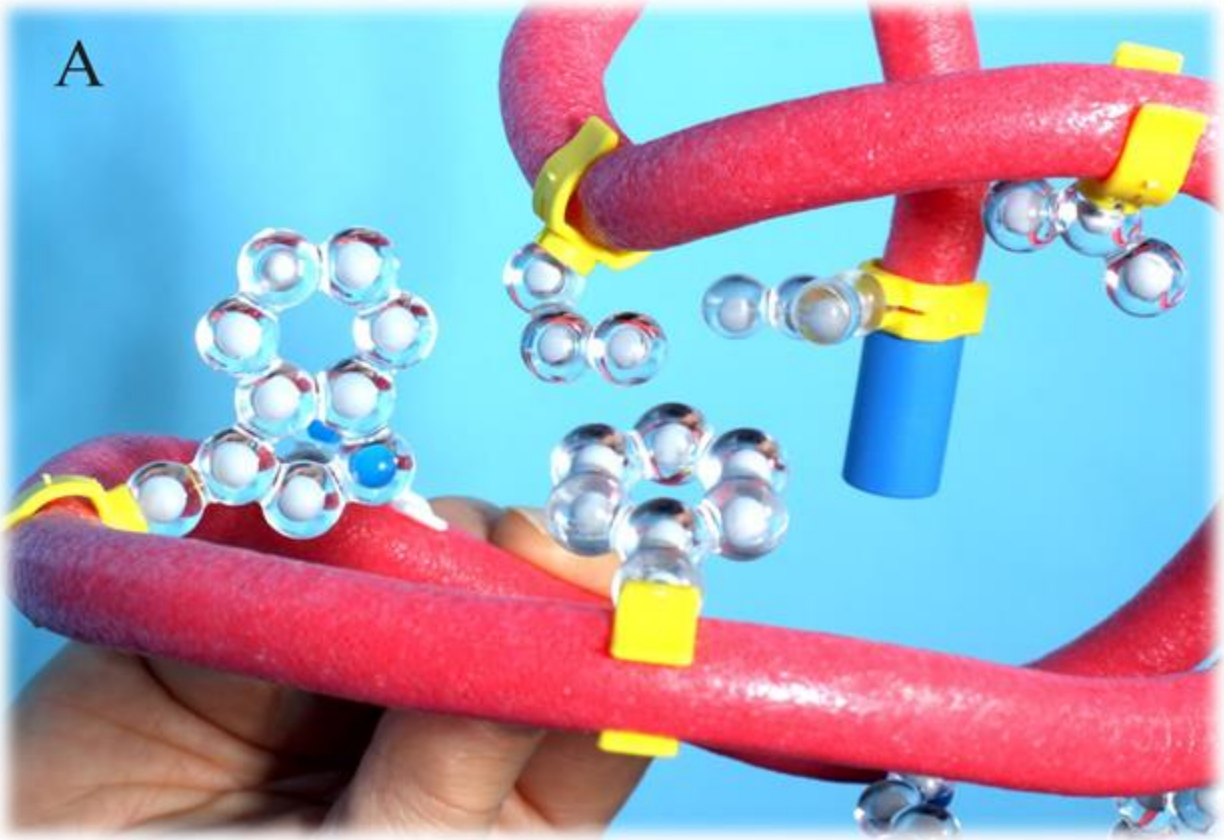
In any order arrange your amino acids so they are equidistant from each other.

You have made a polypeptide.



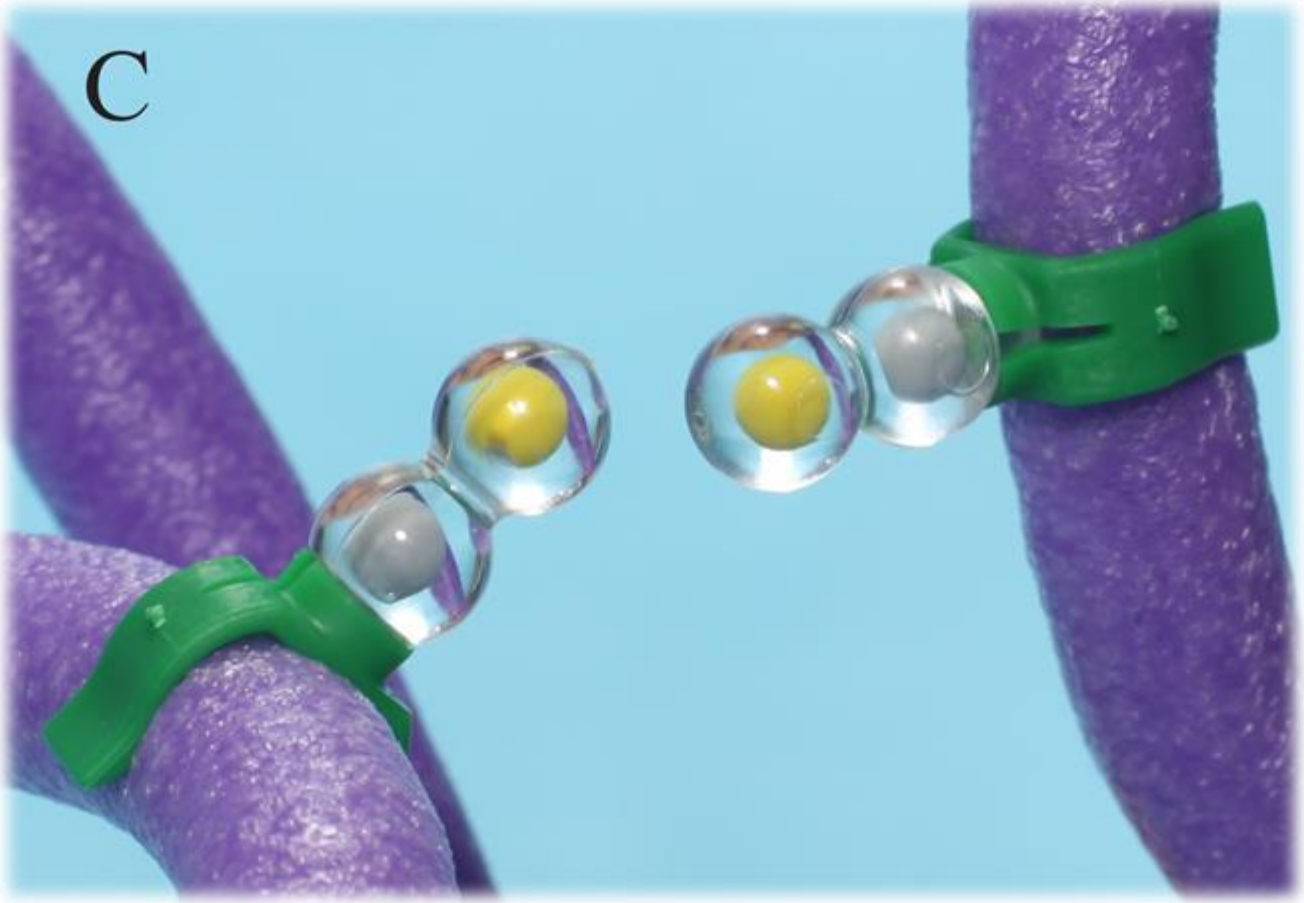
“Fold” the polypeptide into a protein.

Rotate hydrophobic amino acids to the inside.

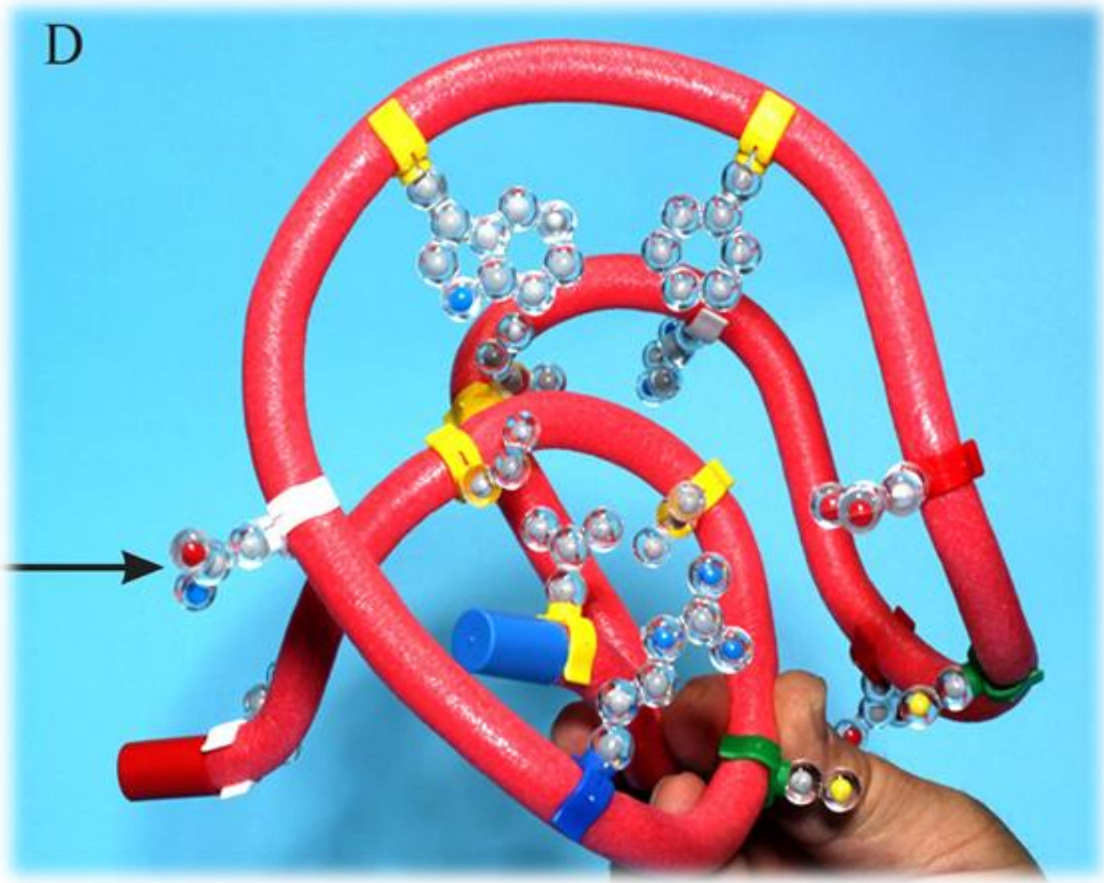


Continue “folding” by bringing the acidic and basic side chains until they are 2 cm apart.

Continue "folding" by positioning cysteines so they are opposite each other.

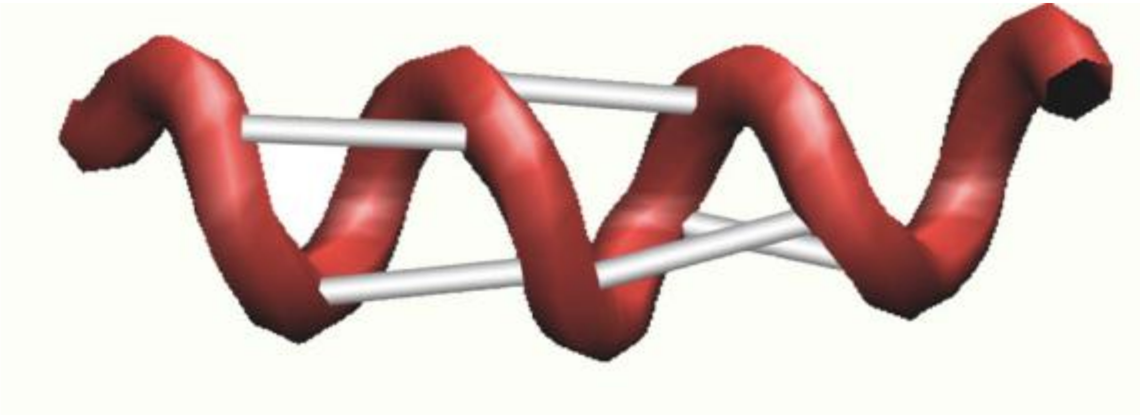


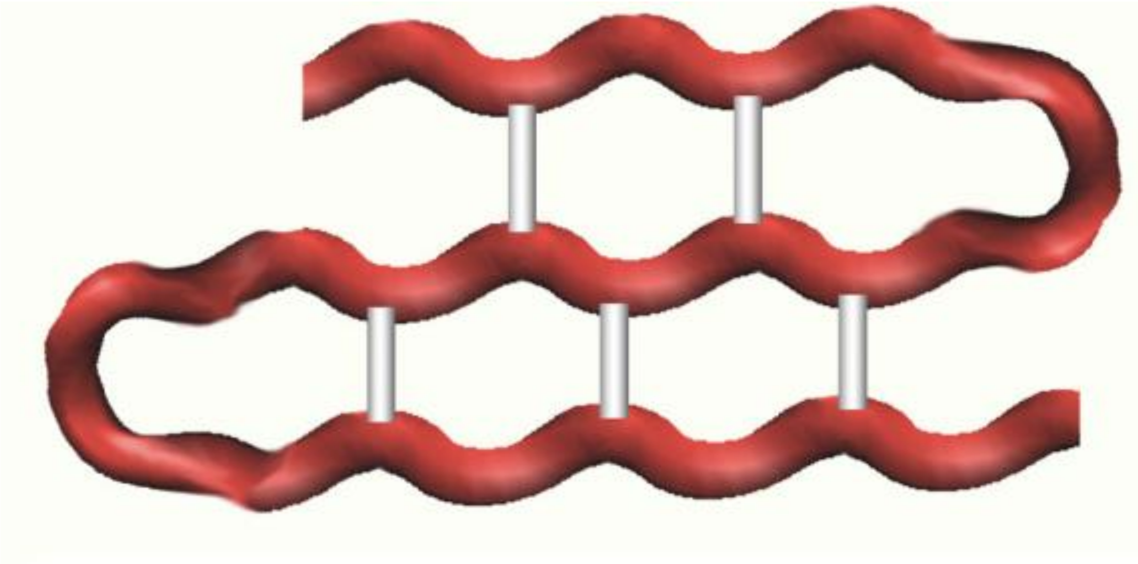
Continue “folding” by rotating the hydrophilic side chains so they are on the outer surface of the protein.



Review of secondary structure

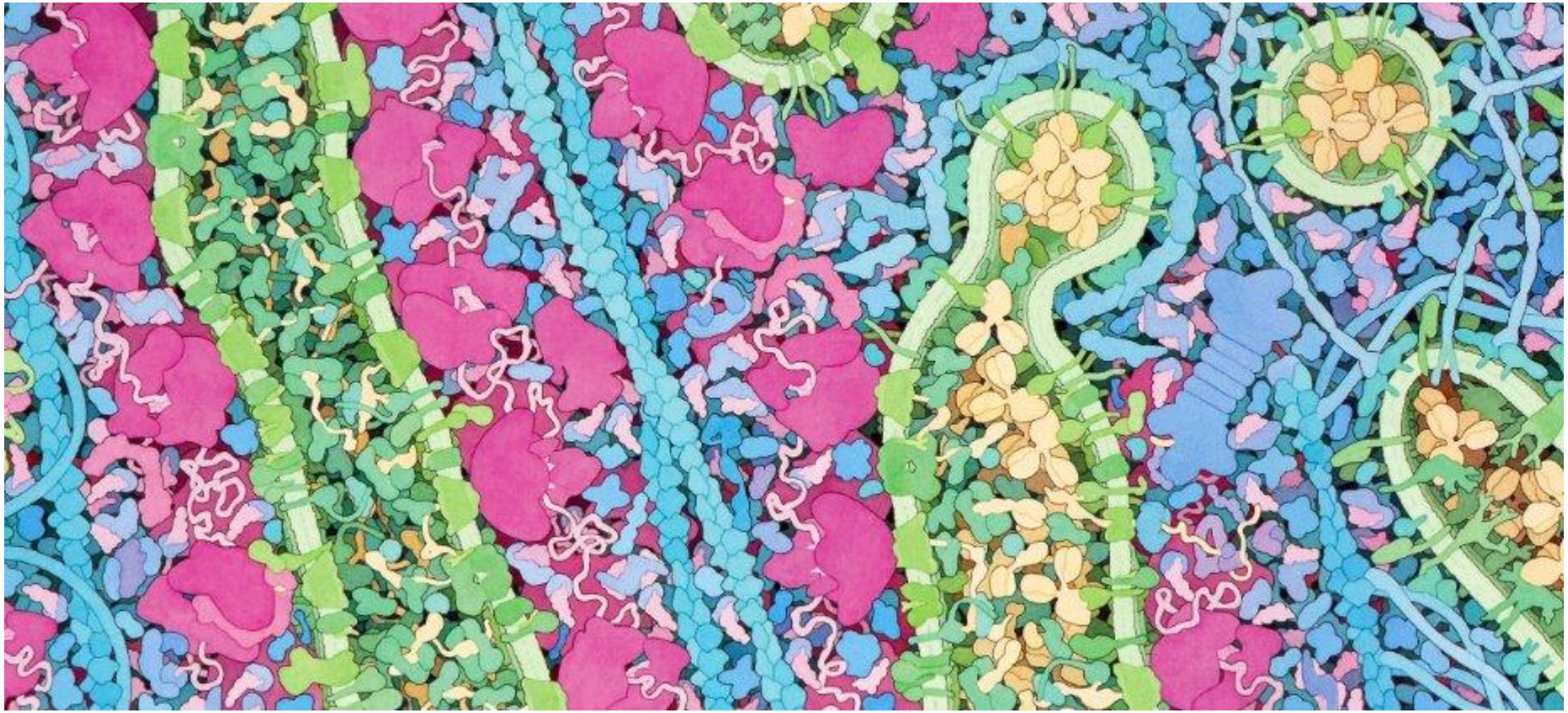
Alpha Helix



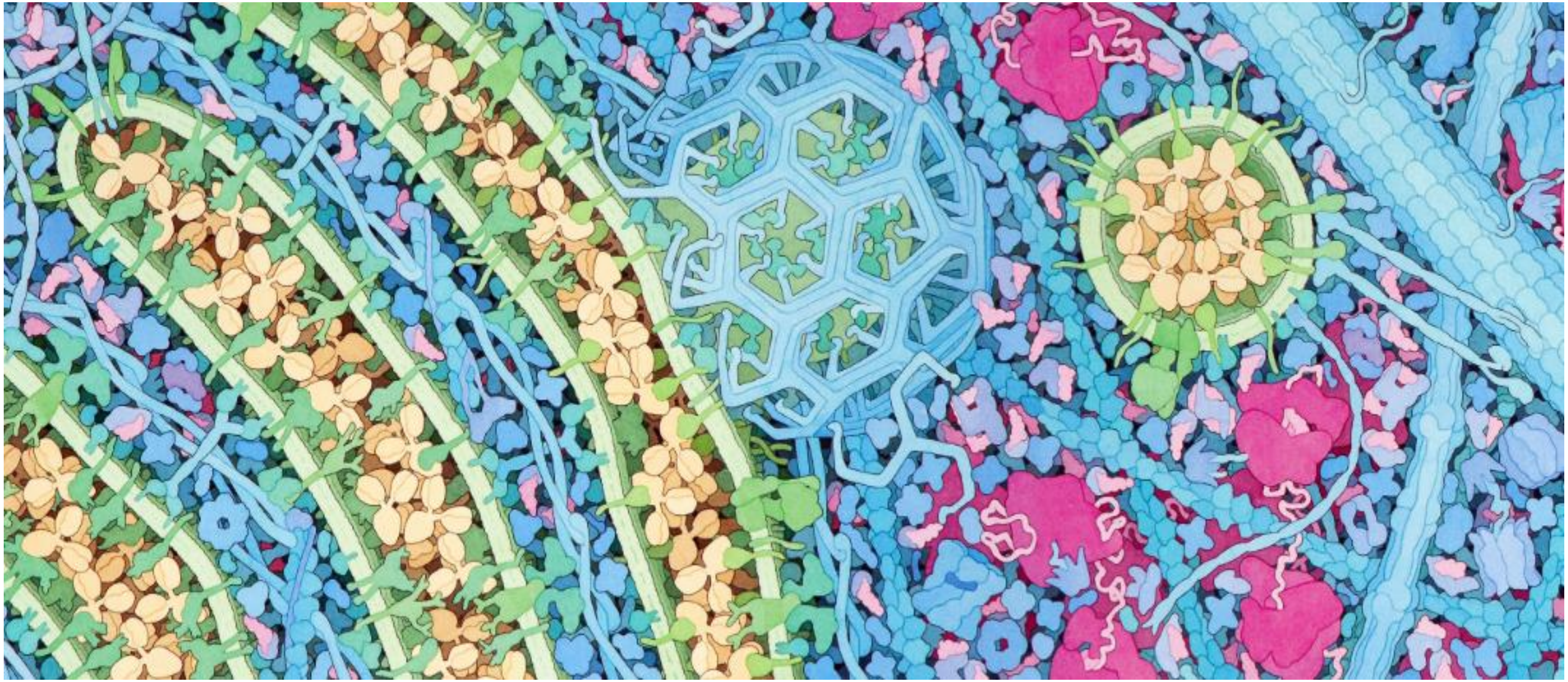


Beta Sheet

Revisit the panorama



Revisit the panorama



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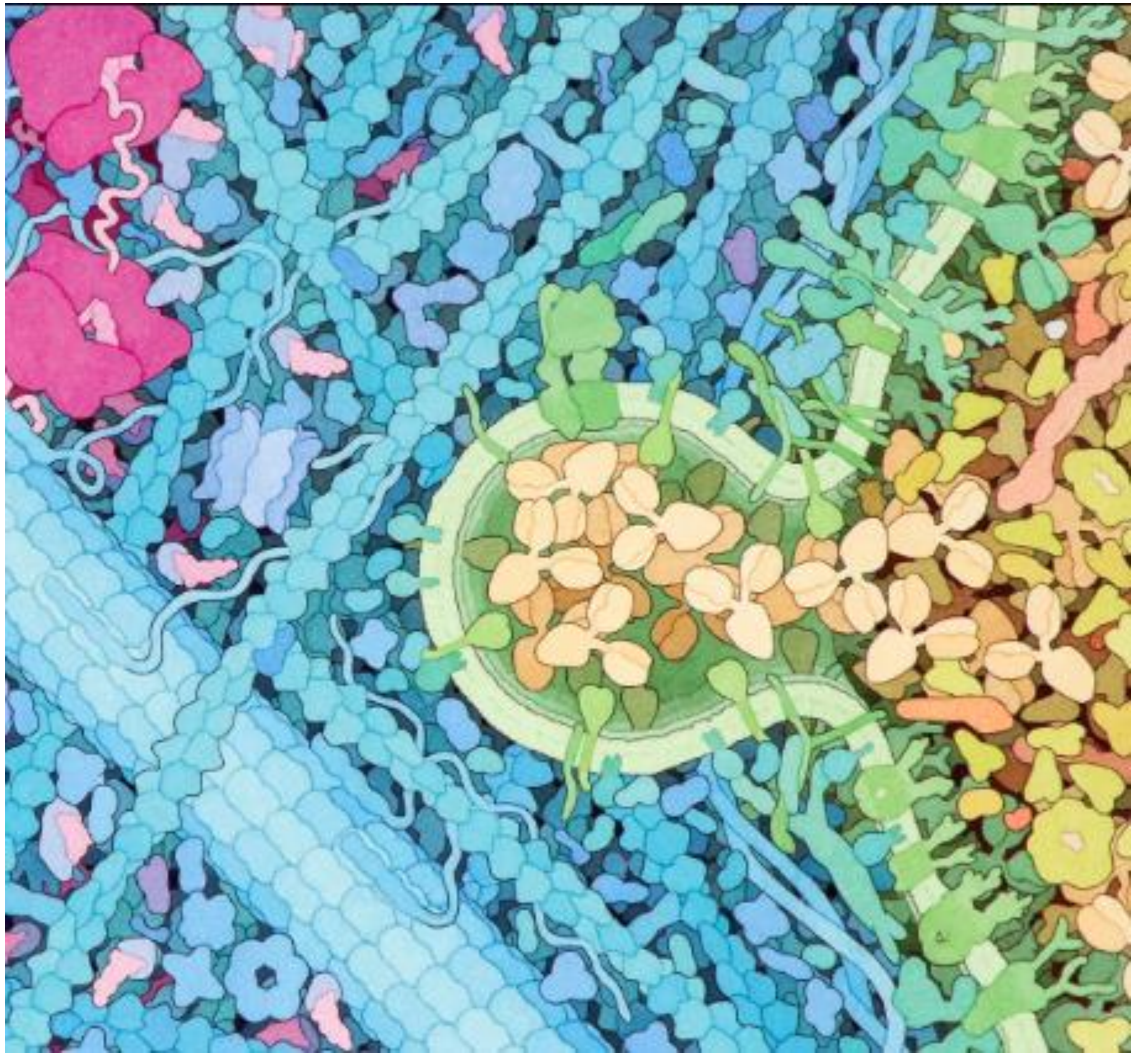
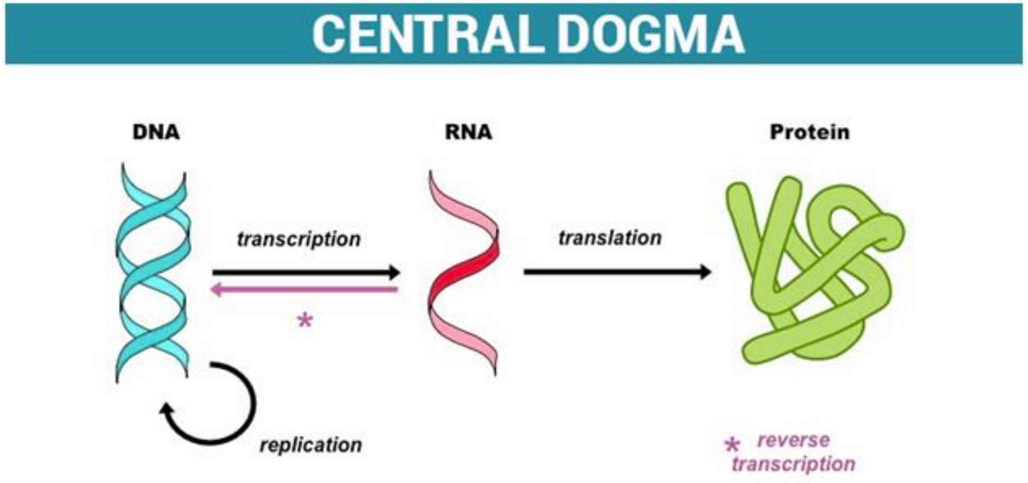
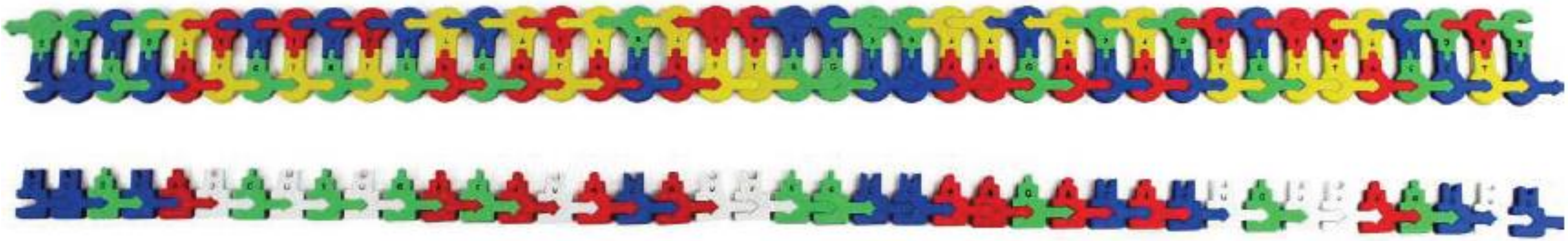


Let's review

DNA Base	RNA Base
T	A
G	C
C	G
A	U
C	G
A	U



DNA and RNA



Helpful Resources

- Tracking the Resolution of Student Misconceptions about the Central Dogma of Molecular Biology - PubMed (nih.gov)
- DNA → RNA: What Do Students Think the Arrow Means? - PMC (nih.gov)
- What's in a cell? — young people's understanding of the genetic relationship between cells, within an individual: Journal of Biological Education: Vol 34, No 3 (tandfonline.com)
- Teaching More by Lecturing Less | CBE—Life Sciences Education (lifescied.org)
- Eukaryotic cell panorama - Goodsell - 2011 - Biochemistry and Molecular Biology Education - Wiley Online Library

Workshop NGSS Connections

SEPs	CCCs	DCIs
Asking Questions	Scale, Proportion, and Quantity	HS-LS1-1
Developing and Using Models	Patterns	MS-LS1-2
Constructing Explanations and Designing Solutions	Structure and Function	Georgia Standards: SB1 and SB2

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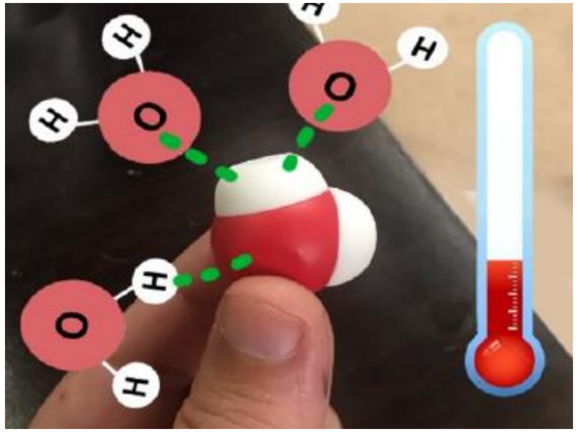

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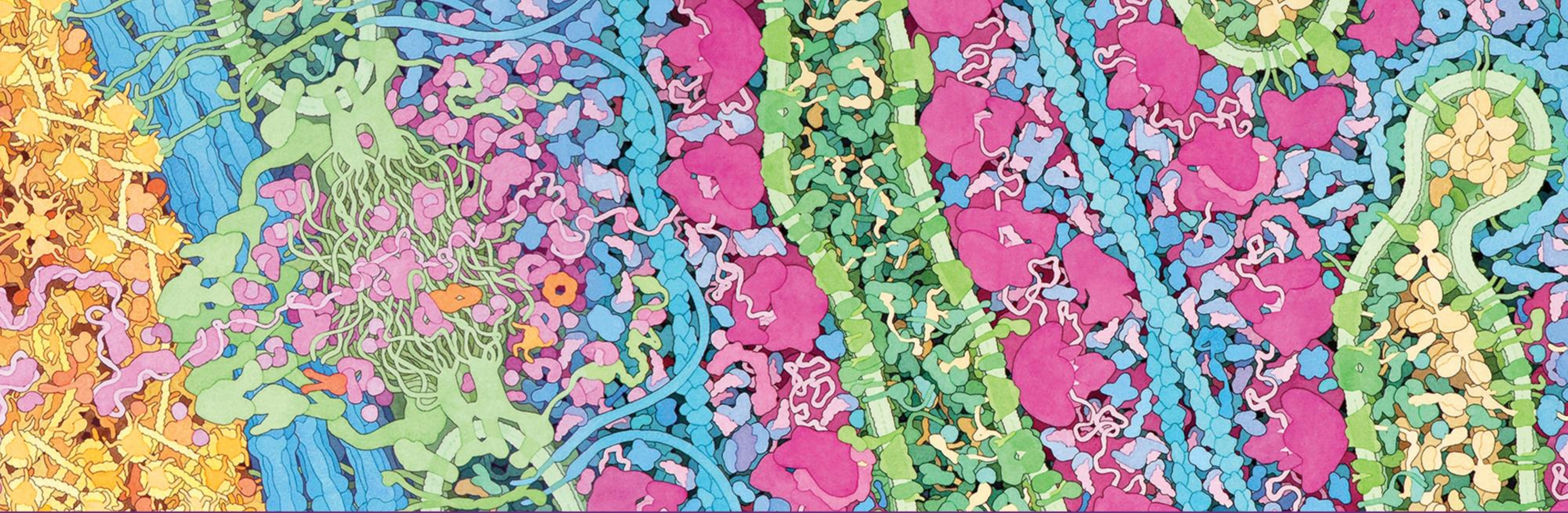

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