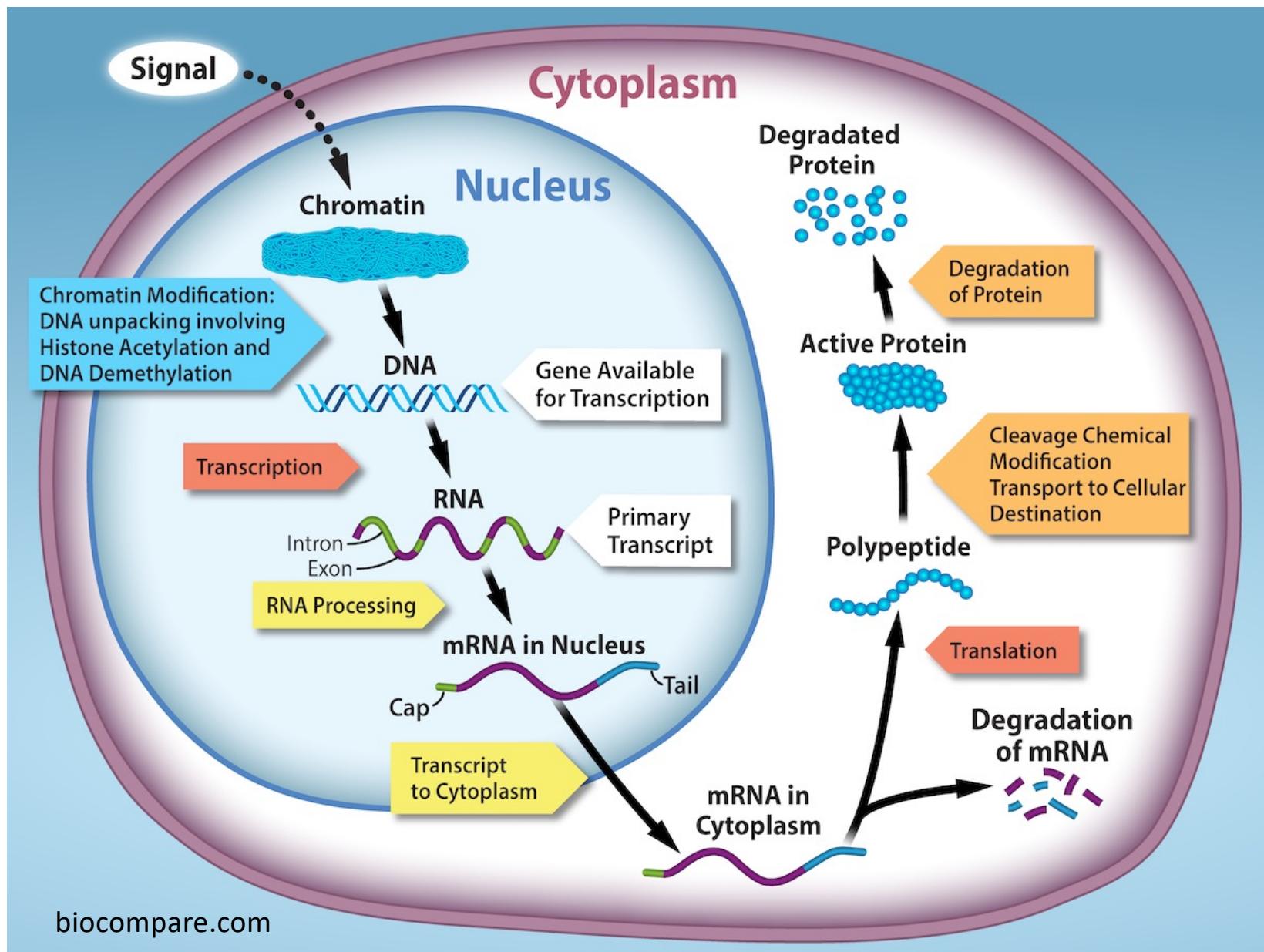


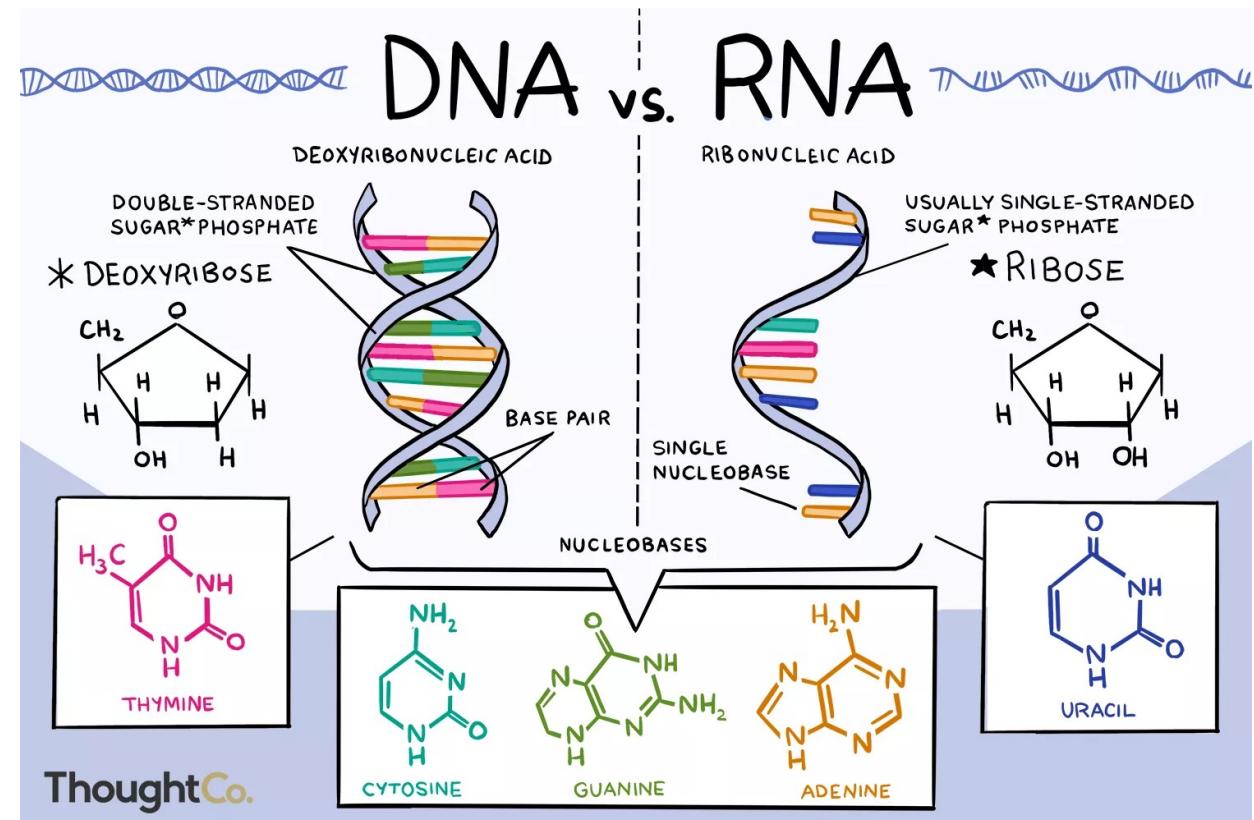
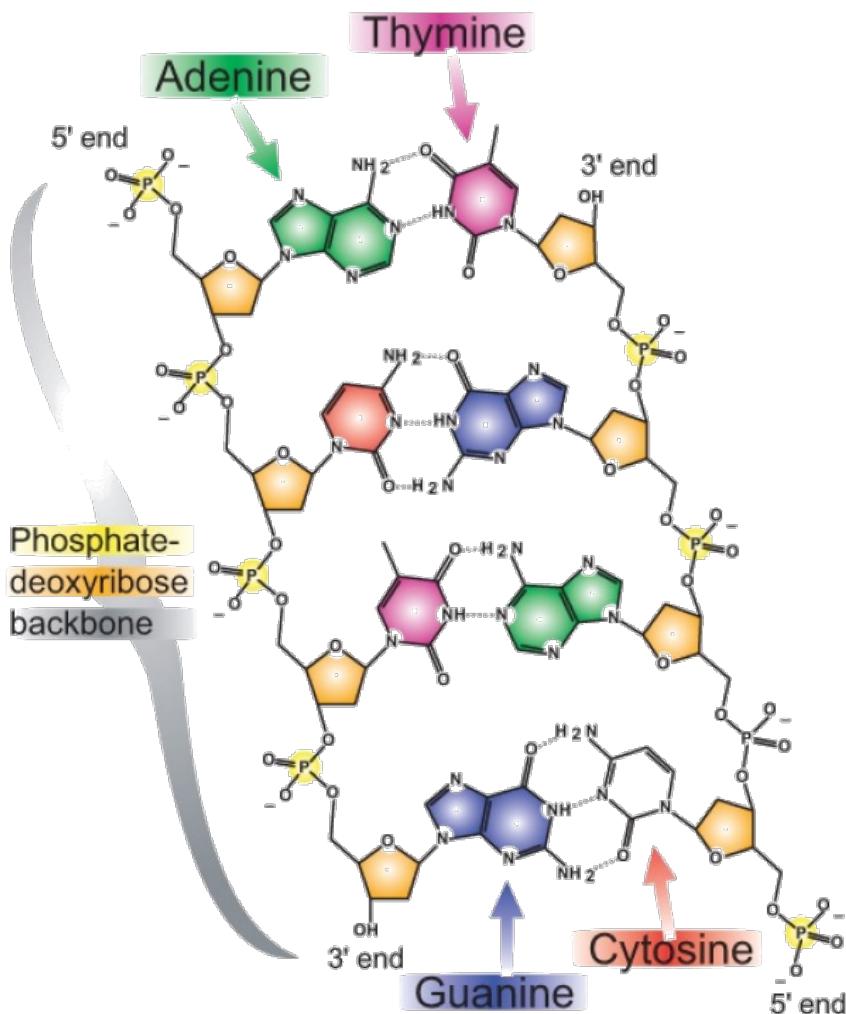
Nucleus

Transmembrane protein

Endoplasmic reticulum



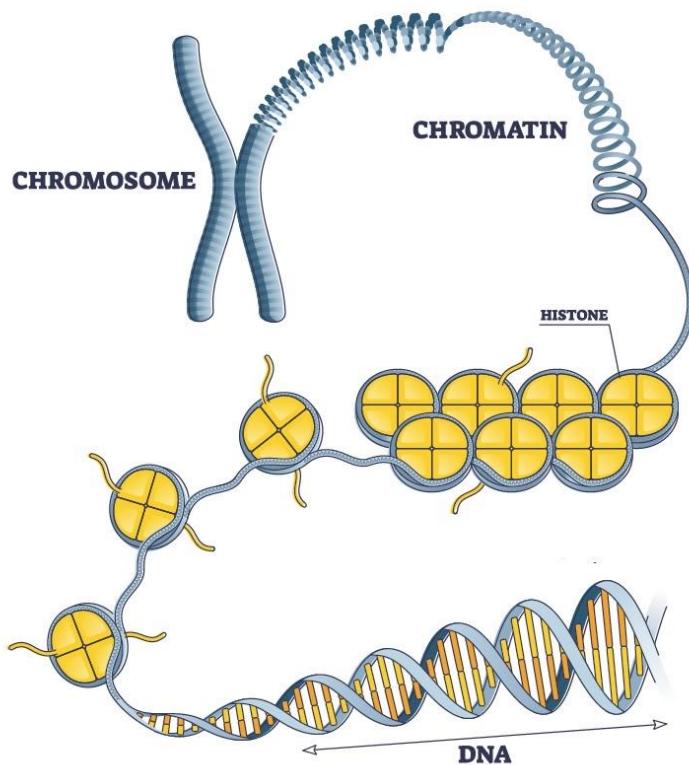
Nucleic acids, nucleobases



<https://www.thoughtco.com/>

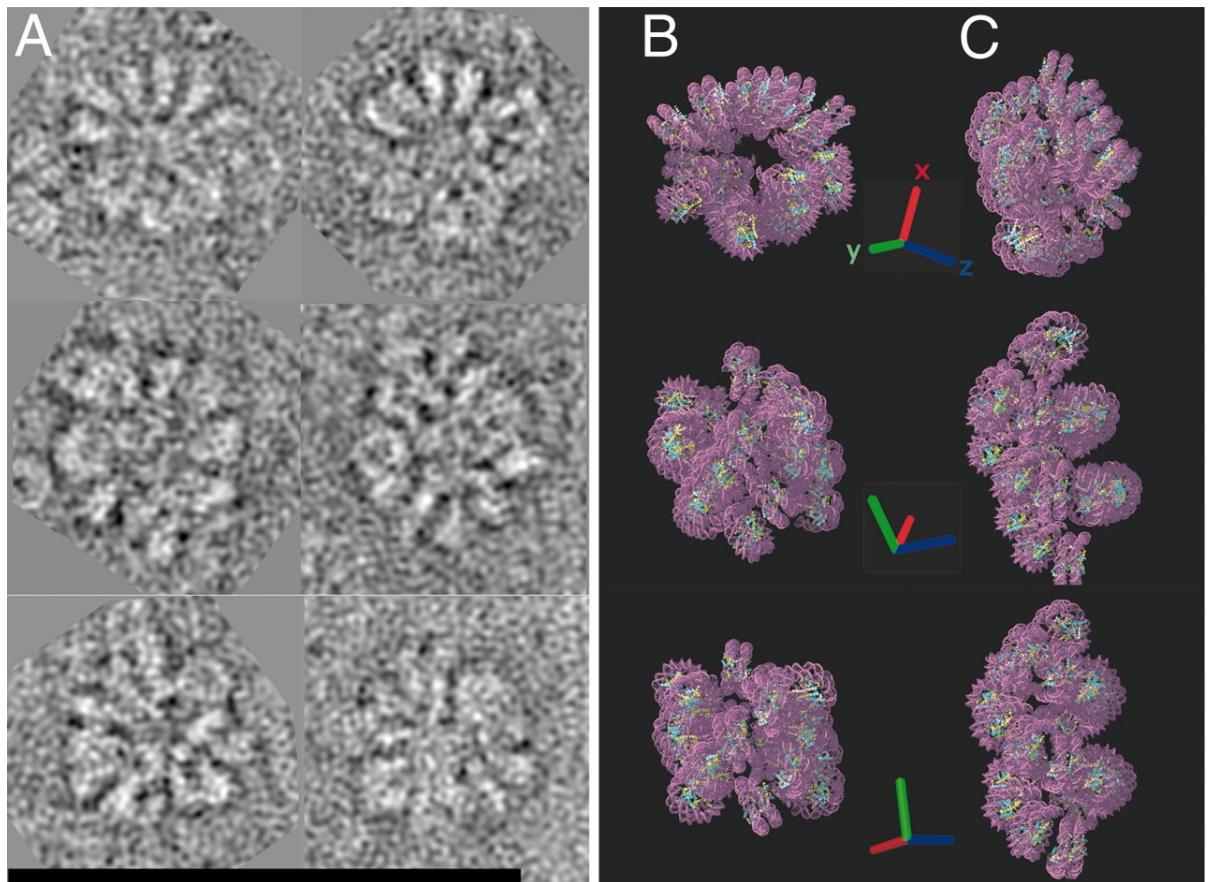
<https://opencurriculum.org/5348/dna-and-rna/>

Chromatin – complex of DNA and proteins



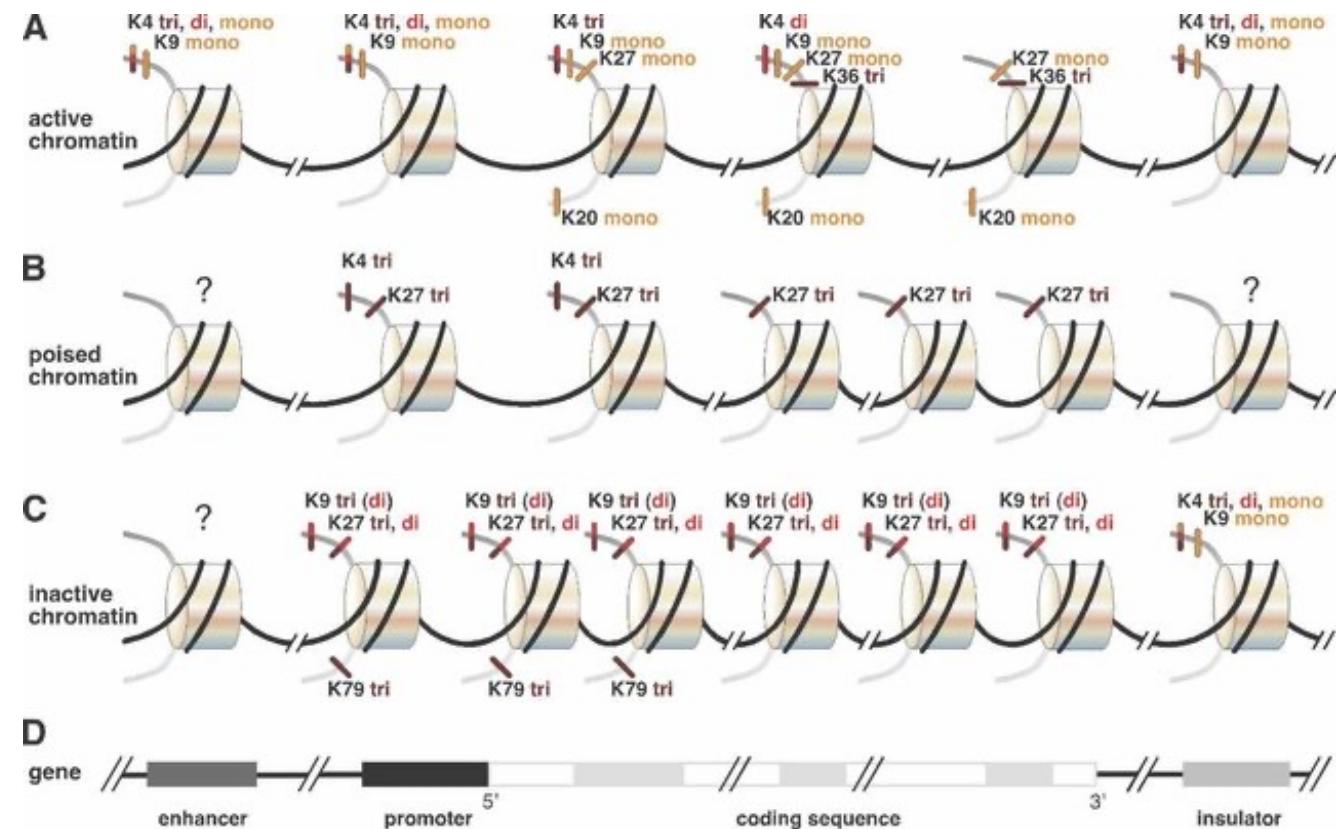
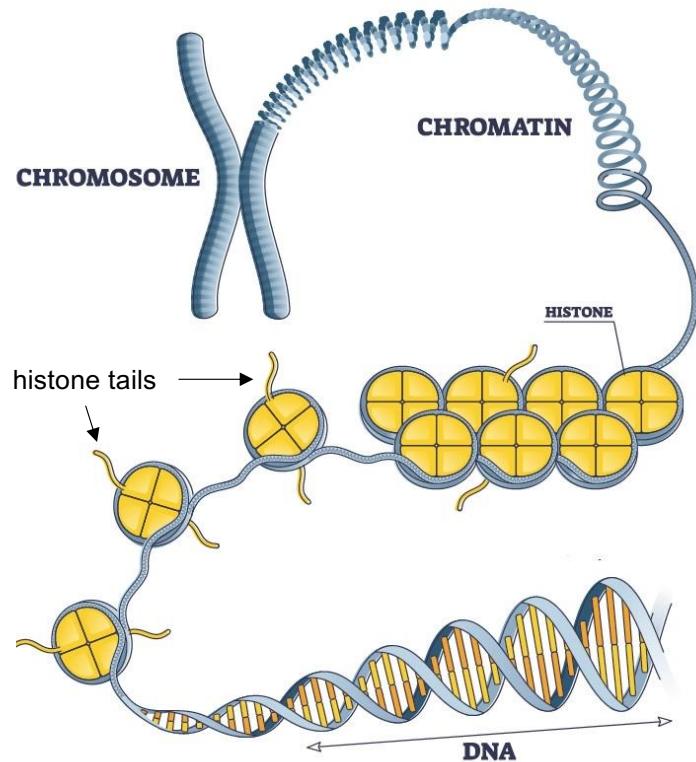
<https://research.pasteur.fr/>

Folded chromatin array of 22 nucleosomes
with repeat length 177 bp DNA



Robinson P J J et al. PNAS 2006;103:6506-6511

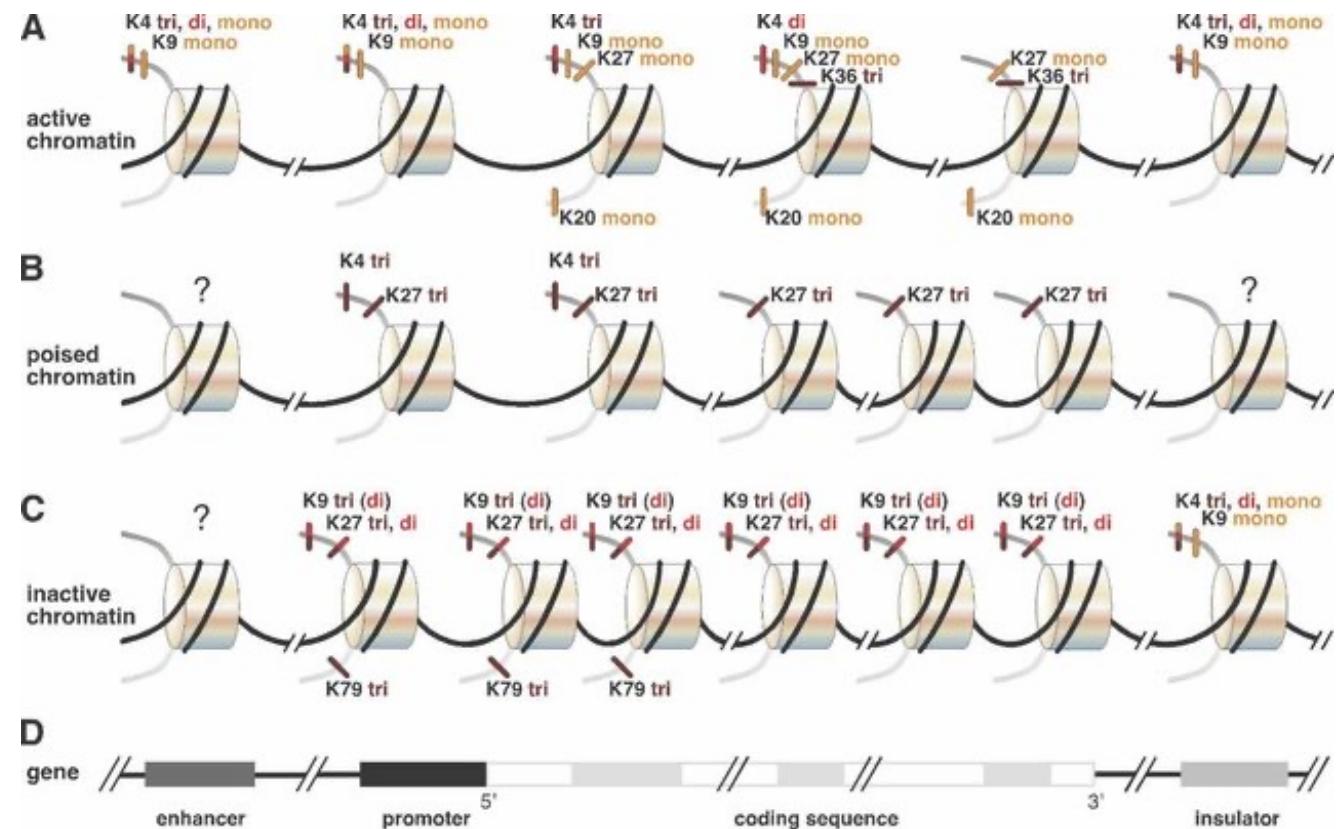
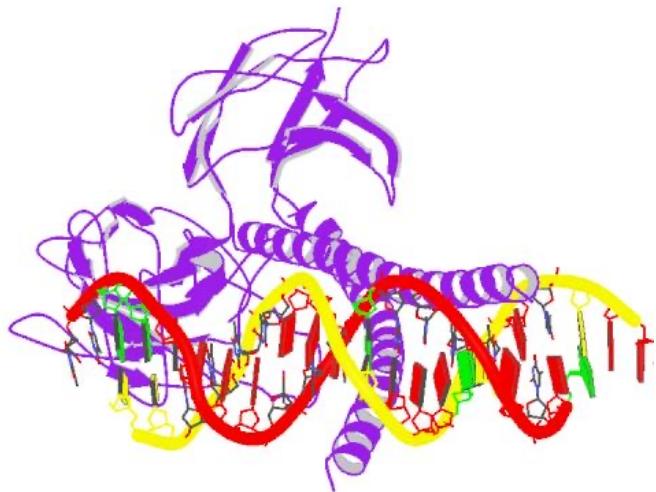
Epigenetics - the histone “code”



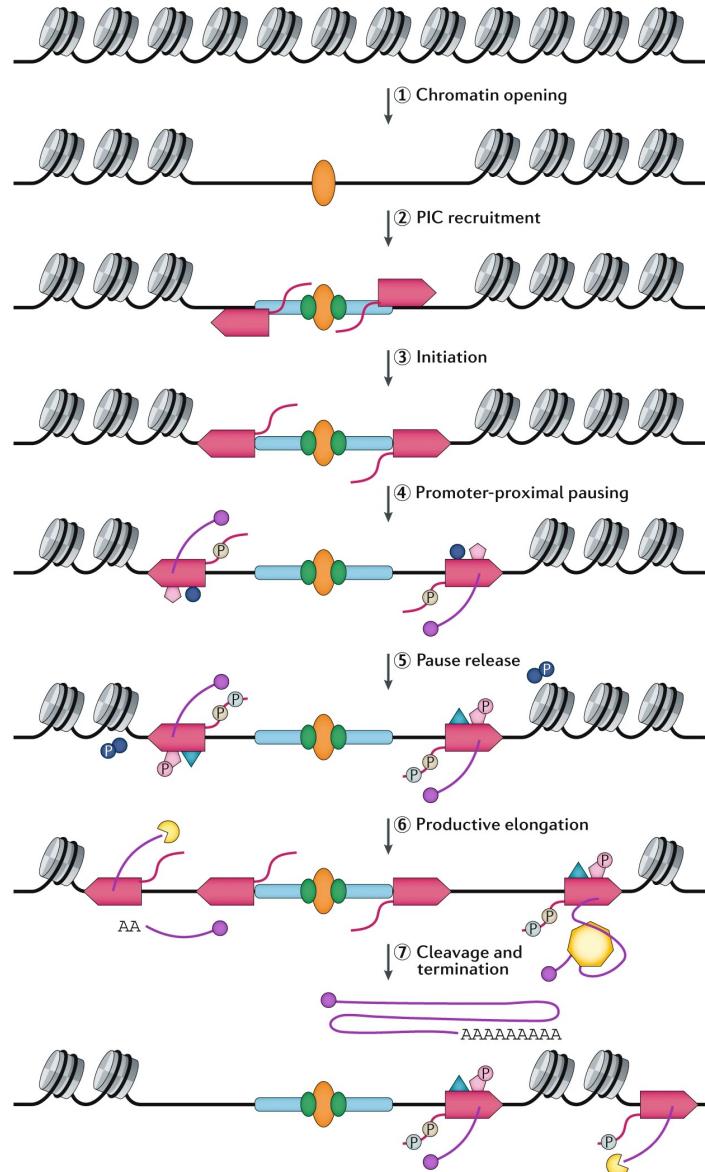
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Schneider & Grosschedl, Genes Dev. 2008

Transcription factors: finding addresses in the DNA



Schneider & Grosschedl, Genes Dev. 2008

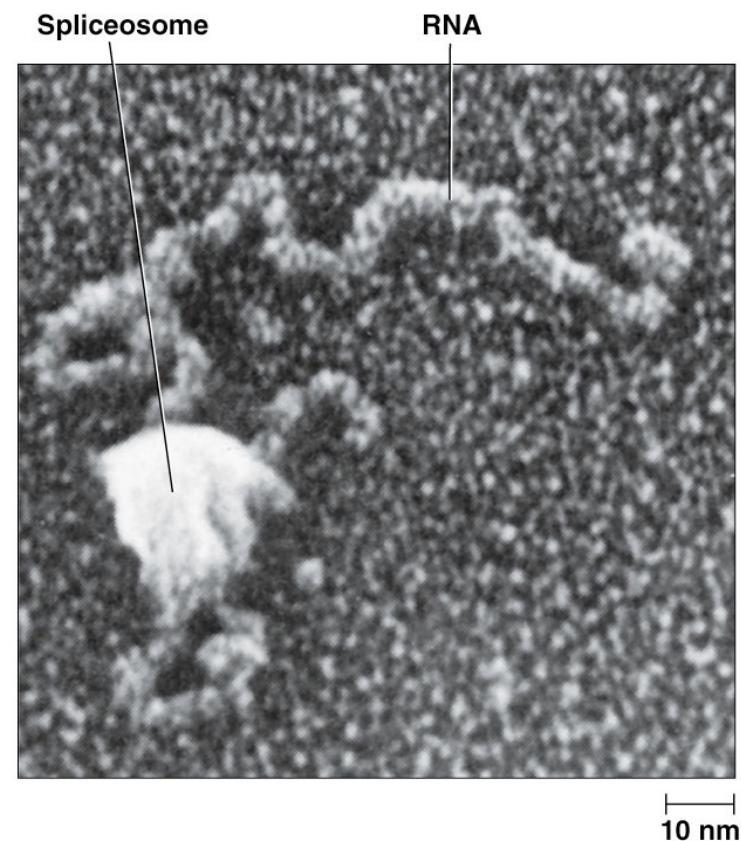
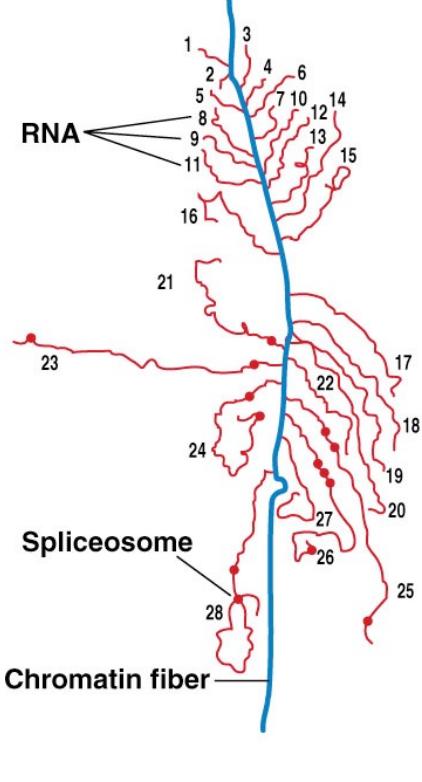
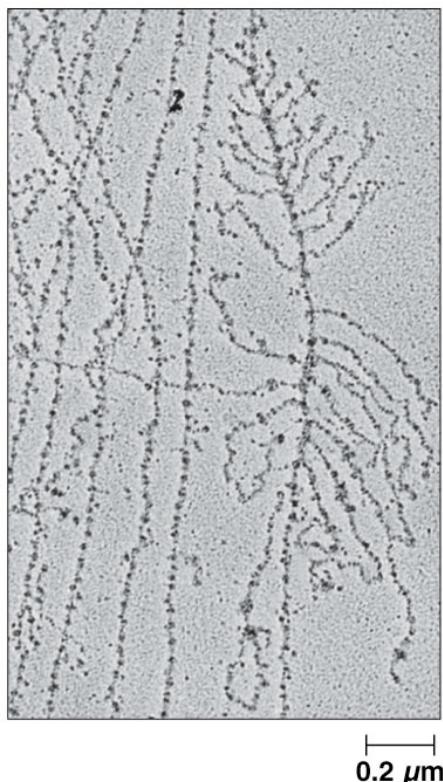


Transcription: from DNA to mRNA

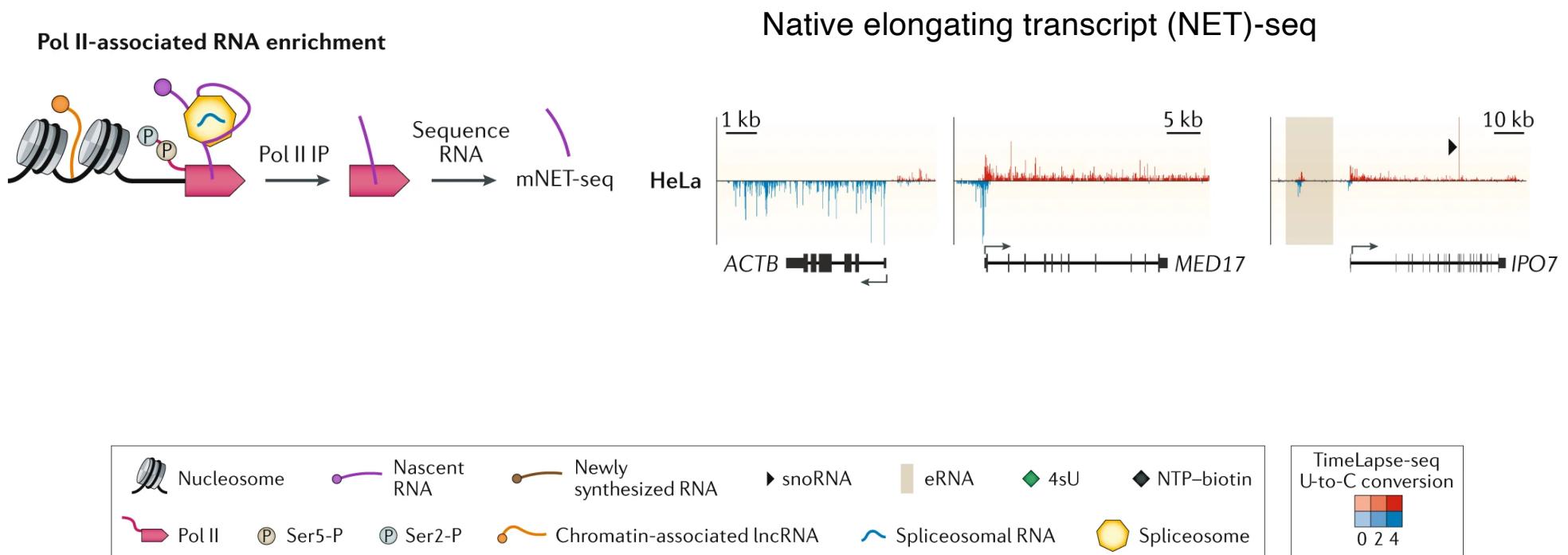


Wissink et al. NRG 2019

pre-mRNA processing

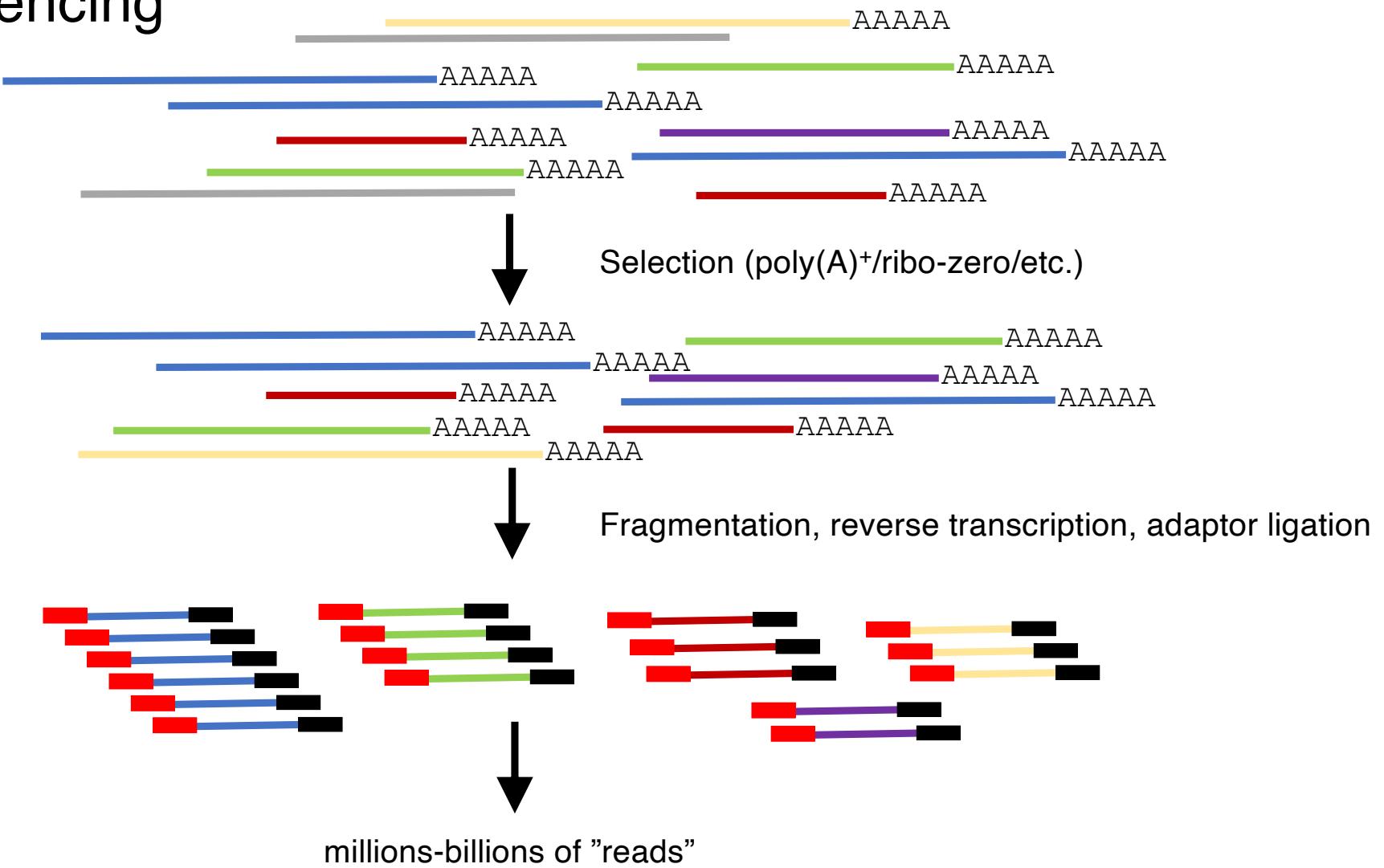


Using sequencing to understand biology

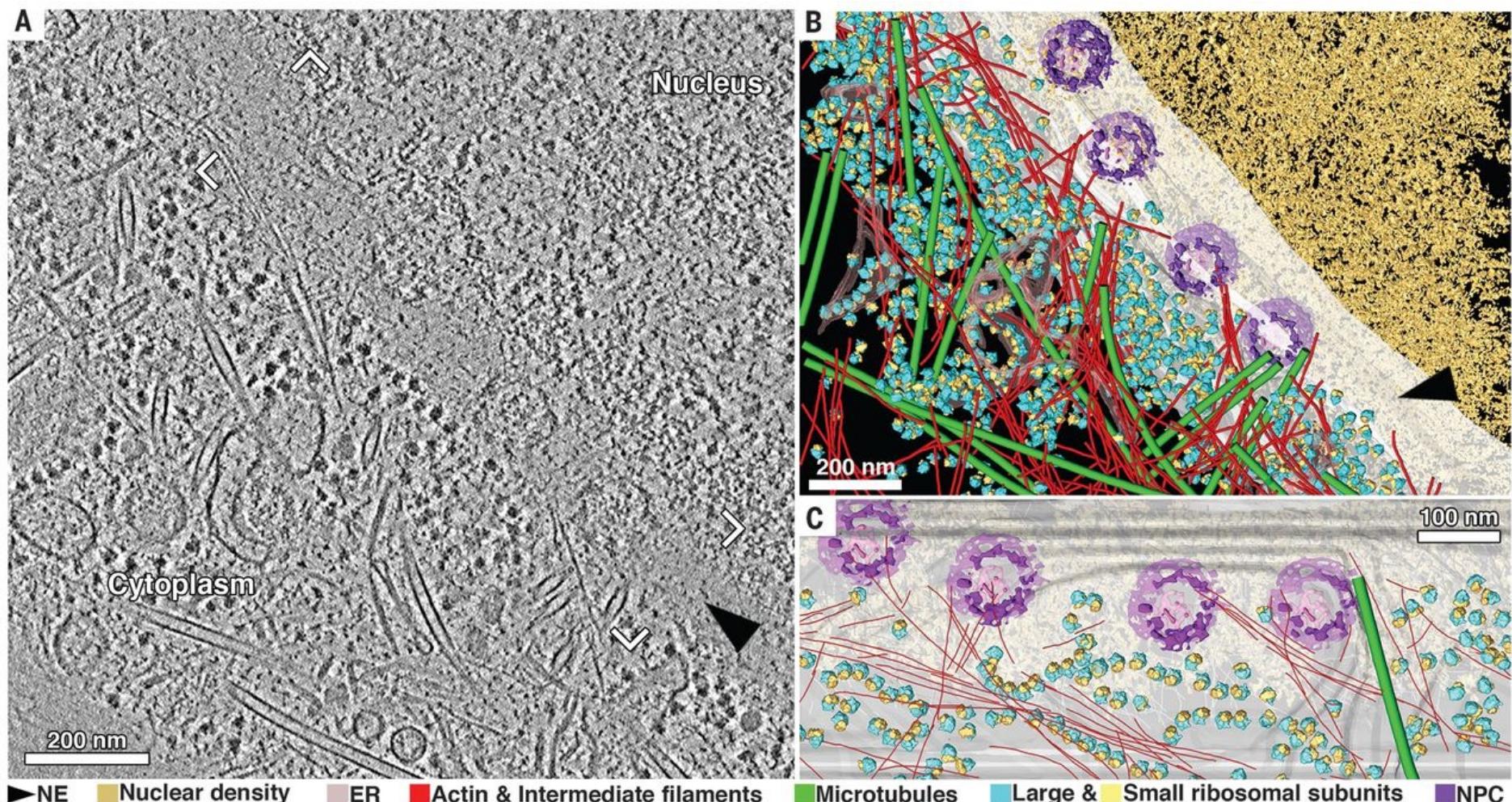


Wissink et al. NRG 2019

RNA sequencing



Nuclear export: moving between very crowded environments

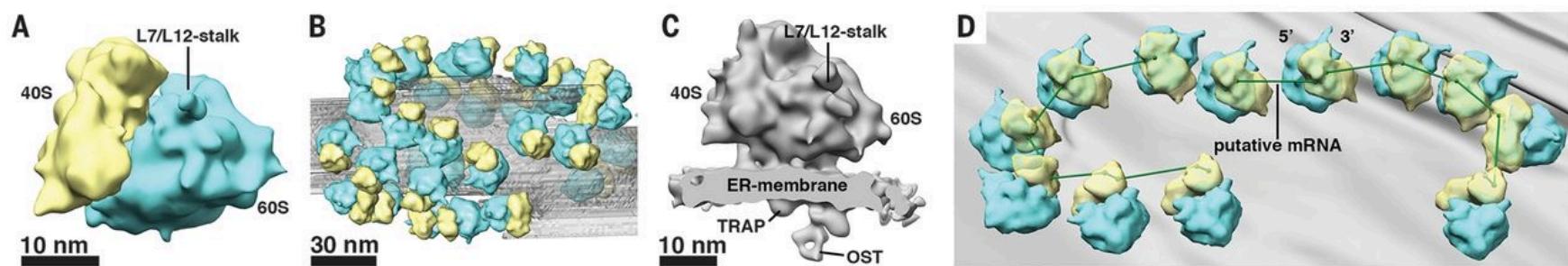
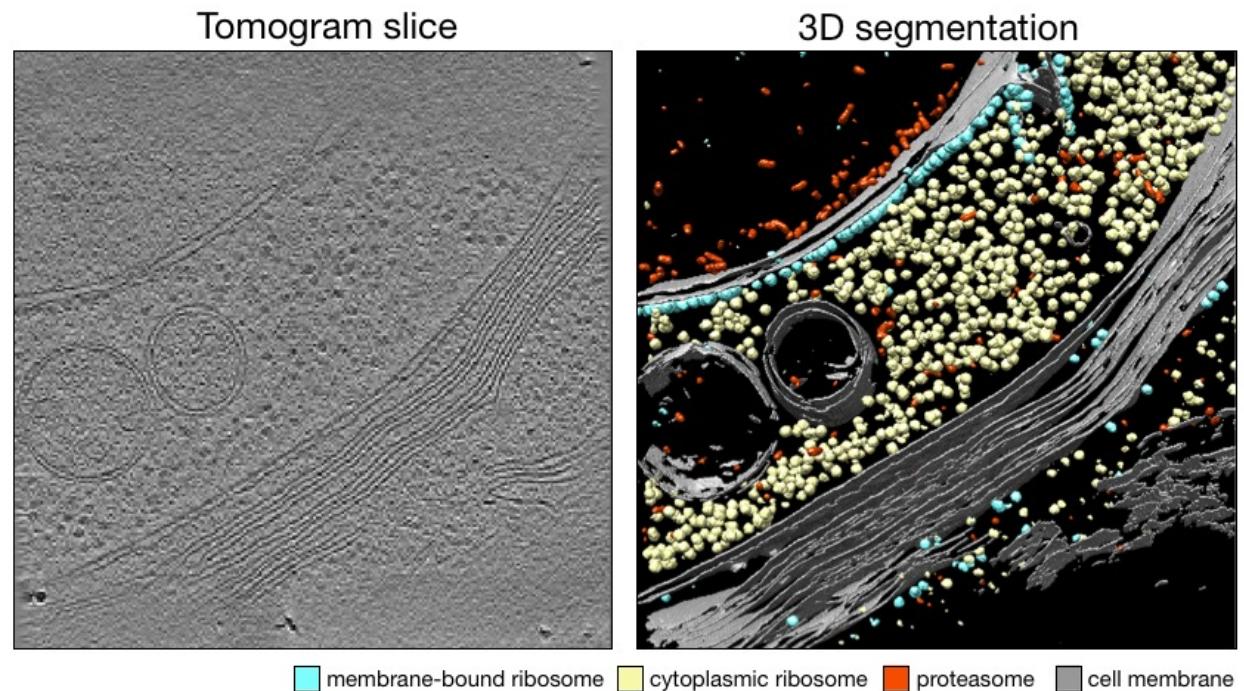


CryoET of a HeLa cell

Mahamid et al. Science 2016

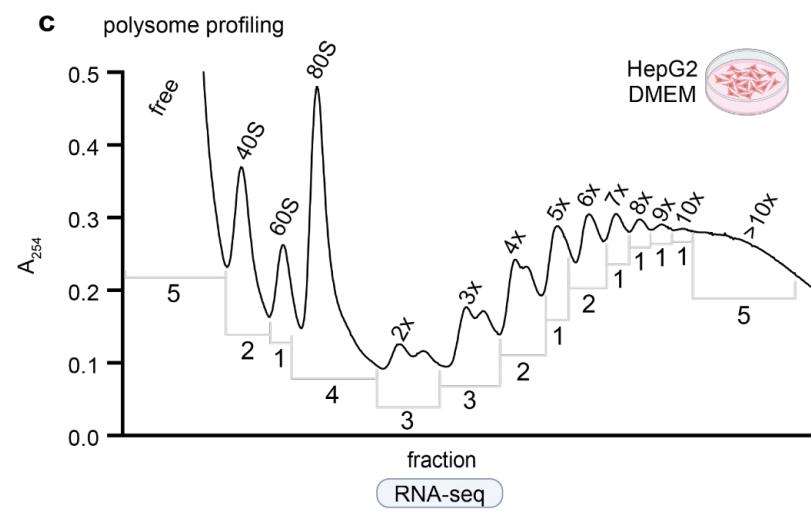
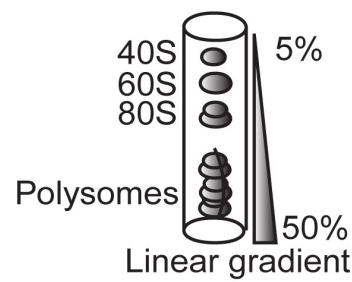
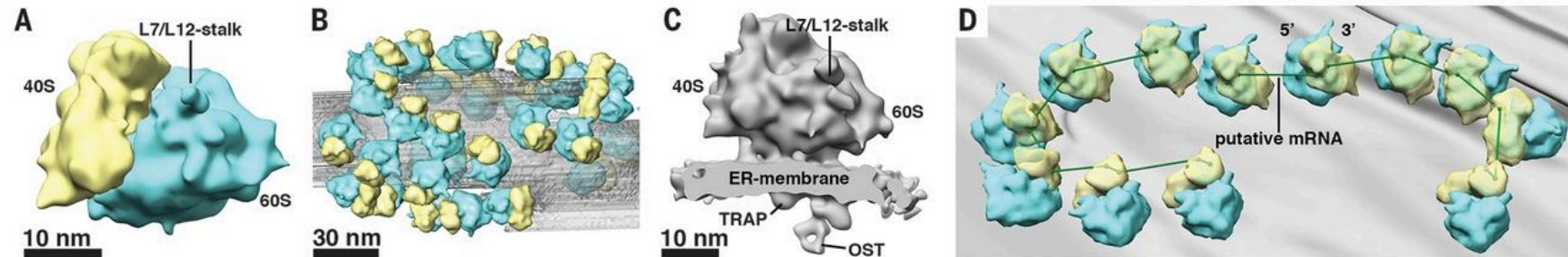
Translation: from RNA to protein

<https://radar.inria.fr/>

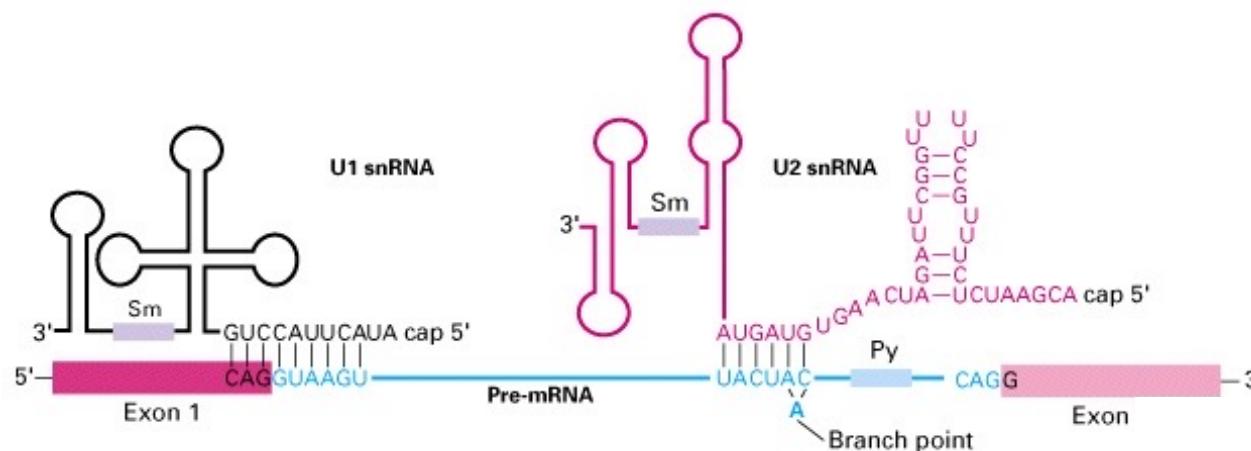


Mahamid et al. Science 2016

Analyzing translation



RNA “zip codes”



Splicing – small nuclear RNAs

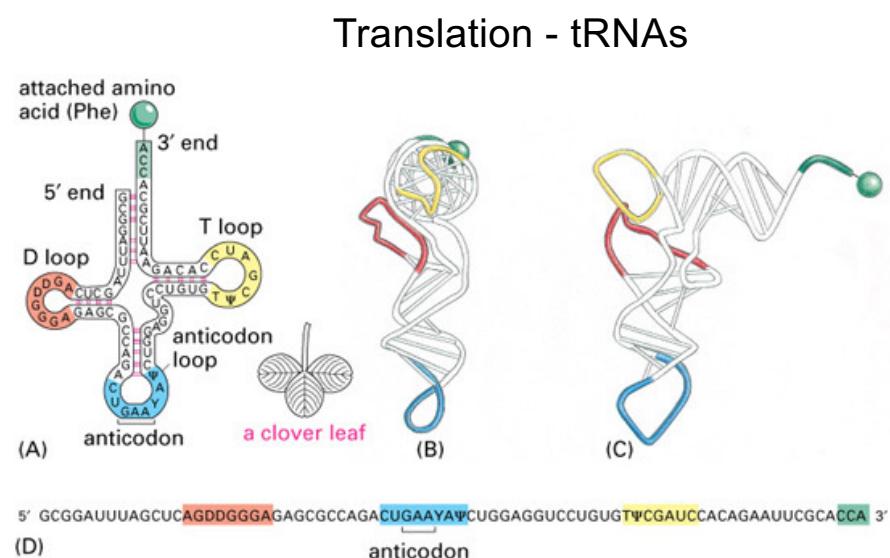
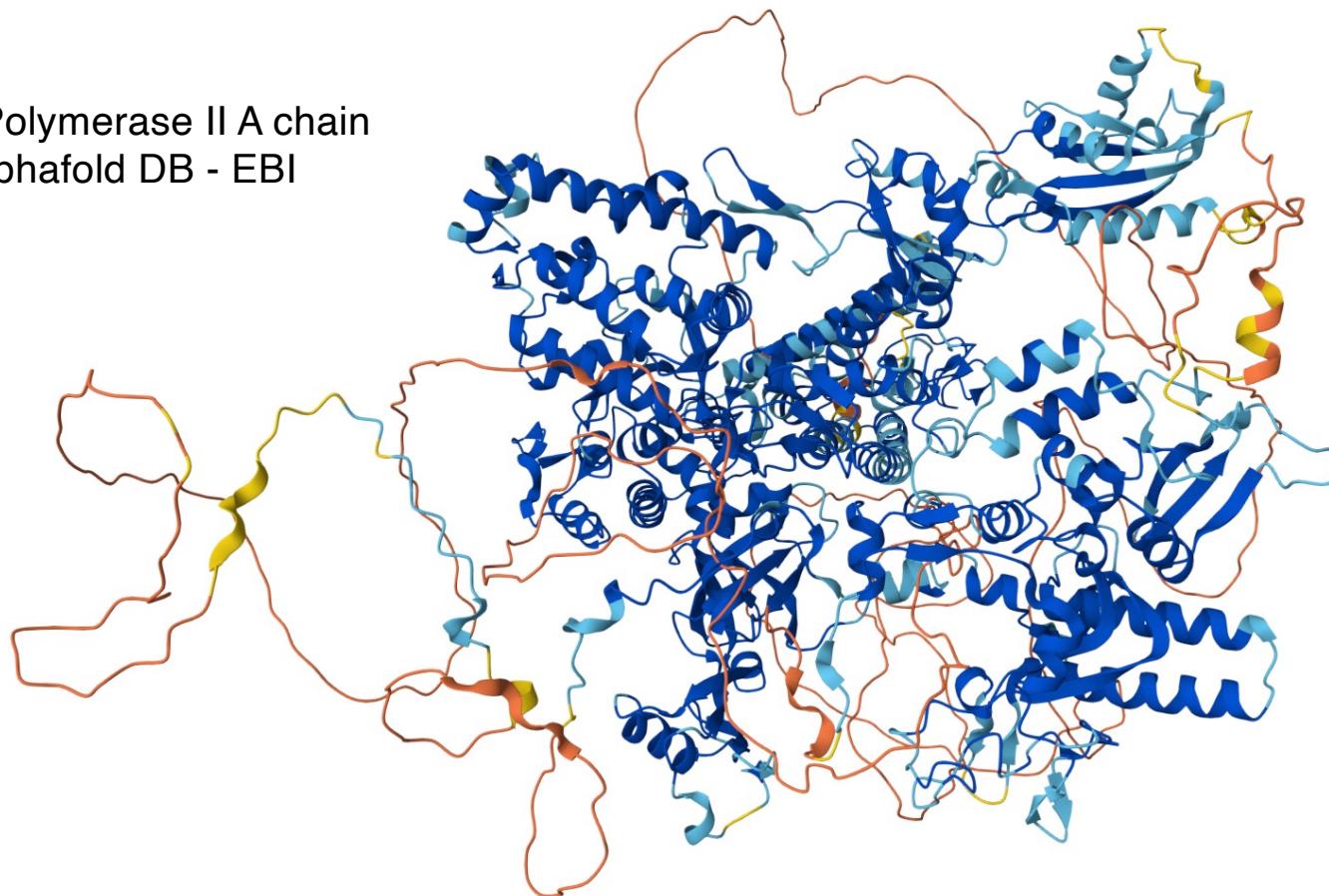


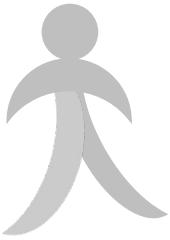
Figure 7-23 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Modular organization of biomolecules

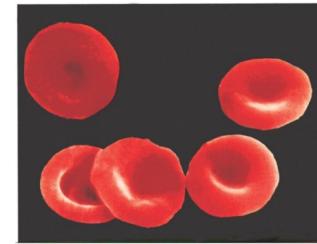
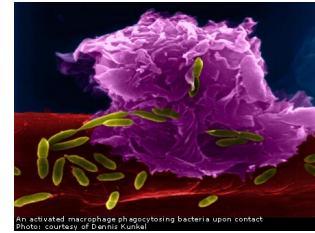
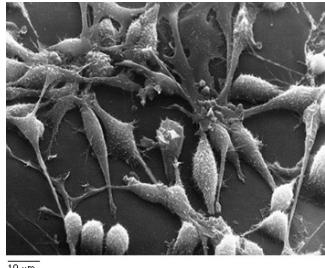
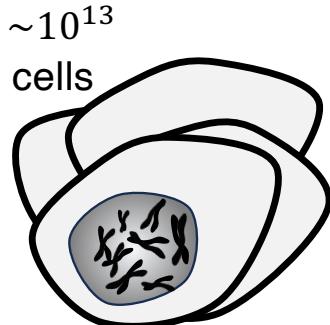
RNA Polymerase II A chain
AlphaFold DB - EBI



Gene “expression”: from one genome to many cell types



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CAGAGGTAATACCCATGTTACAGTCGAGAAGGCTTTAGCCATGTTAAATACGGTGGGGGACATCAAGCTCGCAAATG



Genotype, phenotype, genotype-phenotype map

Genotype = the entire genetic material of an organism

- though also being used to refer to different variants of a given gene/locus

Phenotype = set of observable characteristics of an individual

- depends on the genotype but also the environment

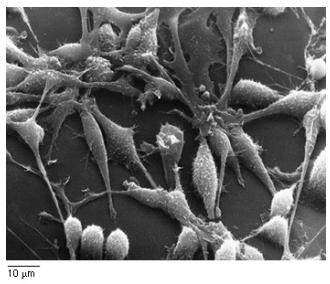
Genotype-phenotype map = conceptual model of the dependency of phenotypes on genotypes

Fitness landscape = related conceptual model denoting the relationship between genotype and fitness (reproductive success/number of offspring) of an individual.

Genealogy = trace of individuals linking a particular member of a population to its ancestor

Phylogeny = network (typically tree) representing the evolutionary history of a population

The “activity” of genes varies across cell types

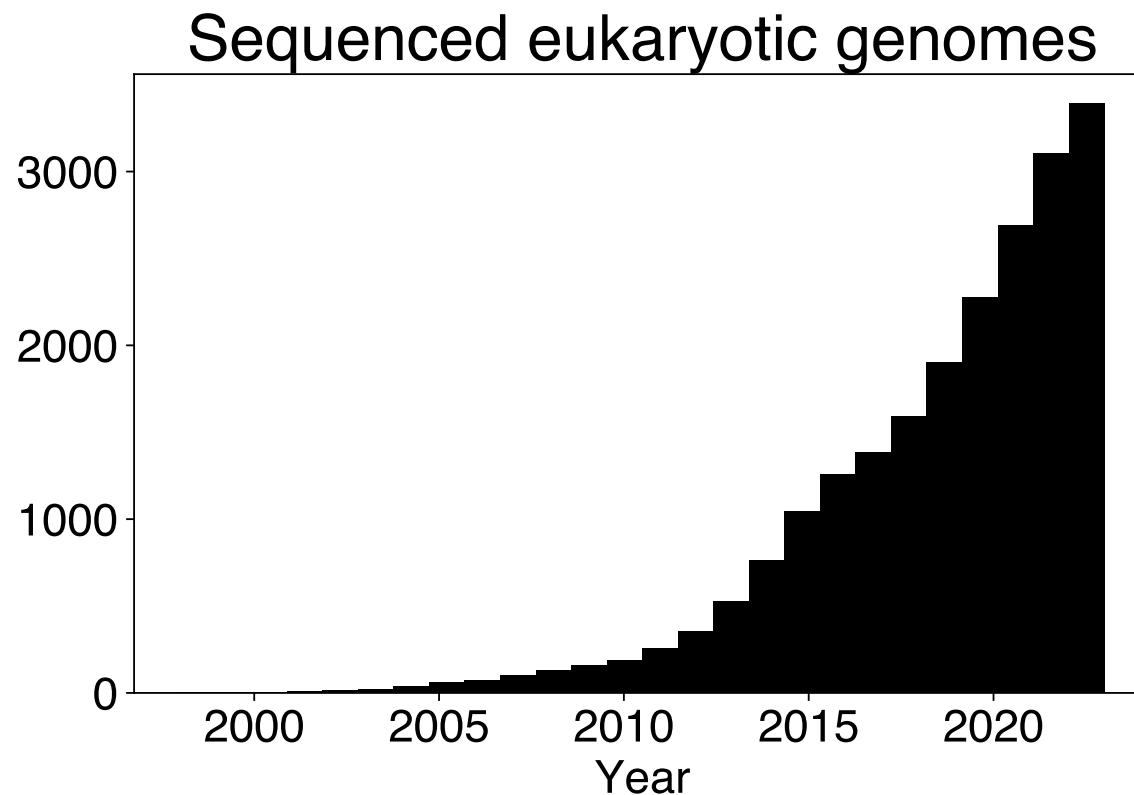


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Analyzing genome sequences to learn about regulation



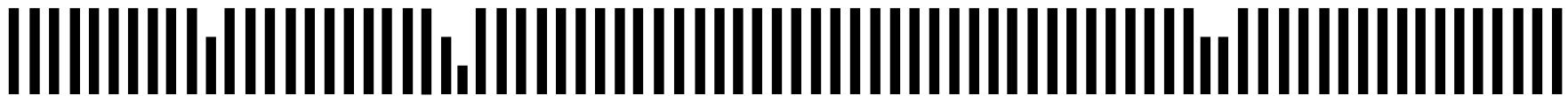
Looking at the genome through the lens of evolution

Human

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ACT **Chimp** CTGAAGTGCACTCGGTCGTATGCCGTAGGGCGGCTGGTAGTACGCCATTTTCGGATGAAGTC
TGG AGTAGTGTGCCCGTCTGTCGATCTTCTTGCCTCGTGTGACTCTGGTAGCTACAAAACAAAAGTCAGCAAAAA
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CAG GCGCCCGAACAGGGACTTAAAGCGTCGCTGACCGAATTCAAAGTAAACCAGAGGAGATCTCTCGACGCAGGTCGTATG
GAA ACT **Dog** TGCTGAAGTGCACTCGGTCGTATGCCGTAGGGCGGCTGGTAGTACGCCATTTTCGGATGAAGTC
CAG TGG AGTAGTGTACCGTCTGTTCAGATCTTCTTGCCTCGTGTGACTCTGGTAGCTACAGGACAAAAGTCAGCAAAAA
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Aligning genomes

Human	AGTAGTGTGT G CCCGTCTGTT C TATCTTCTTGCCTTCGTGTGACTCTGGTAGCTACAAAACAAAAGTCAGCAAAAA
Chimp	AGTAGTGTGT G CCCGTCTGTT G CATCTTCTTGCCTTCGTGTGACTCTGGTAGCTACAAAACAAAAGTCAGCAAAAA
Dog	AGTAGTGTGT A CCCGTCTGTT A GATCTTCTTGCCTTCGTGTGACTCTGGTAGCTACAG G ACAAAAGTCAGCAAAAA



Evolutionary conservation indicates biological function