3DGenomics

Marc A. Marti-Renom

CNAG-CRG · ICREA

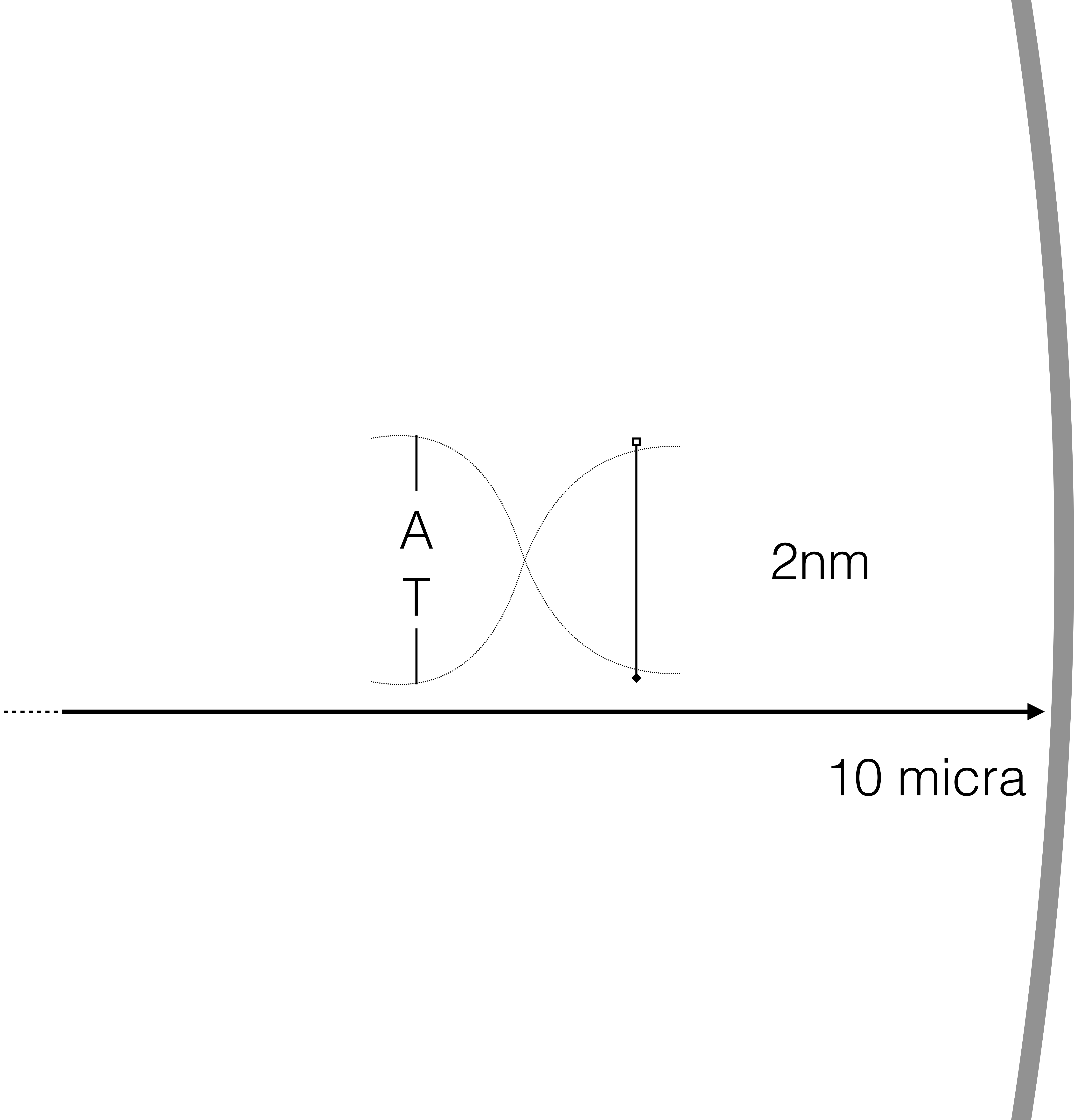
http://marciuslab.org
http://3DGenomes.org
http://cnag.crg.eu

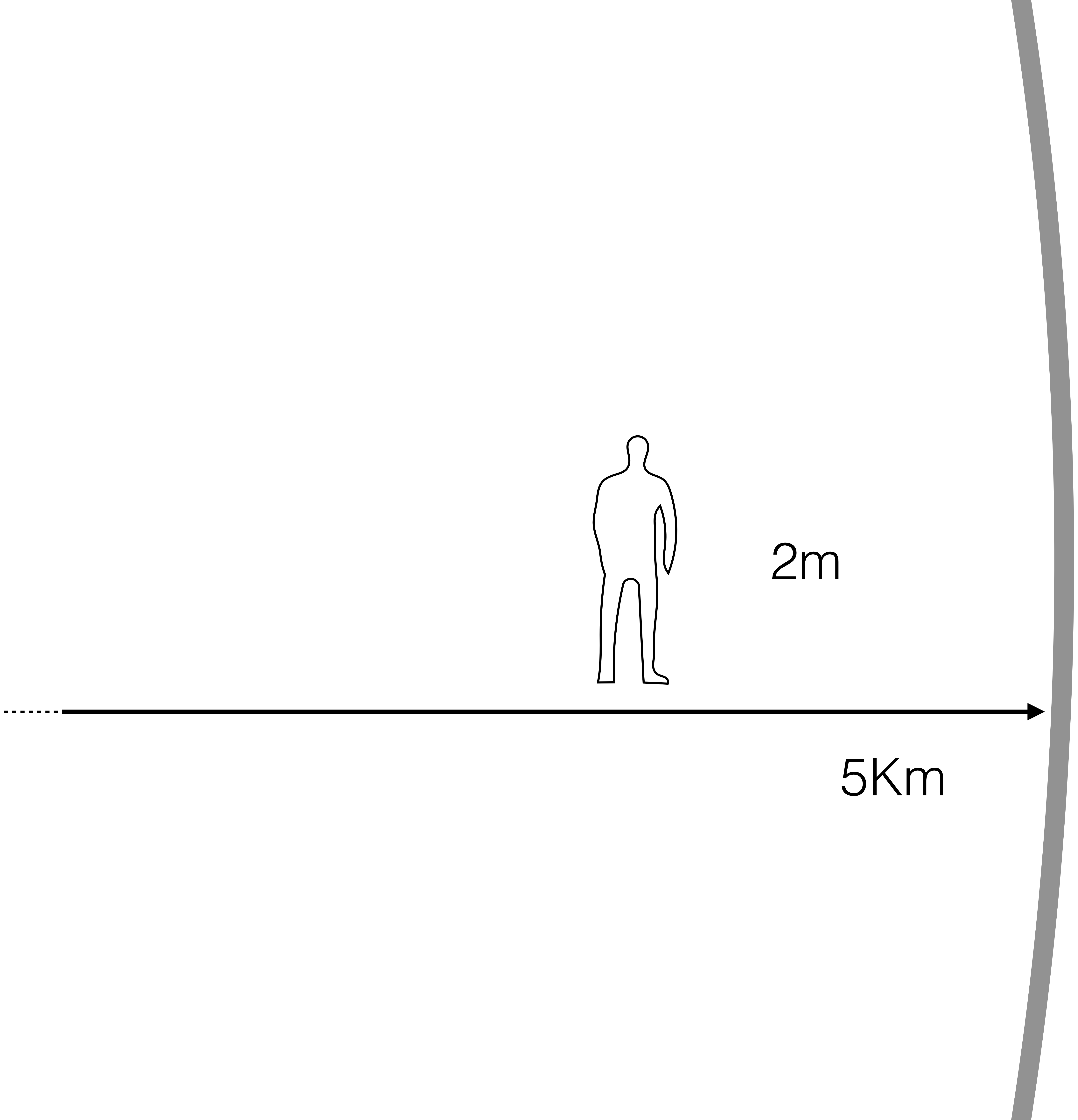
3.000.000.000 (300.000 book pages)

2 metres of DNA

Your body carries about 60.000.000.000Km of DNA

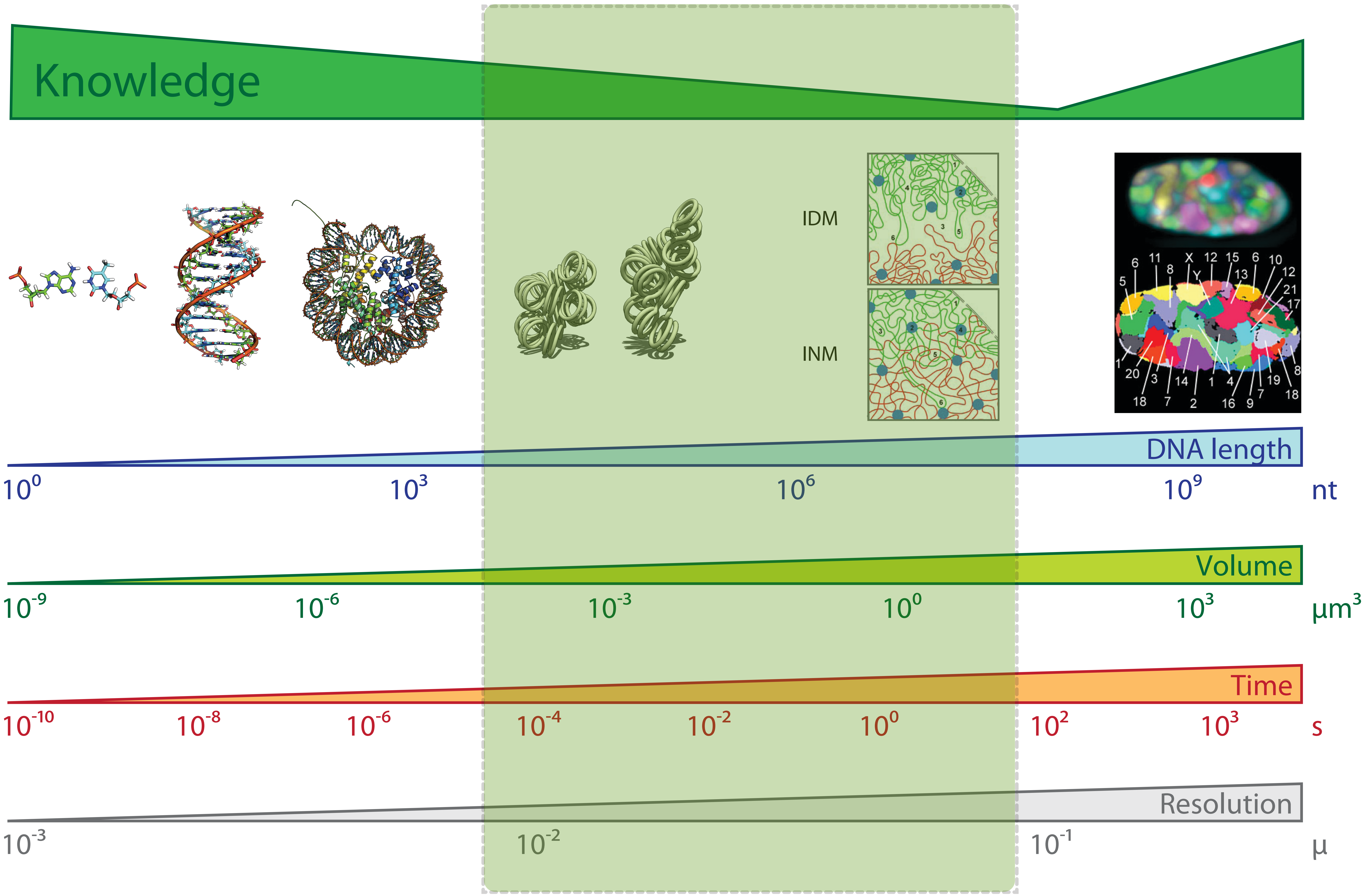
As much as needed for 95.000 round trips to the moon!!


A
T
2nm
10 micra


2m
5Km

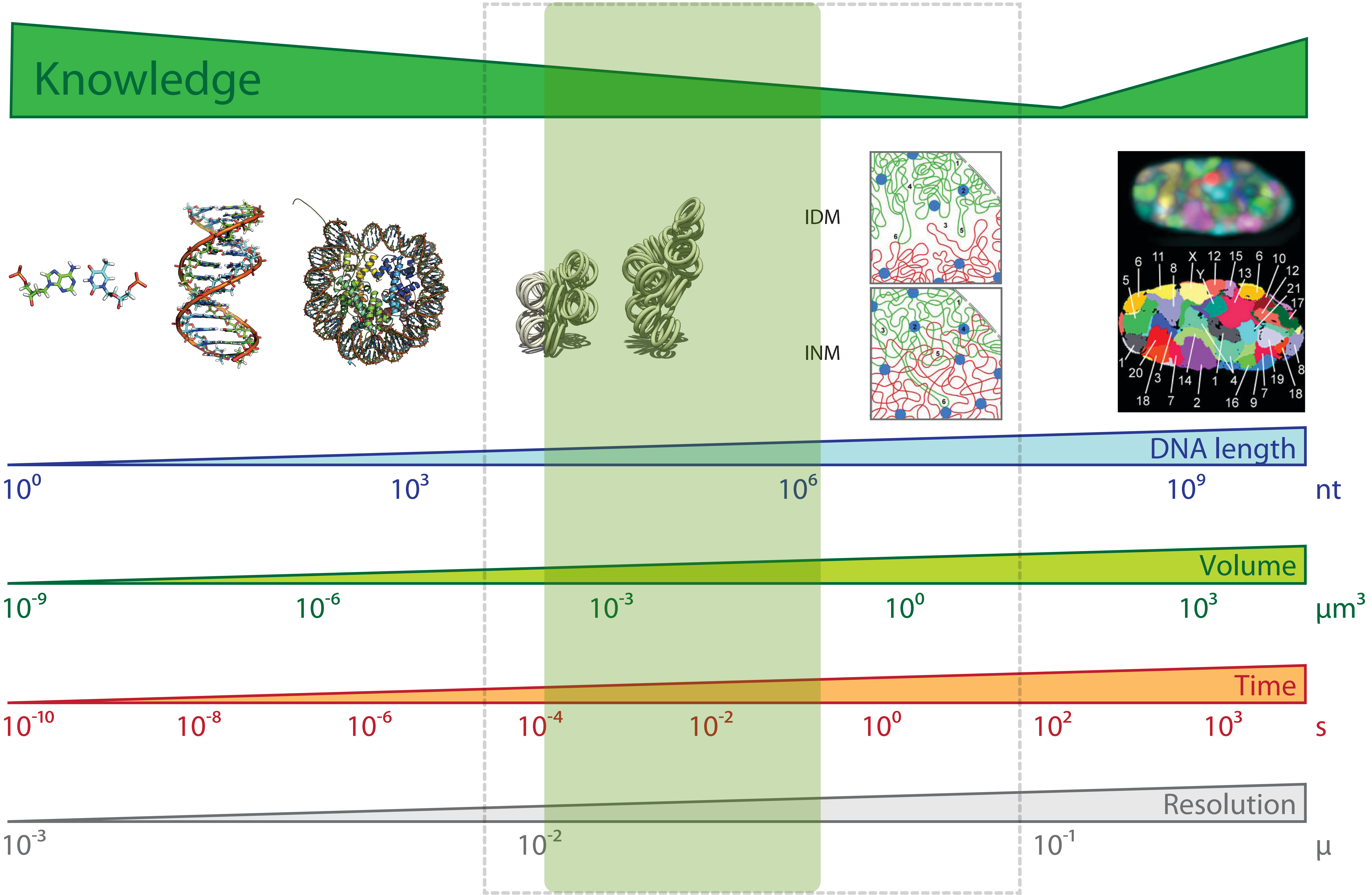
Resolution Gap

Marti-Renom, M. A. & Mirny, L. A. PLoS Comput Biol 7, e1002125 (2011)



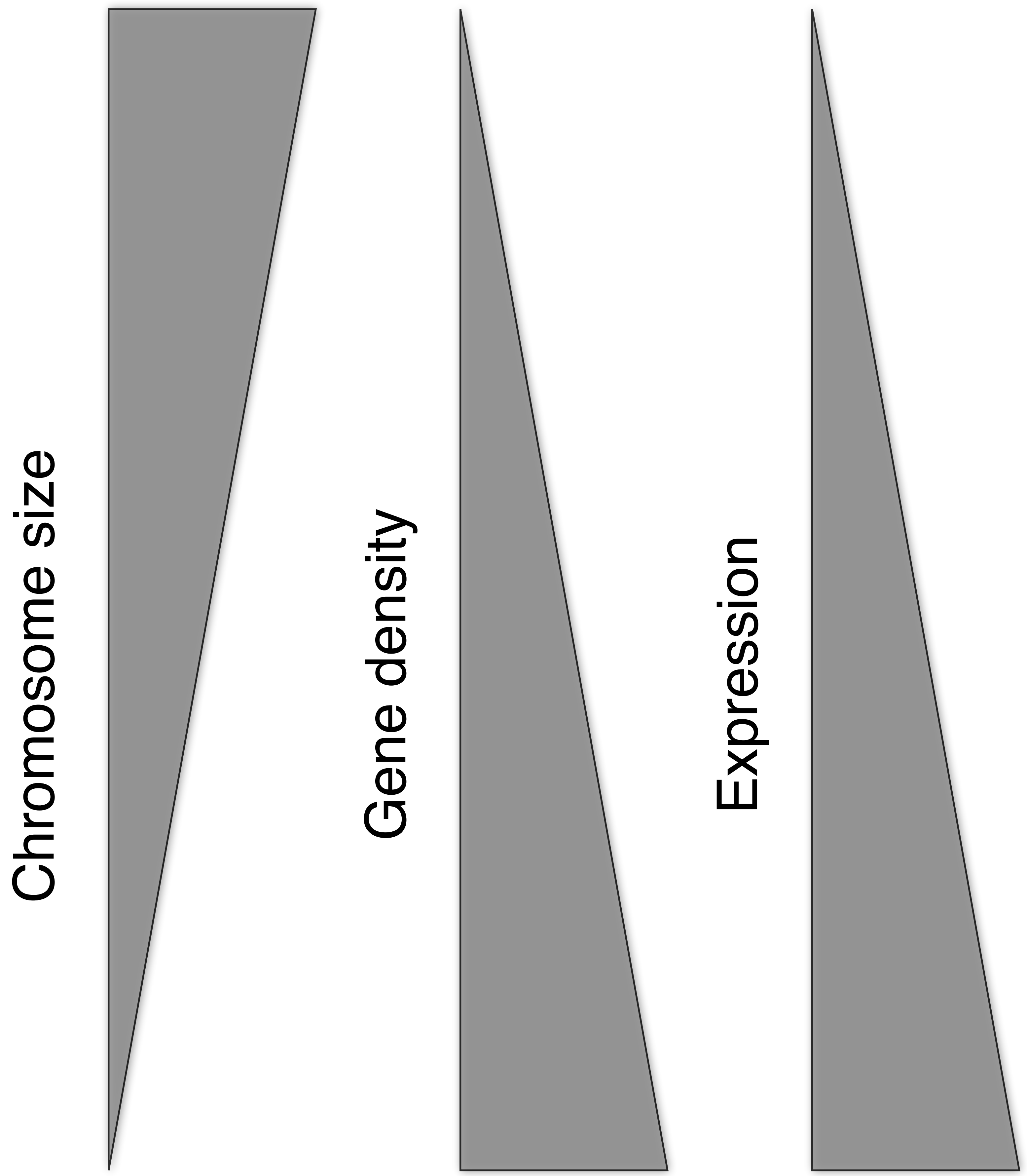
Resolution Gap

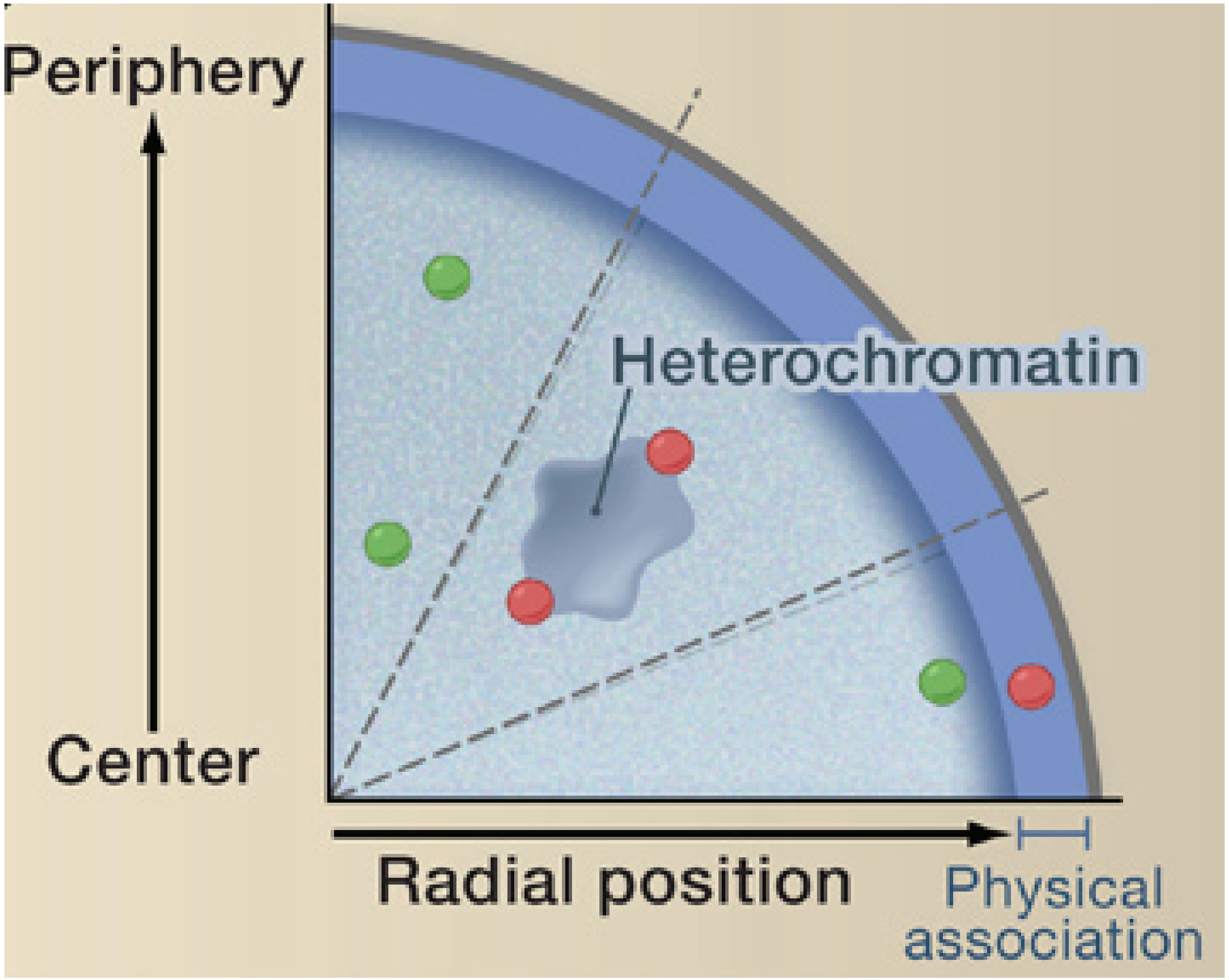
Marti-Renom, M. A. & Mirny, L. A. PLoS Comput Biol 7, e1002125 (2011)



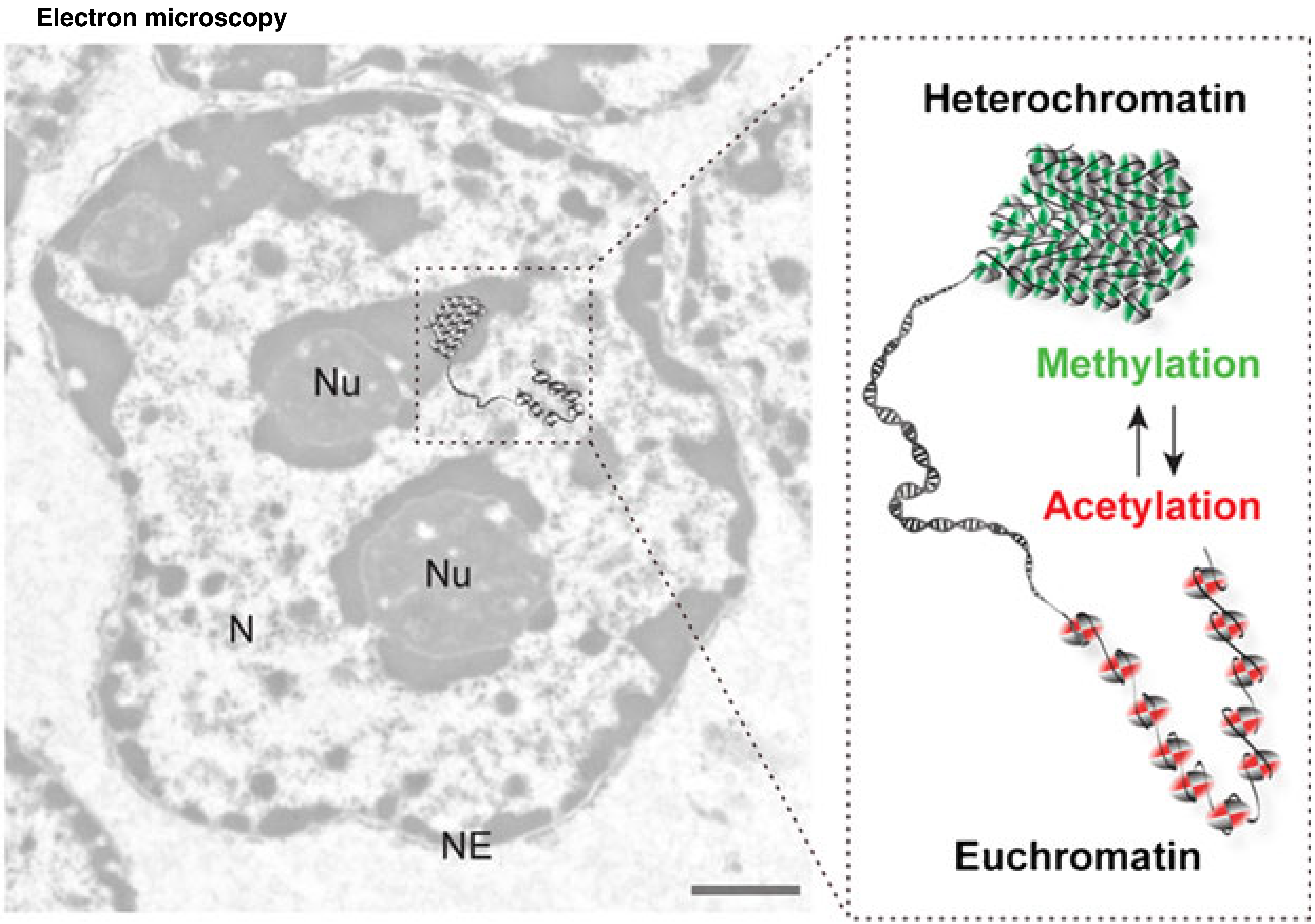
Level I: Radial genome organization

Takizawa, T., Meaburn, K. J. & Misteli, T. The meaning of gene positioning. Cell 135, 9–13 (2008).

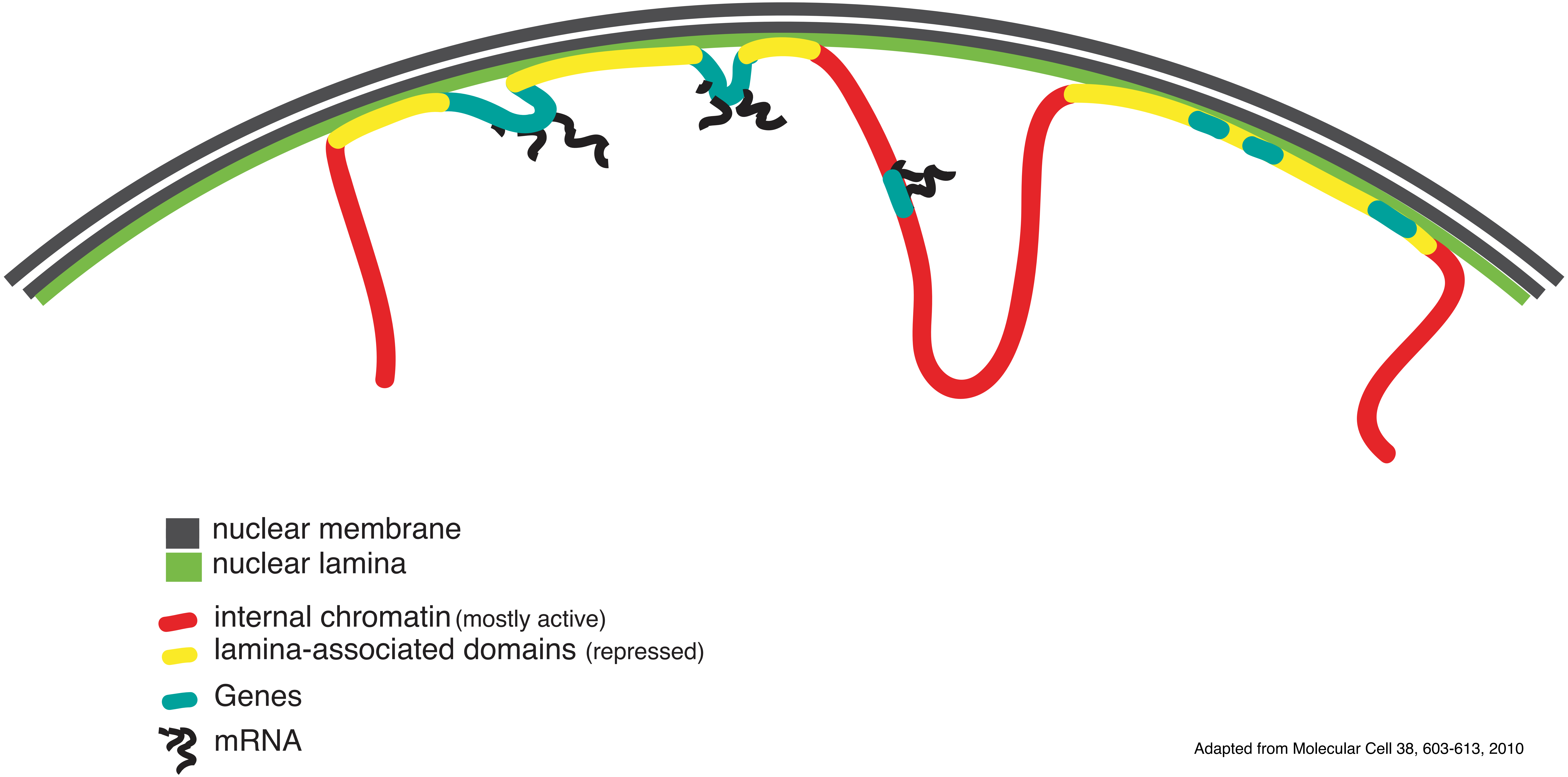




Level II: Euchromatin vs heterochromatin



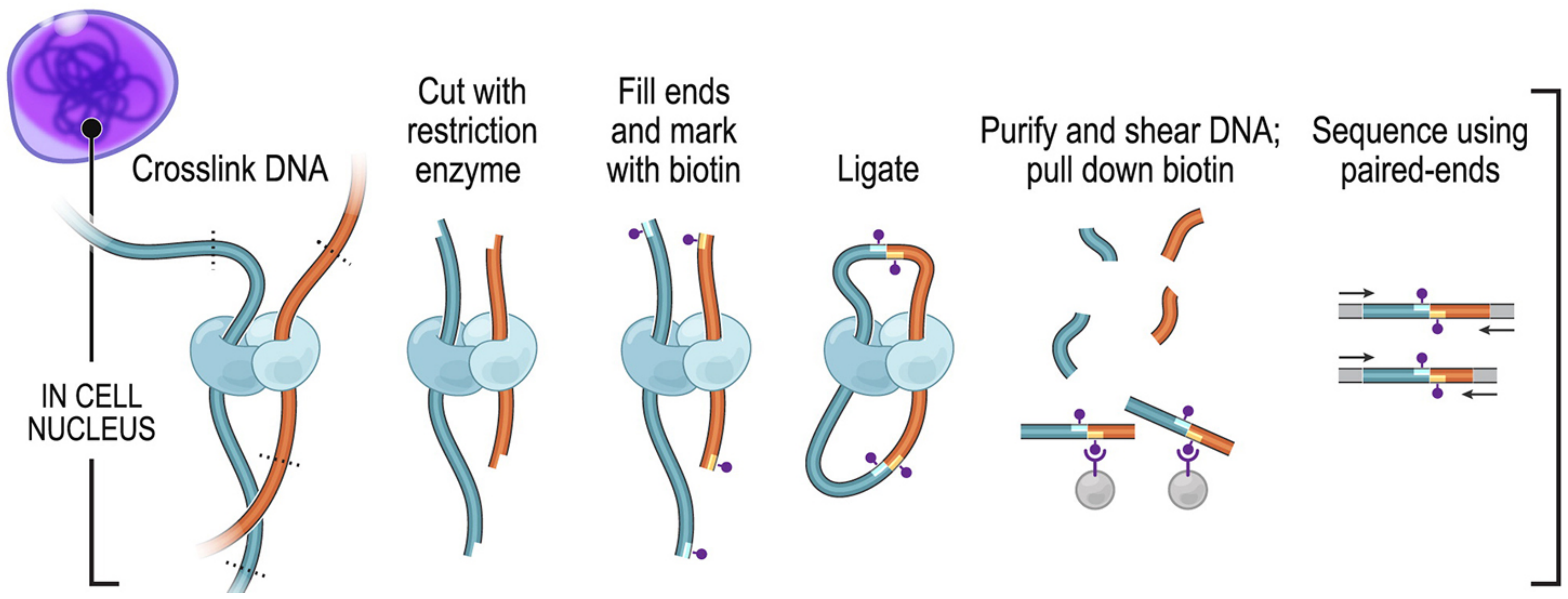
Level III: Lamina-genome interactions

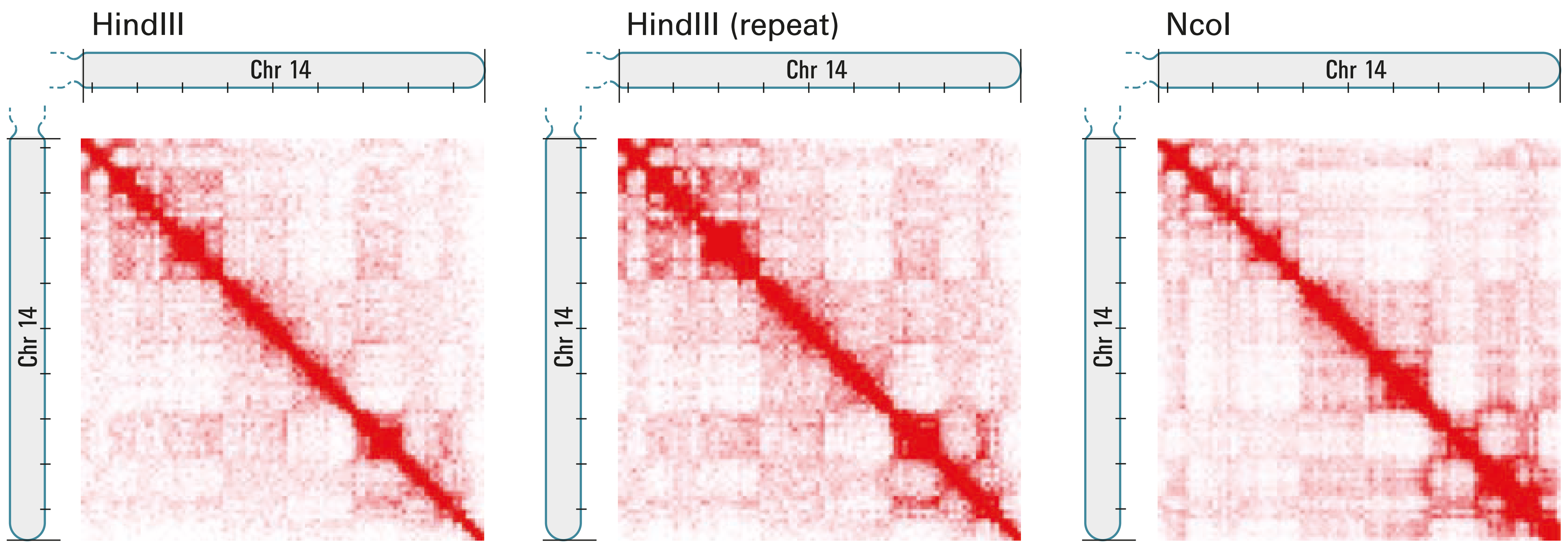


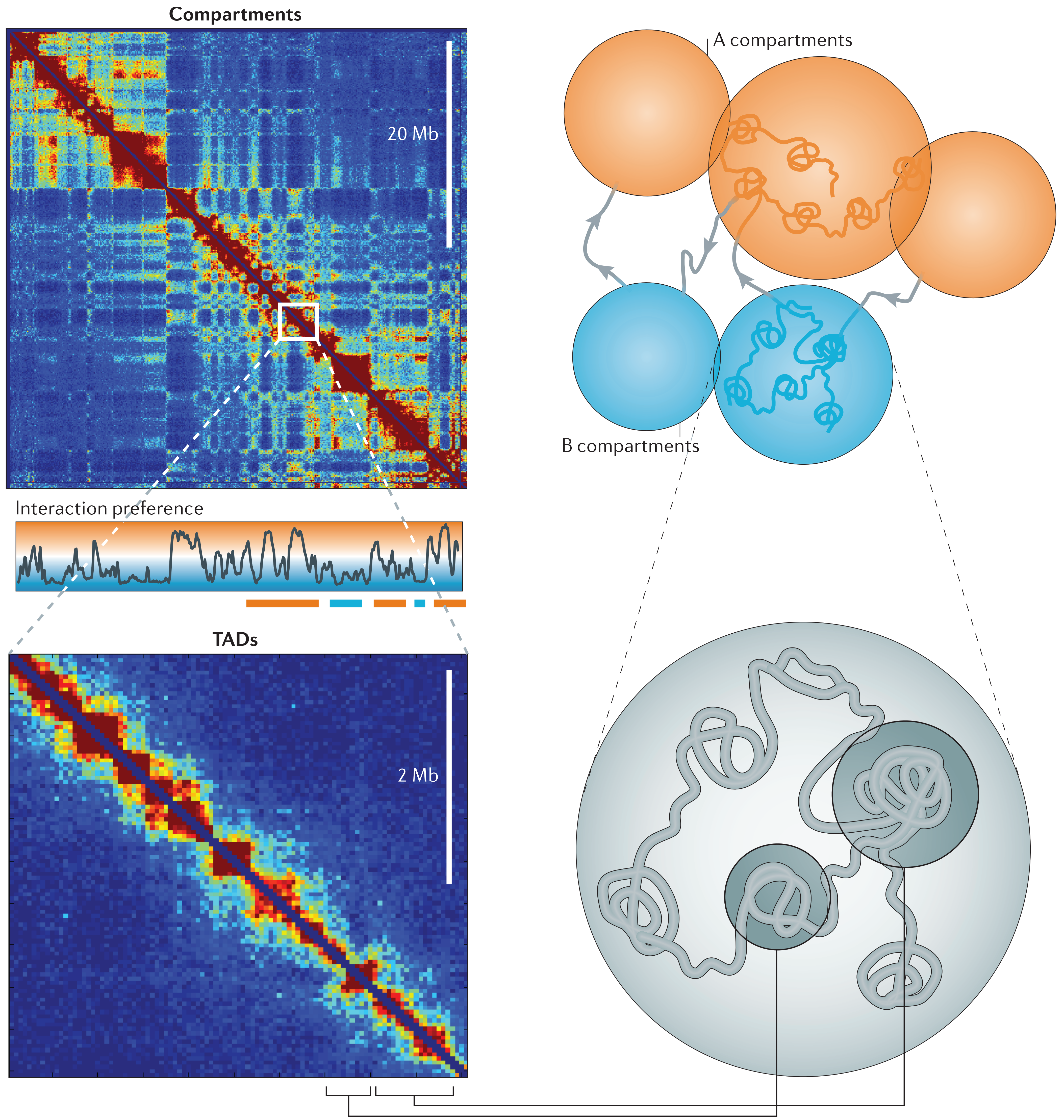
Adapted from Molecular Cell 38, 603-613, 2010

Level IV: Higher-order organization

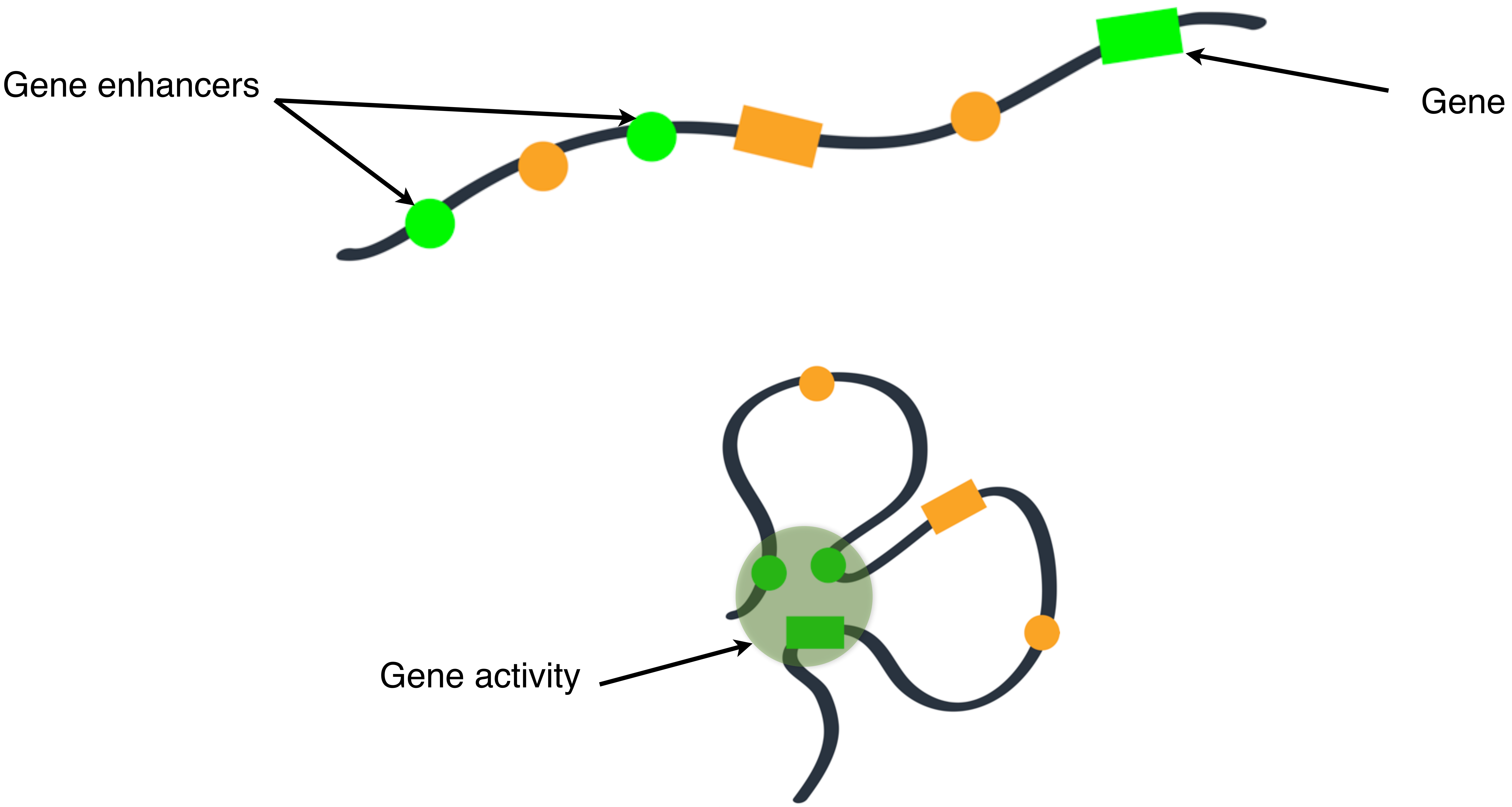
Dekker, J., Marti-Renom, M. A. & Mirny, L. A. Nat Rev Genet 14, 390–403 (2013).



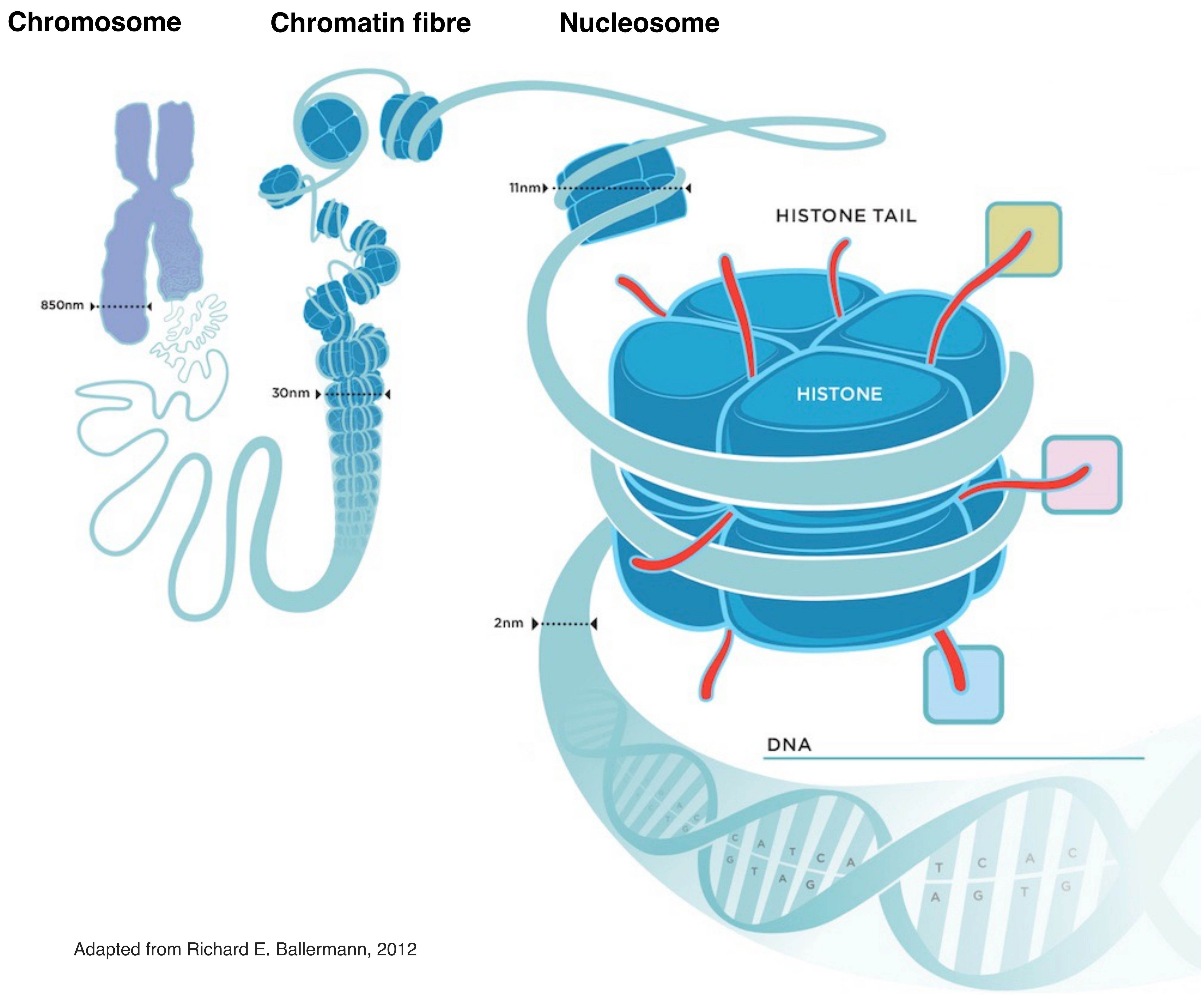




Level V: Chromatin loops



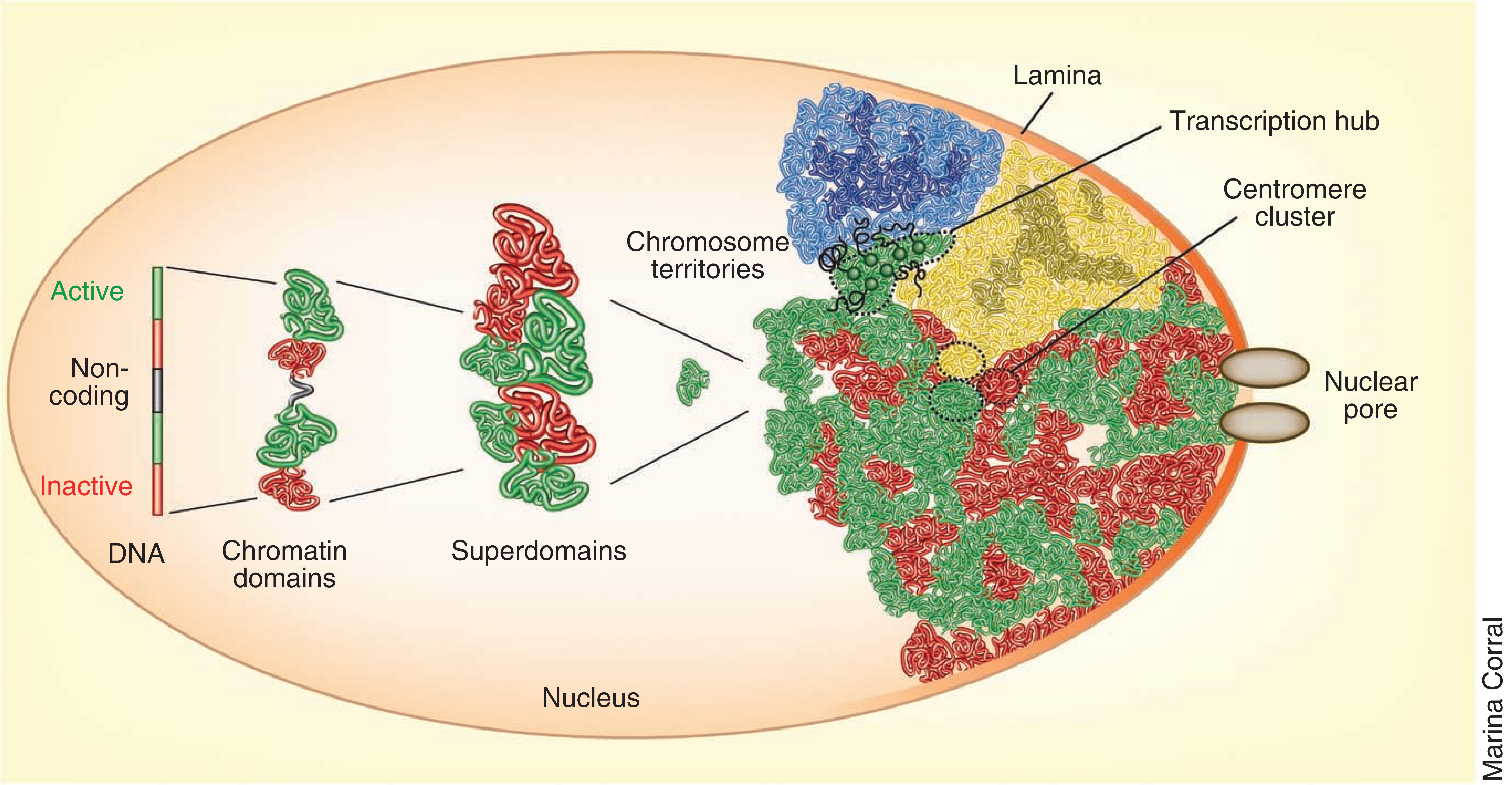
Level VI: Nucleosome



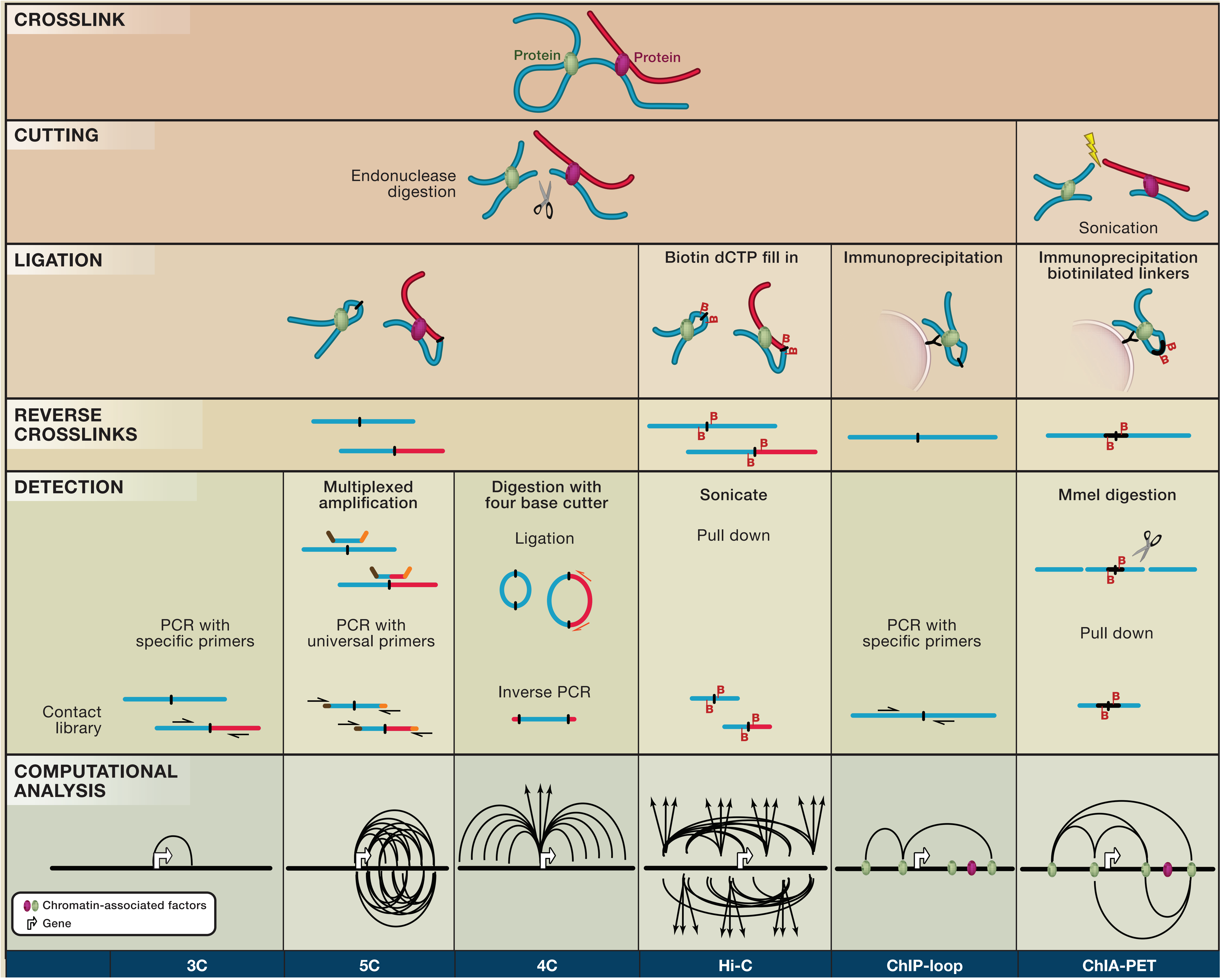
Adapted from Richard E. Ballermann, 2012

Complex genome organization

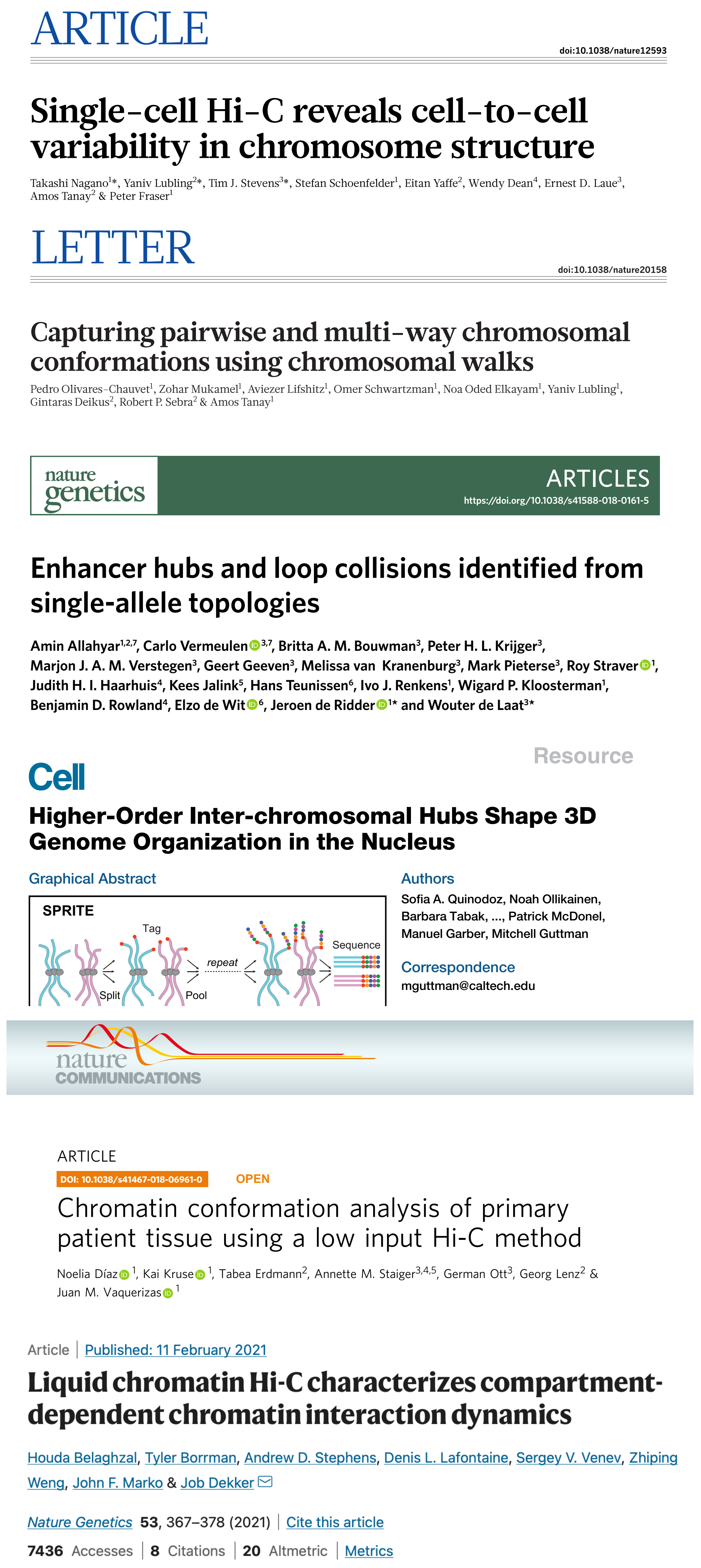
Cavalli, G. & Misteli, T. Functional implications of genome topology. Nat Struct Mol Biol 20, 290–299 (2013).



Chromosome Conformation Capture



Hakim, O., & Misteli, T. (2012). SnapShot: Chromosome Confirmation Capture. Cell, 148(5), 1068–1068.e2.



ARTICLE
doi:10.1038/nature12593

Single-cell Hi-C reveals cell-to-cell variability in chromosome structure

Takashi Nagano[1]*, Yaniv Lubling[2]*, Tim J. Stevens[3]*, Stefan Schoenfelder[1], Eitan Yaffe[2], Wendy Dean[4], Ernest D. Laue[3], Amos Tanay[2] & Peter Fraser[1]

LETTER
doi:10.1038/nature20158

Capturing pairwise and multi-way chromosomal conformations using chromosomal walks

Pedro Olivares-Chauvet[1], Zohar Mukamel[1], Aviezer Lifshitz[1], Omer Schwartzman[1], Noa Oded Elkayam[1], Yaniv Lubling[1], Gintaras Deikus[2], Robert P. Sebra[2] & Amos Tanay[1]

nature genetics ARTICLES
https://doi.org/10.1038/s41588-018-0161-5

Enhancer hubs and loop collisions identified from single-allele topologies

Amin Allahyar[1,2,7], Carlo Vermeulen[3,7], Britta A. M. Bouwman[3], Peter H. L. Krijger[3], Marjon J. A. M. Verstegen[3], Geert Geeven[3], Melissa van Kranenburg[3], Mark Pieterse[3], Roy Straver[1], Judith H. I. Haarhuis[4], Kees Jalink[5], Hans Teunissen[6], Ivo J. Renkens[1], Wigard P. Kloosterman[1], Benjamin D. Rowland[4], Elzo de Wit[6], Jeroen de Ridder[1]* and Wouter de Laat[3]*

Cell — Resource

Higher-Order Inter-chromosomal Hubs Shape 3D Genome Organization in the Nucleus

Graphical Abstract
SPRITE
Tag
Split
Pool
repeat
Sequence

Authors
Sofia A. Quinodoz, Noah Ollikainen, Barbara Tabak, ..., Patrick McDonel, Manuel Garber, Mitchell Guttman

Correspondence
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nature COMMUNICATIONS

ARTICLE
DOI: 10.1038/s41467-018-06961-0 OPEN

Chromatin conformation analysis of primary patient tissue using a low input Hi-C method

Noelia Díaz[1], Kai Kruse[1], Tabea Erdmann[2], Annette M. Staiger[3,4,5], German Ott[3], Georg Lenz[2] & Juan M. Vaquerizas[1]

Article | Published: 11 February 2021

Liquid chromatin Hi-C characterizes compartment-dependent chromatin interaction dynamics

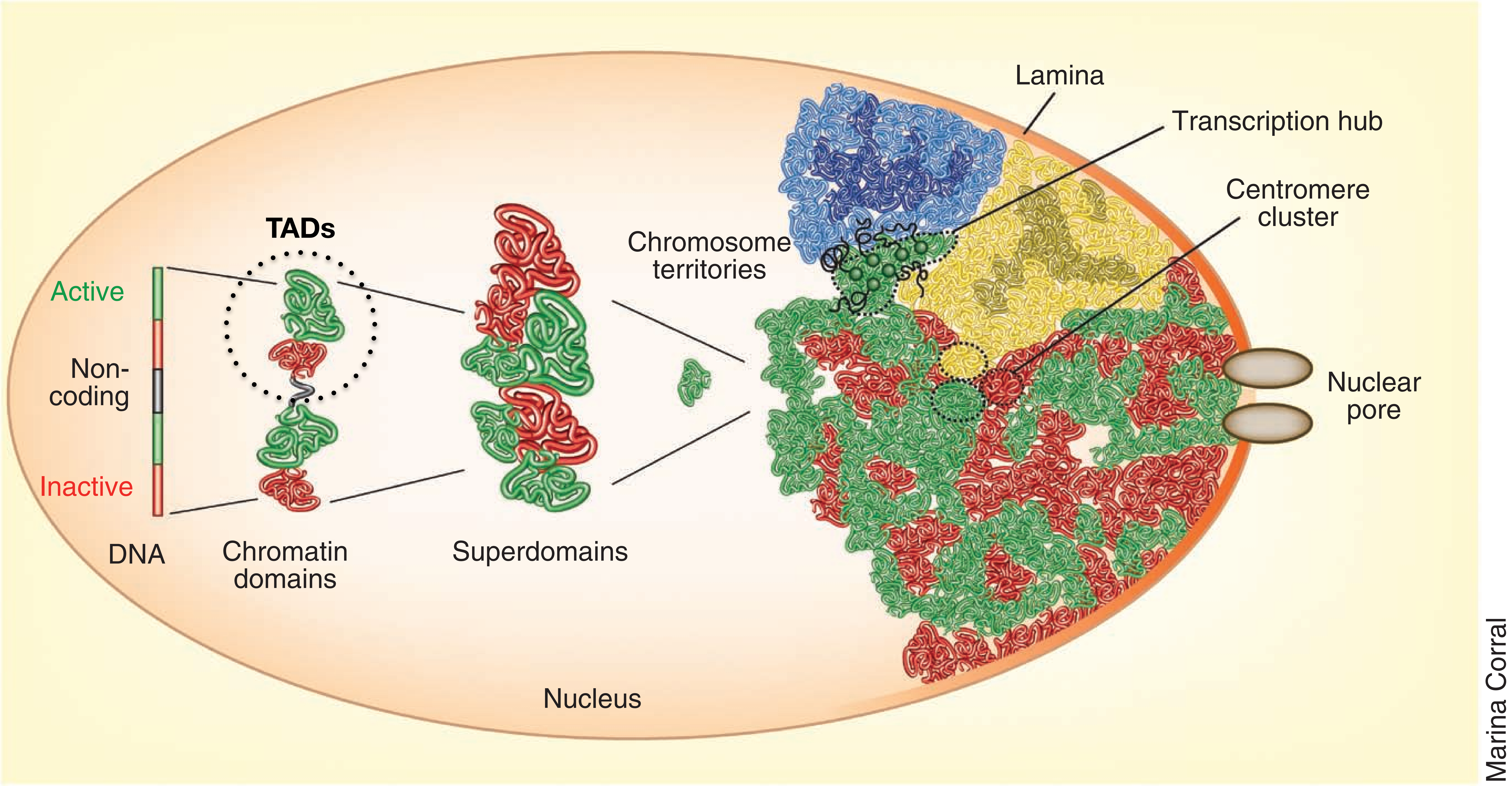
Houda Belaghzal, Tyler Borrman, Andrew D. Stephens, Denis L. Lafontaine, Sergey V. Venev, Zhiping Weng, John F. Marko & Job Dekker

Nature Genetics **53**, 367–378 (2021) | Cite this article

7436 Accesses | **8** Citations | **20** Altmetric | Metrics

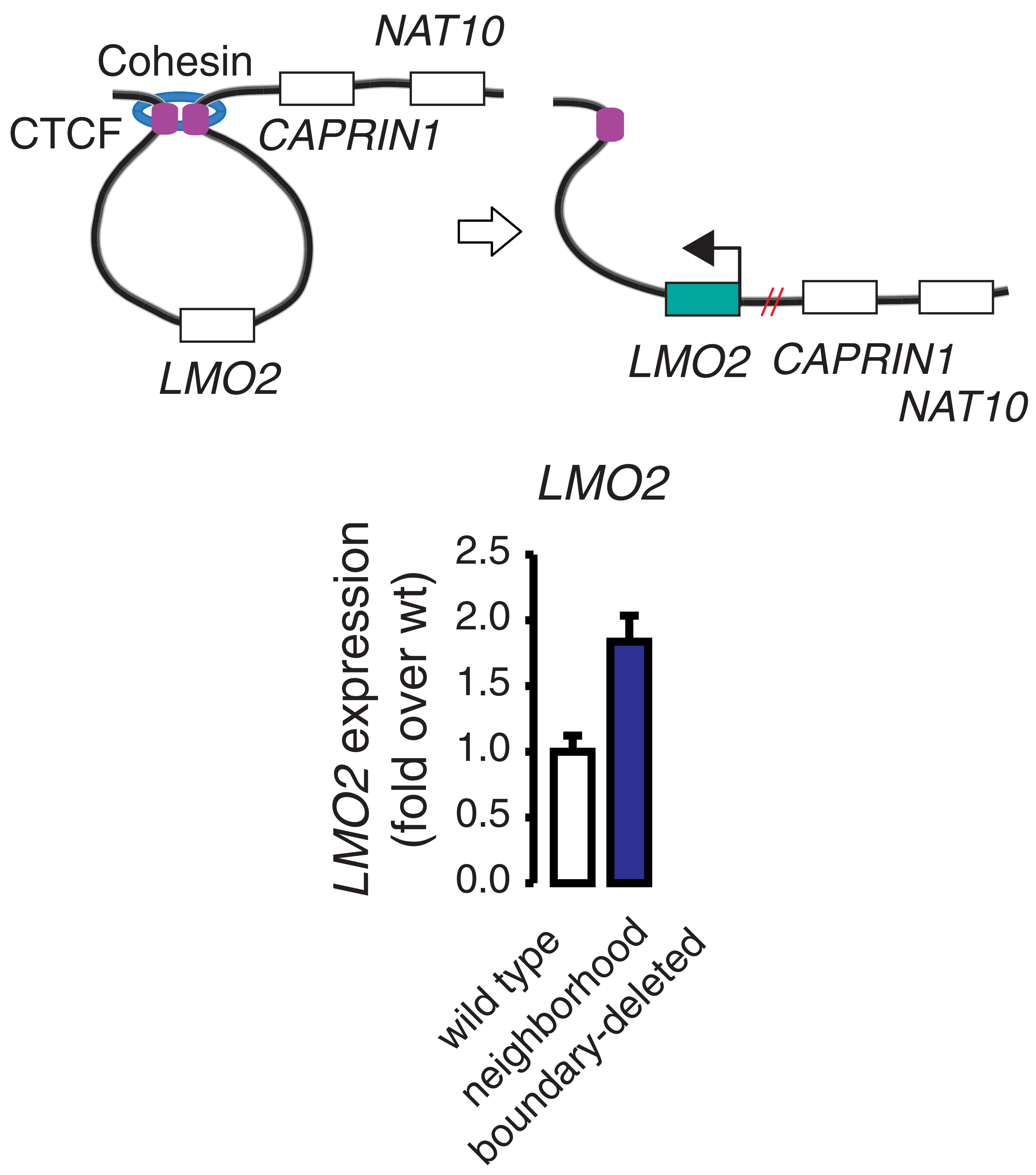
Complex genome organization

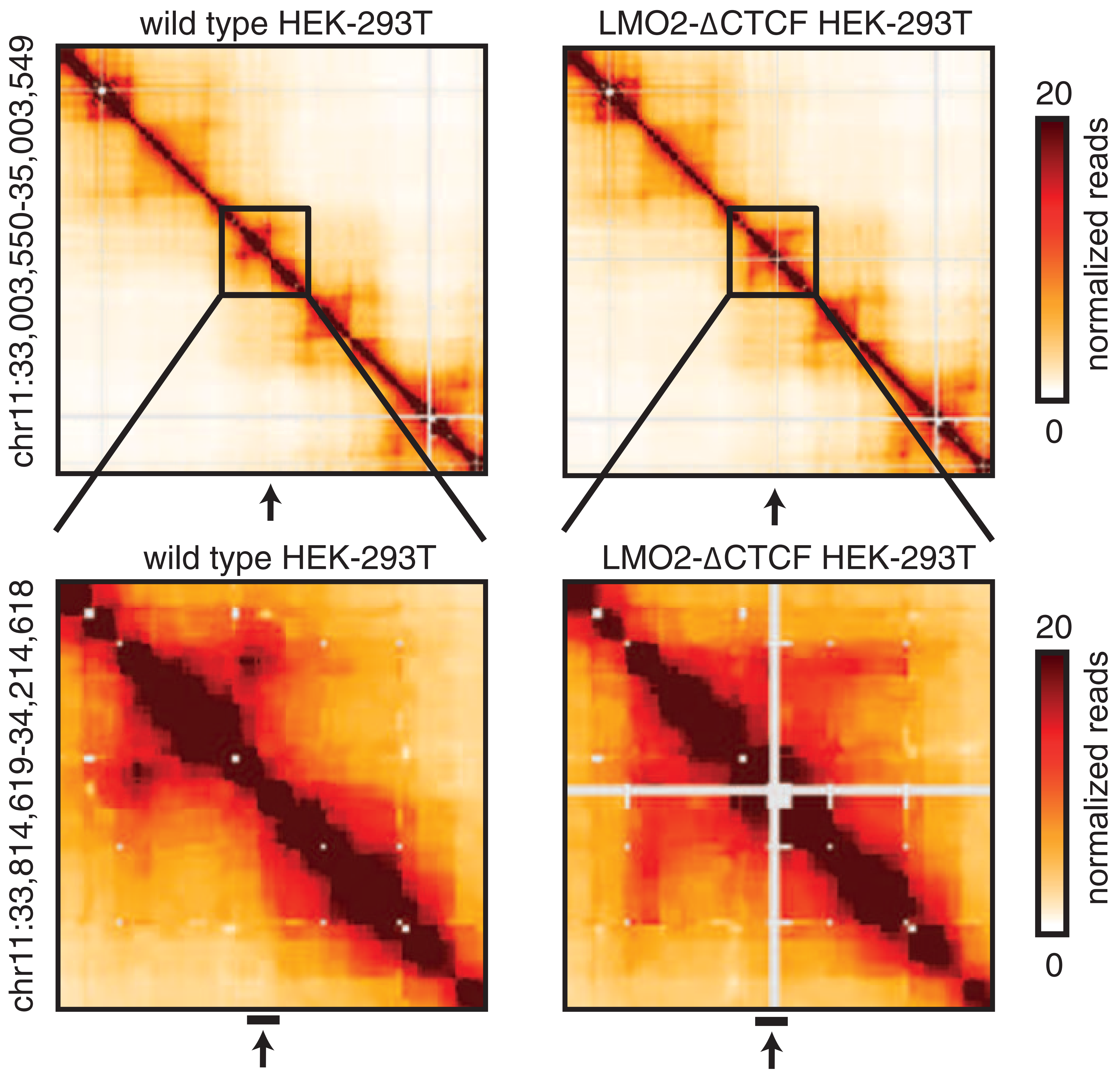
Cavalli, G. & Misteli, T. Functional implications of genome topology. Nat Struct Mol Biol 20, 290–299 (2013).



TADs are functional units

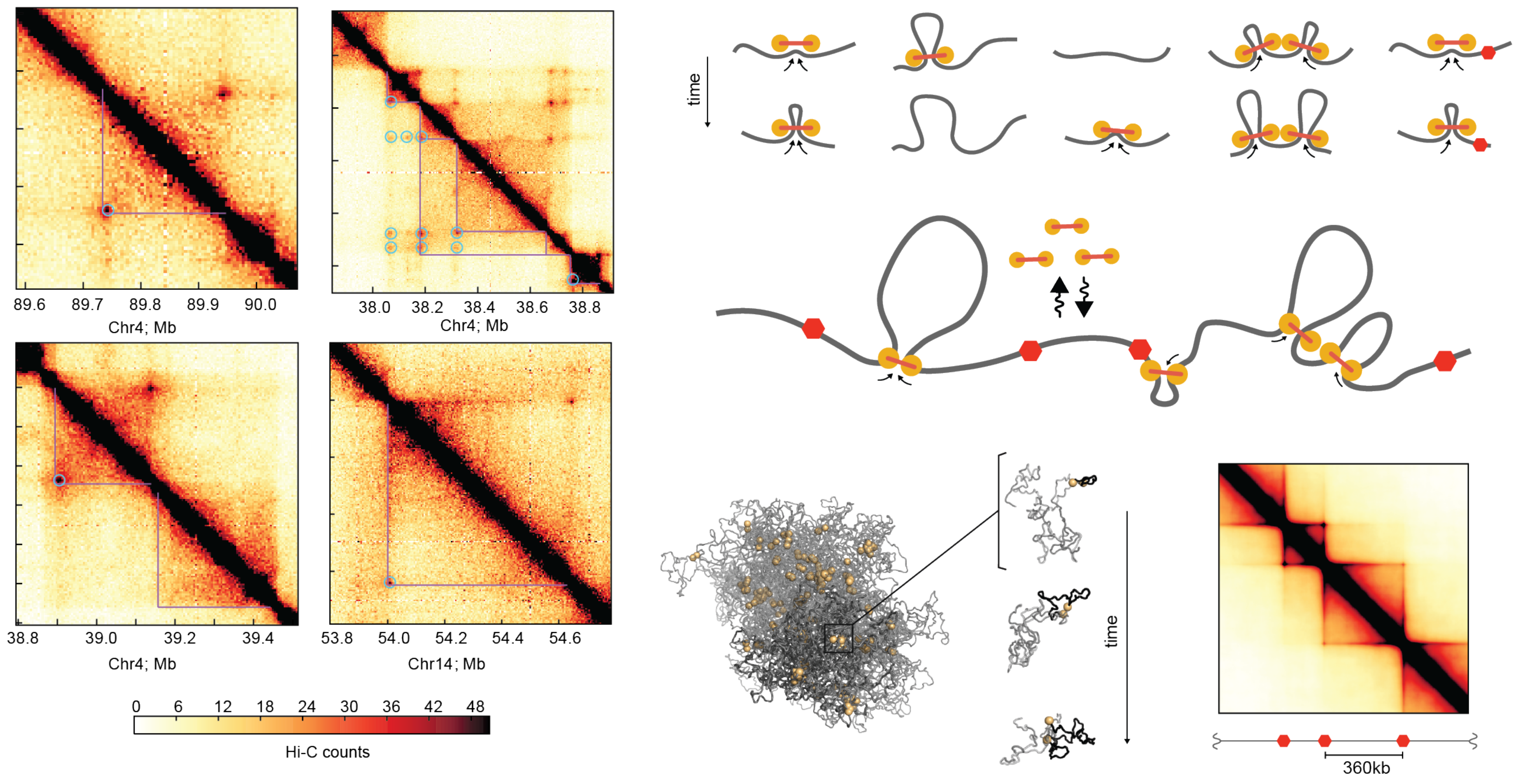
Hnisz, D., et al. (2016). Science





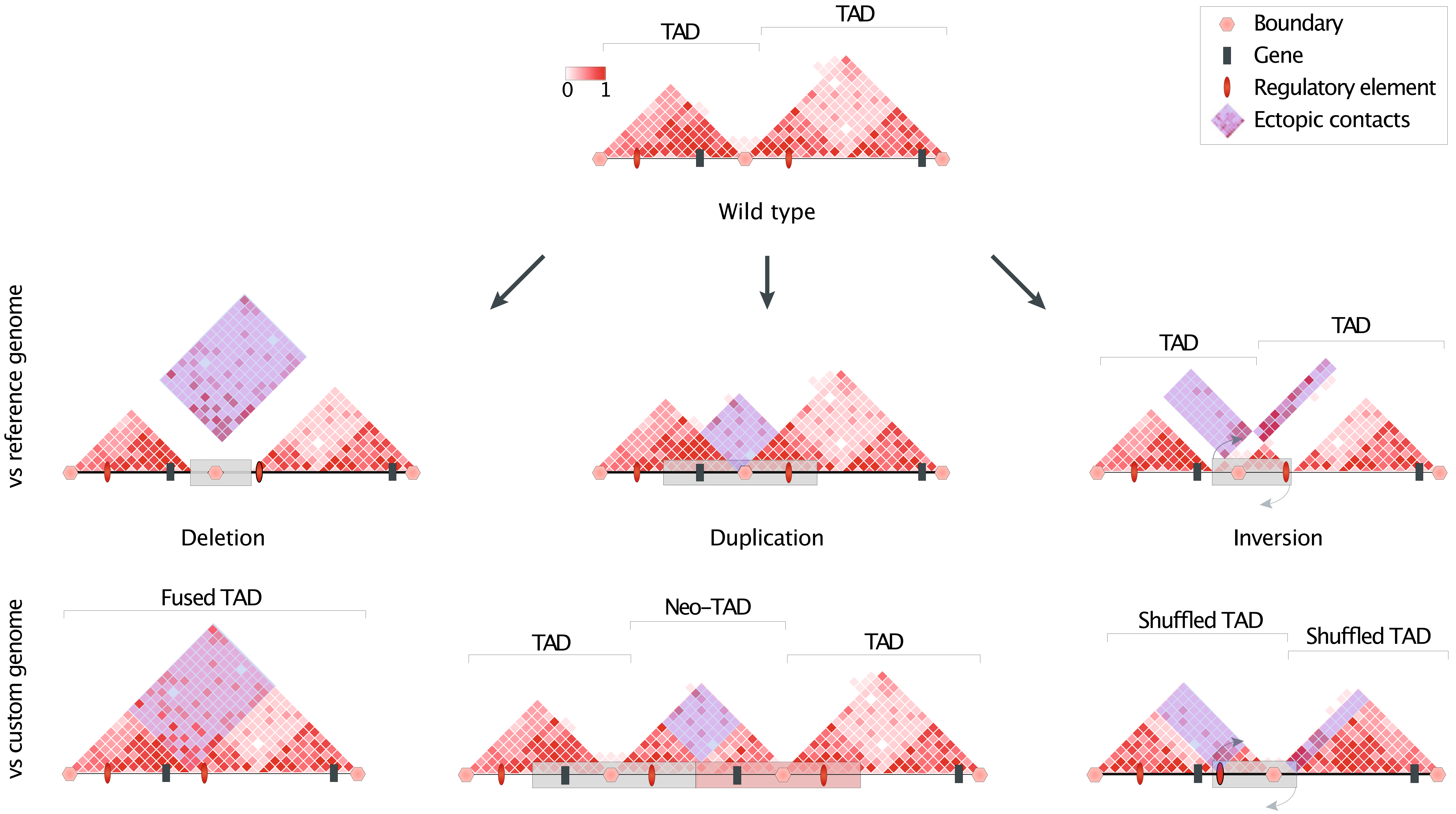
Loop-extrusion as a TAD forming mechanism

Fudenberg, G., Imakaev, M., Lu, C., Goloborodko, A., Abdennur, N., & Mirny, L. A. (2018).
Cold Spring Harb Symp Quant Biol 2017. 82: 45-55



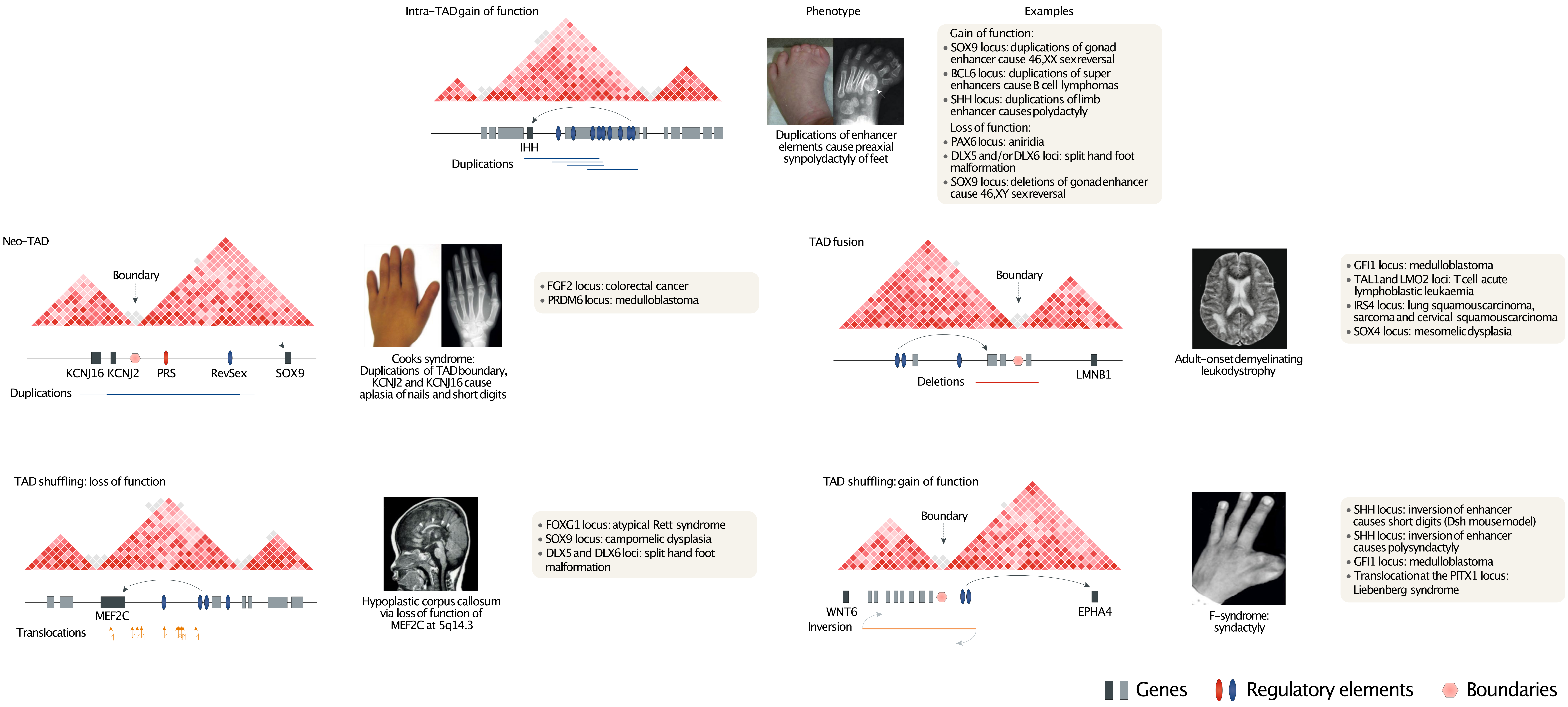
Are TADs functional units?

Spielmann Nature Reviews Genetics 2018 (19) 453–467



Clinical examples of structural variants

Spielmann Nature Reviews Genetics 2018 (19) 453–467



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Meritxell Novillo
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Leo Zuber

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NIH National Human Genome Research Institute

.: Conflict of Interest Statement :.
Between Sep 2021 and Apr 2022, Marc A. Marti-Renom served as a consultant to Acuity Spatial Genomics, Inc., and received compensation for these services.