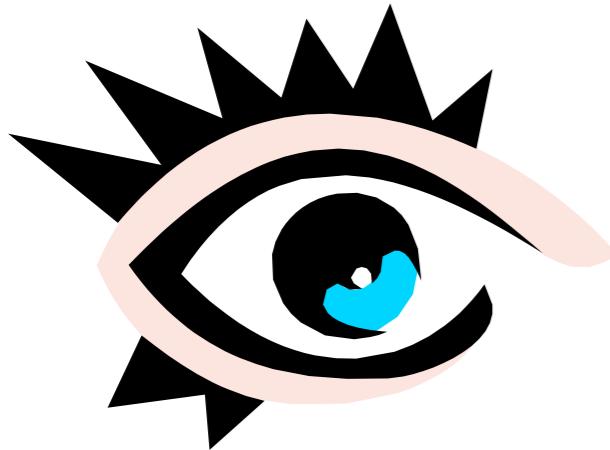


3D modeling of genomes and genomic domains: an overview.

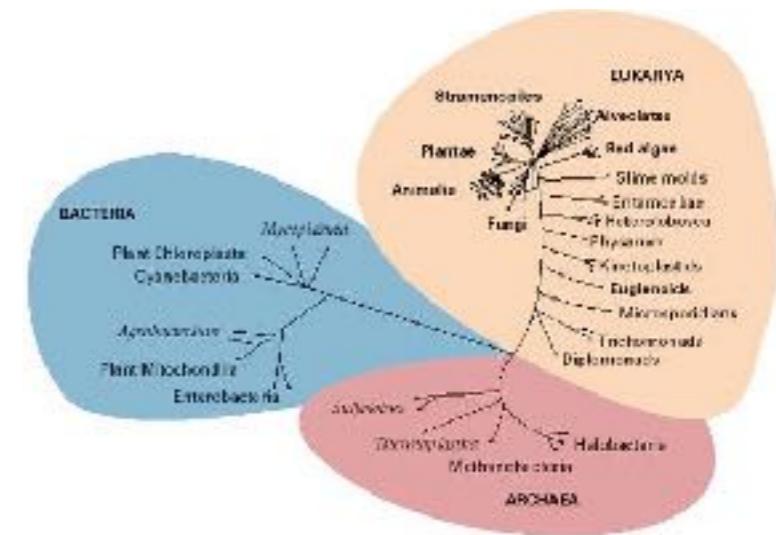
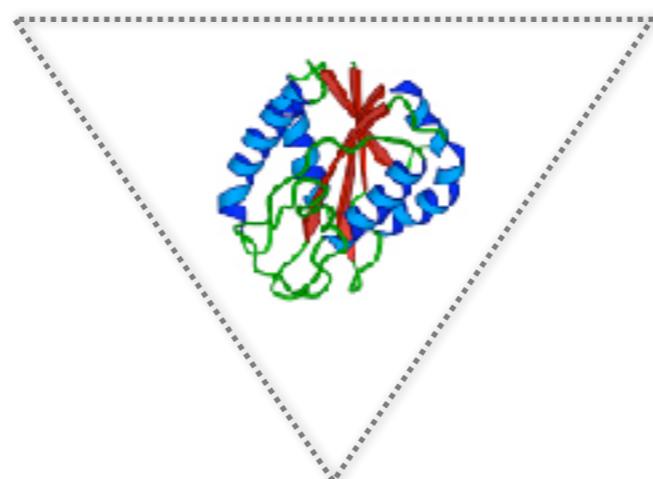
François Serra, Marco Di Stefano & Marc A. Martí-Renom
Structural Genomics Group (CNAG-CRG)



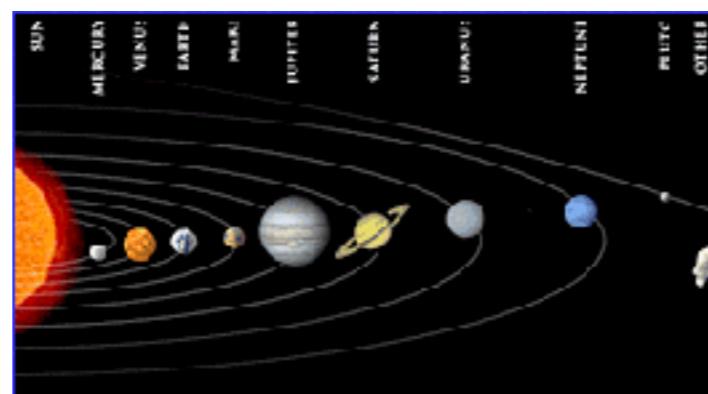
Data groups



Experimental
observations



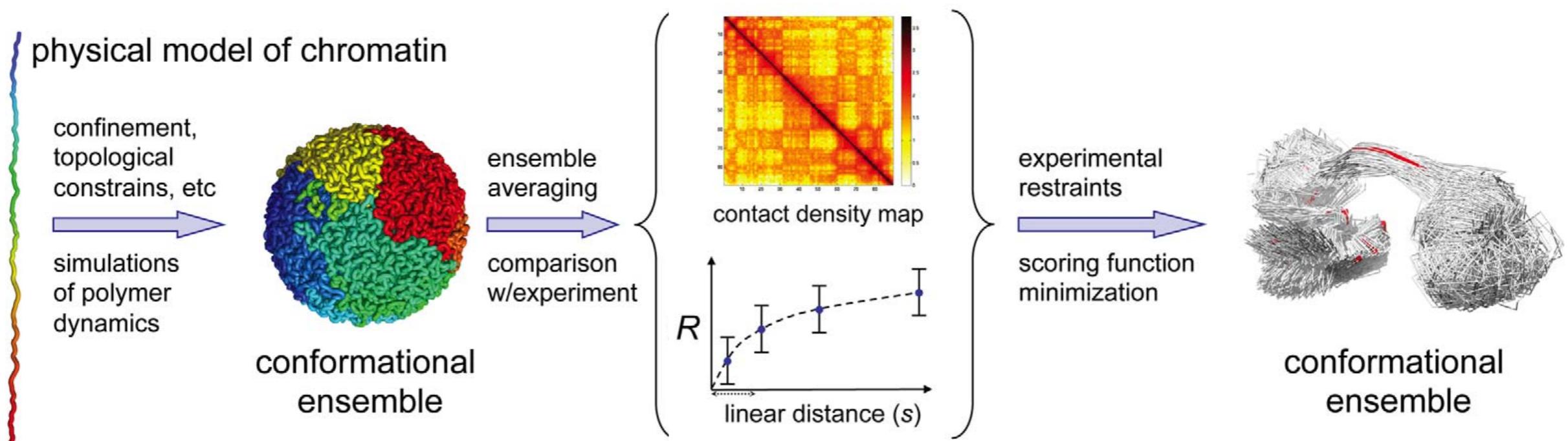
Statistical rules



Laws of physics

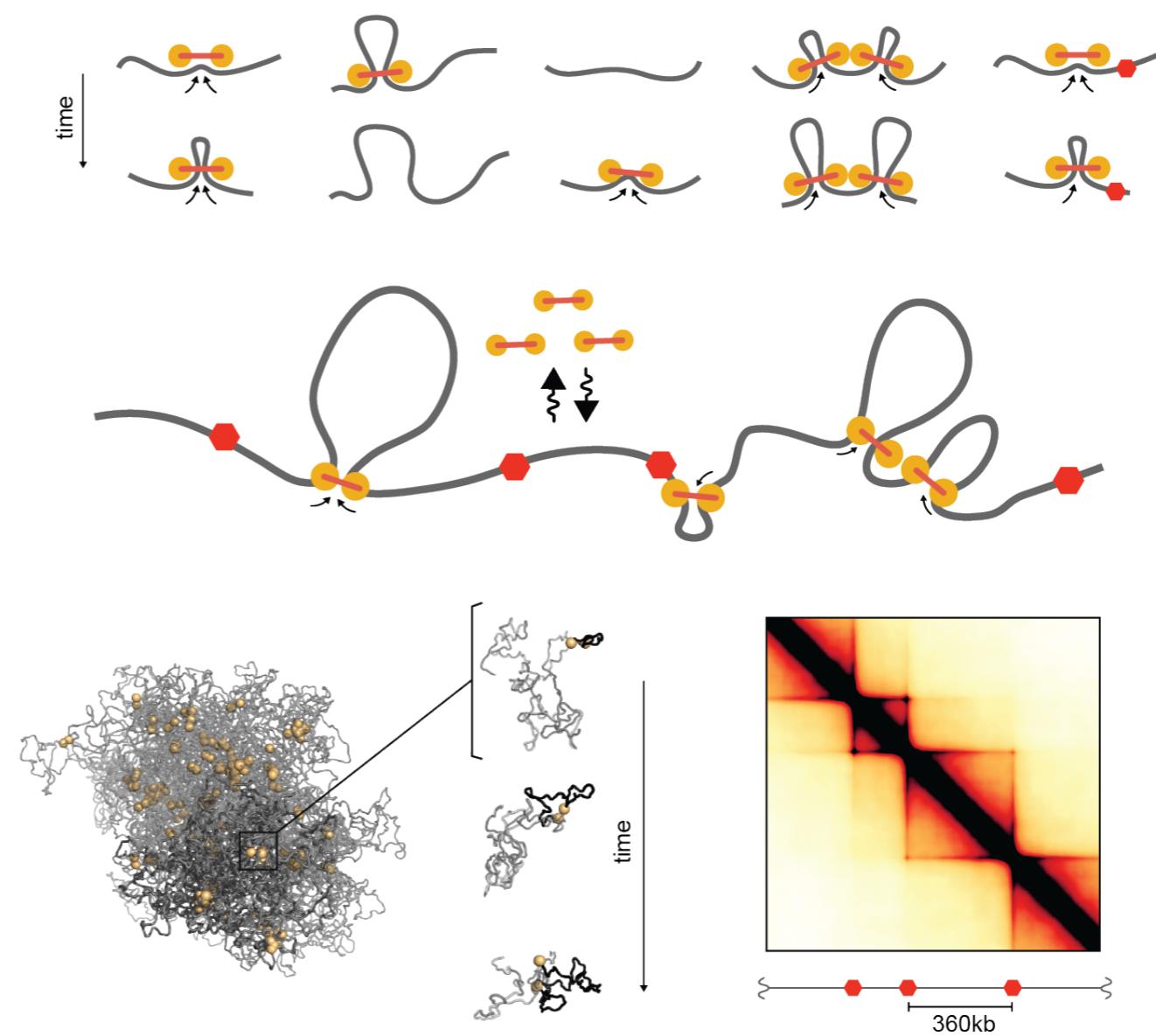
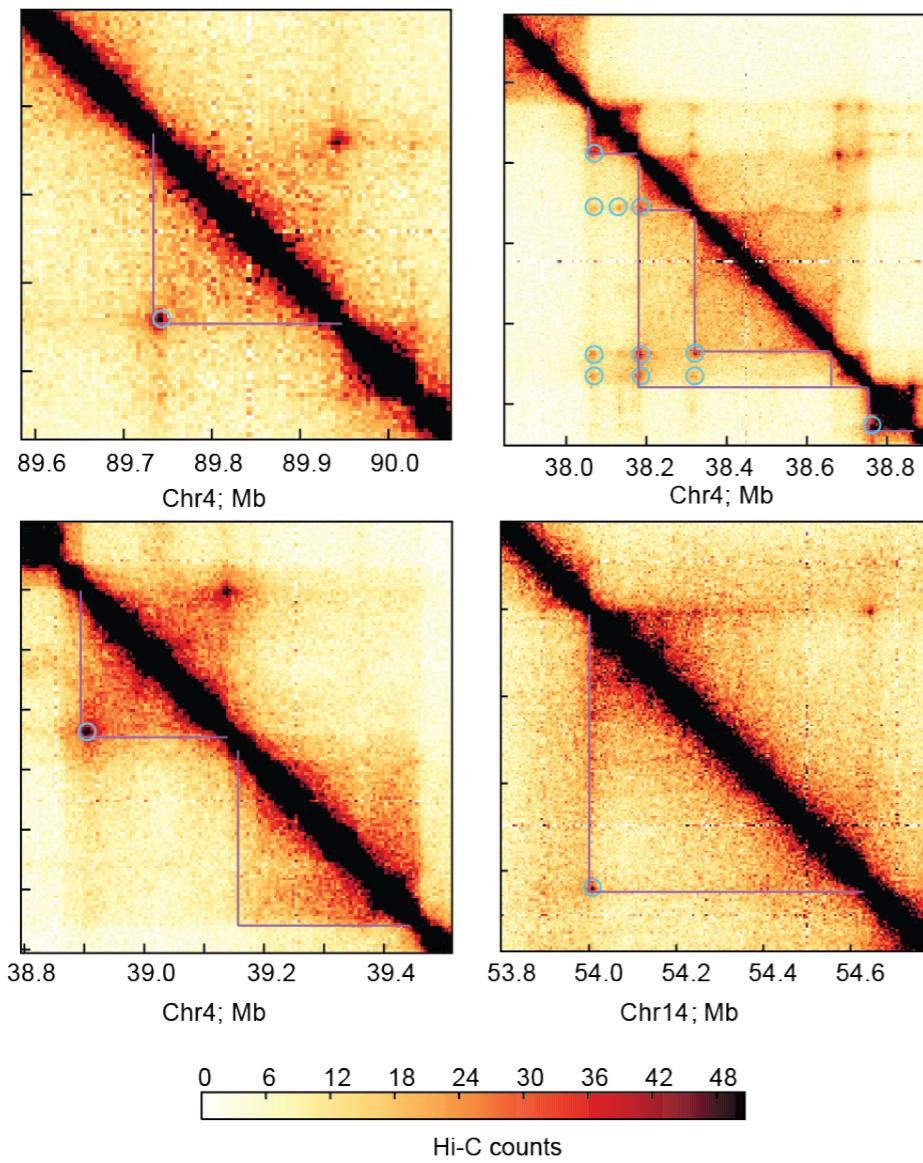
Modeling Genomes

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

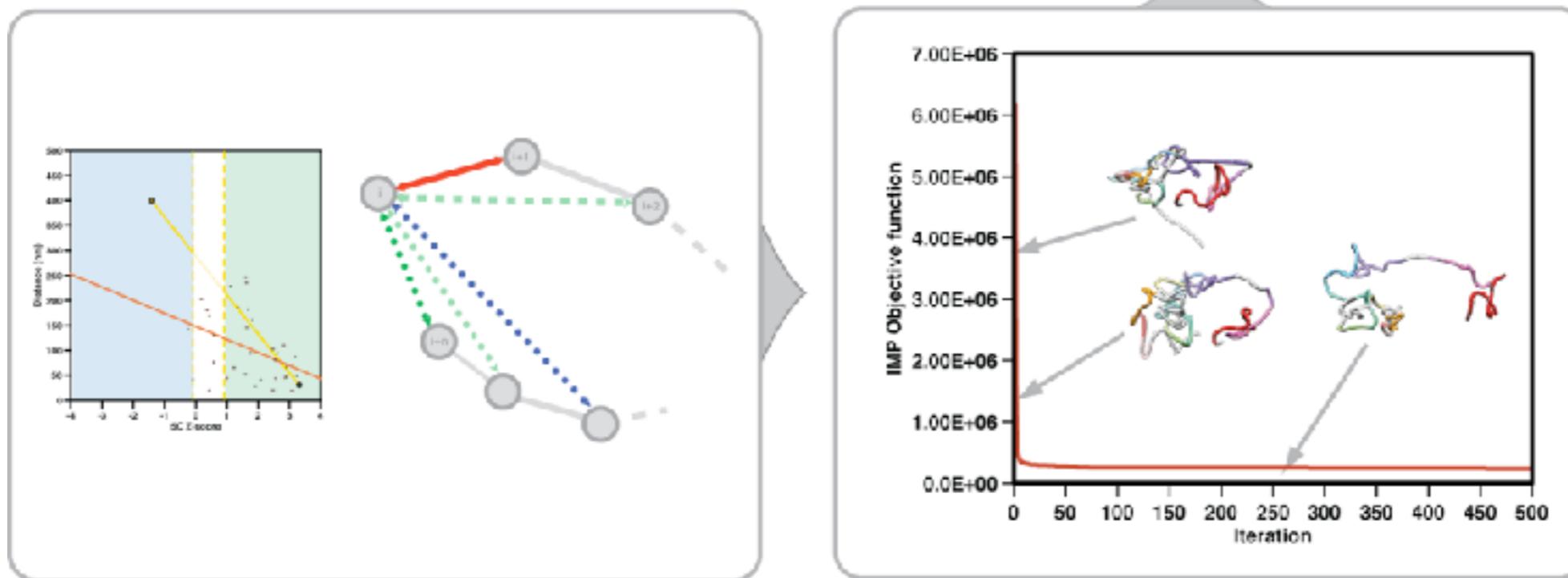
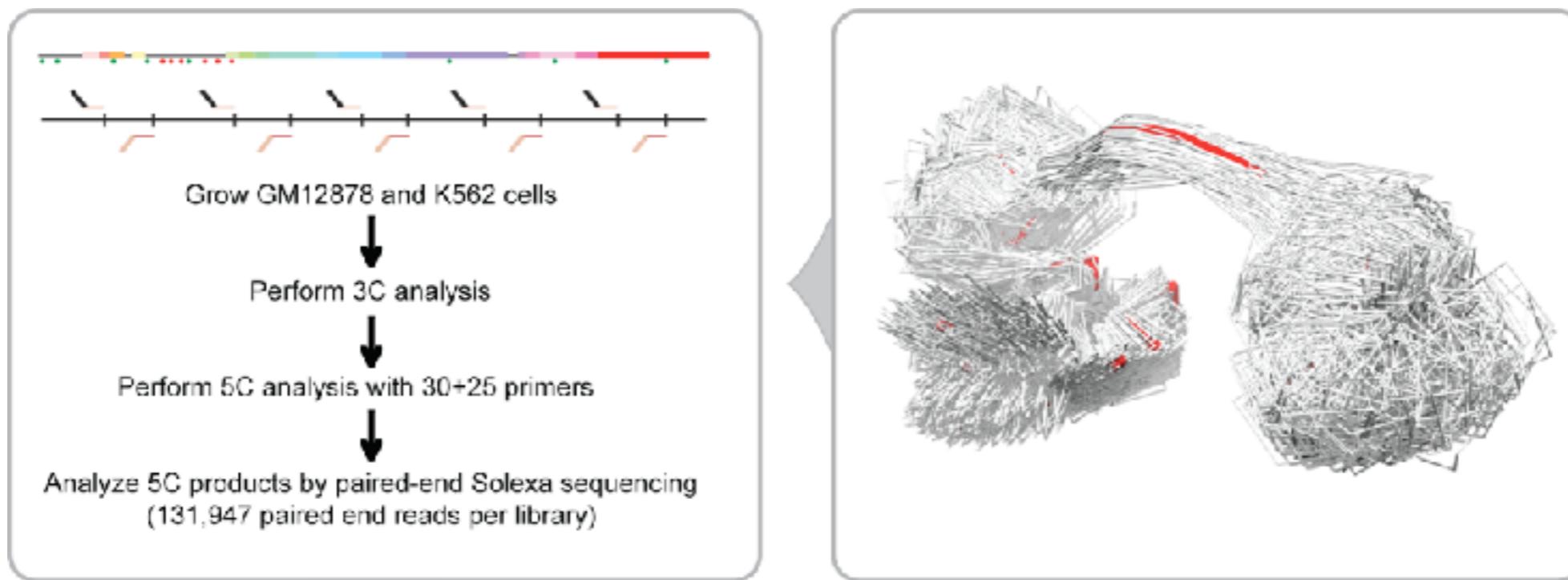


Level V: Loop-extrusion as a driving force

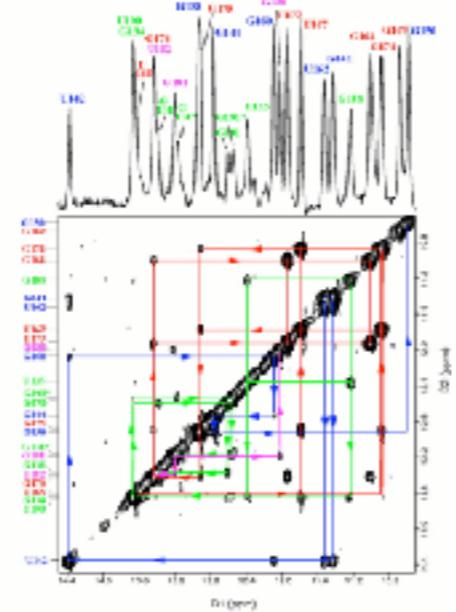
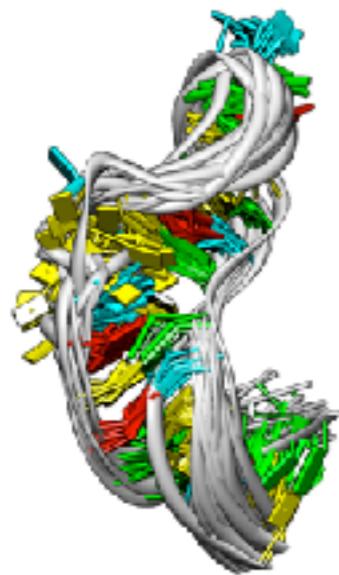
Fudenberg, G., Imakaev, M., Lu, C., Goloborodko, A., Abdennur, N., & Mirny, L. A. (2015).
Formation of Chromosomal Domains by Loop Extrusion. *bioRxiv*.



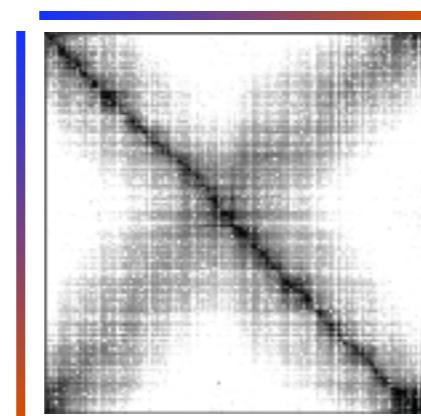
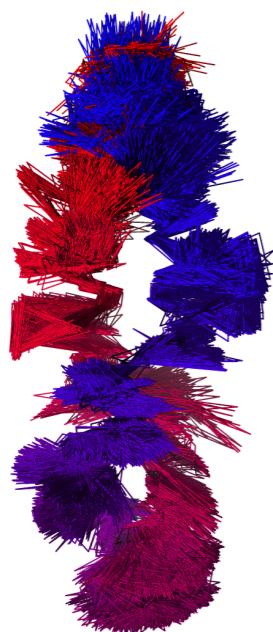
Experiments



Computation



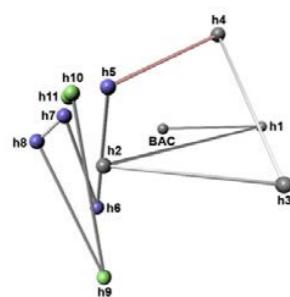
Biomolecular structure determination
2D-NOESY data



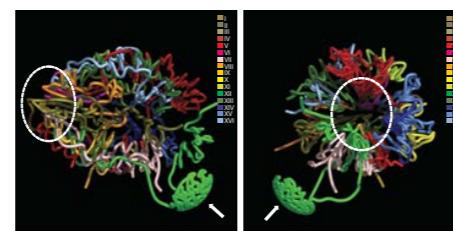
Chromosome structure determination
5C data

3D modeling of genomic domains: other methods

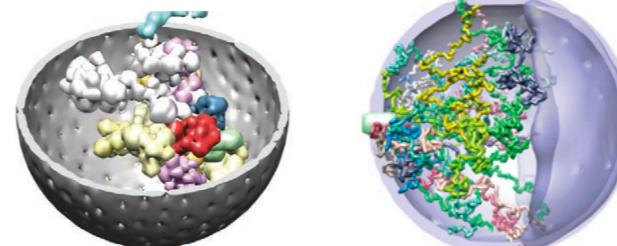
Jhunjhunwala (2008) Cell



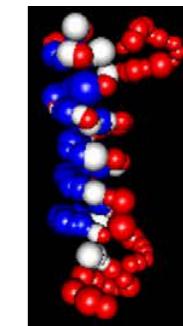
Duan (2010) Nature



Kalhor (2011) Nature Biotechnology
Tjong (2012) Genome Research

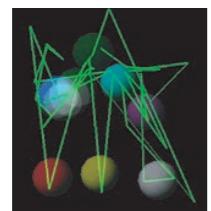


Hu (2013) PLoS Computational Biology

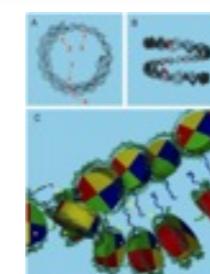
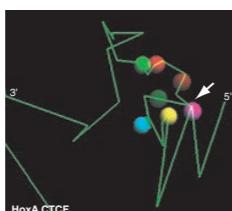


2008

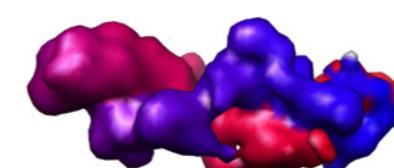
2014



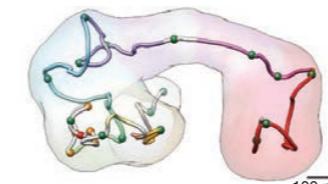
Fraser (2009) Genome Biology
Ferraiuolo (2010) Nucleic Acids Research



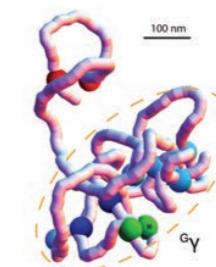
Asbury (2010) BMC Bioinformatics



Baù (2011) Nature Structural & Molecular Biology
Umbarger (2011) Molecular Cell

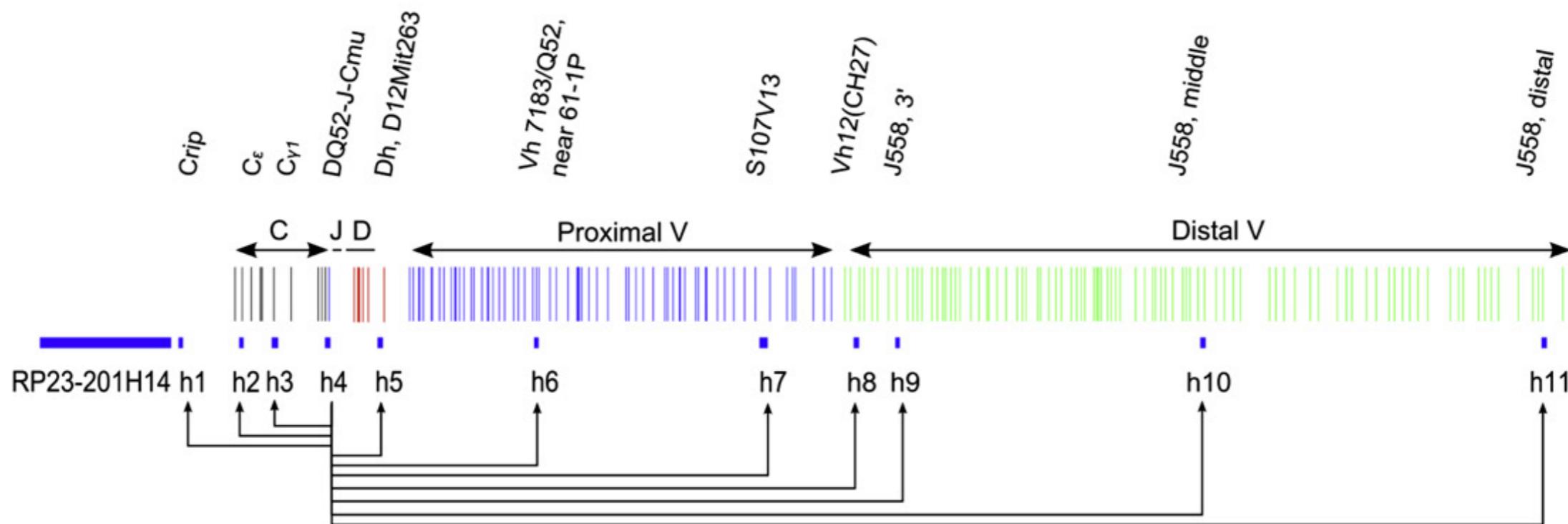


Junier (2012) Nucleic Acids Research



The 3D structure of the IgH-chain locus

Jhunjhunwala et al, (2008) Cell

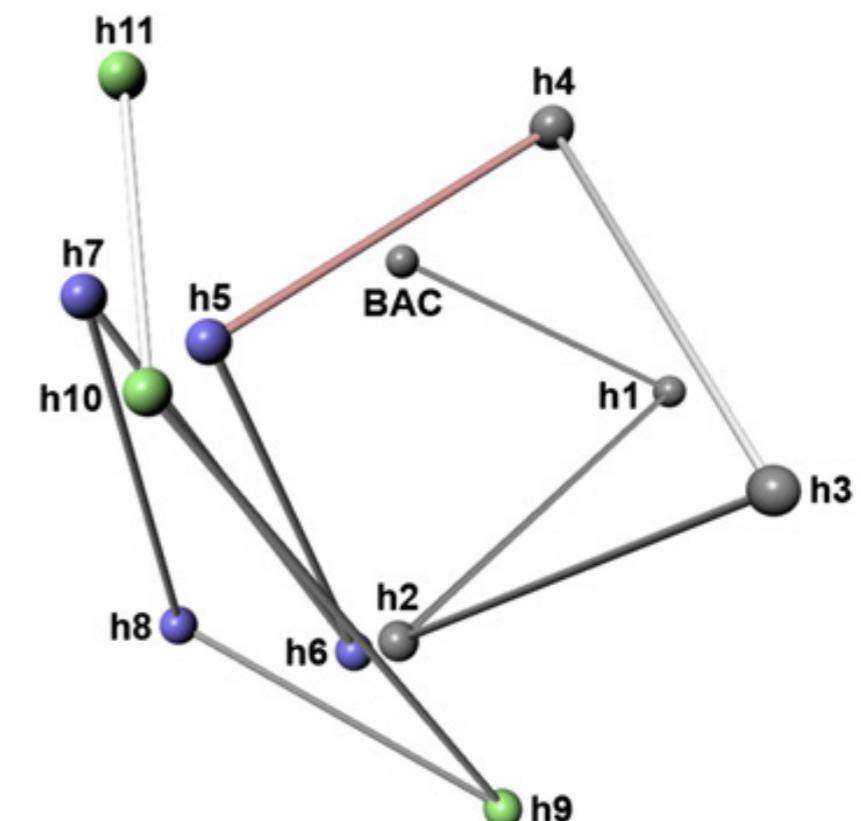
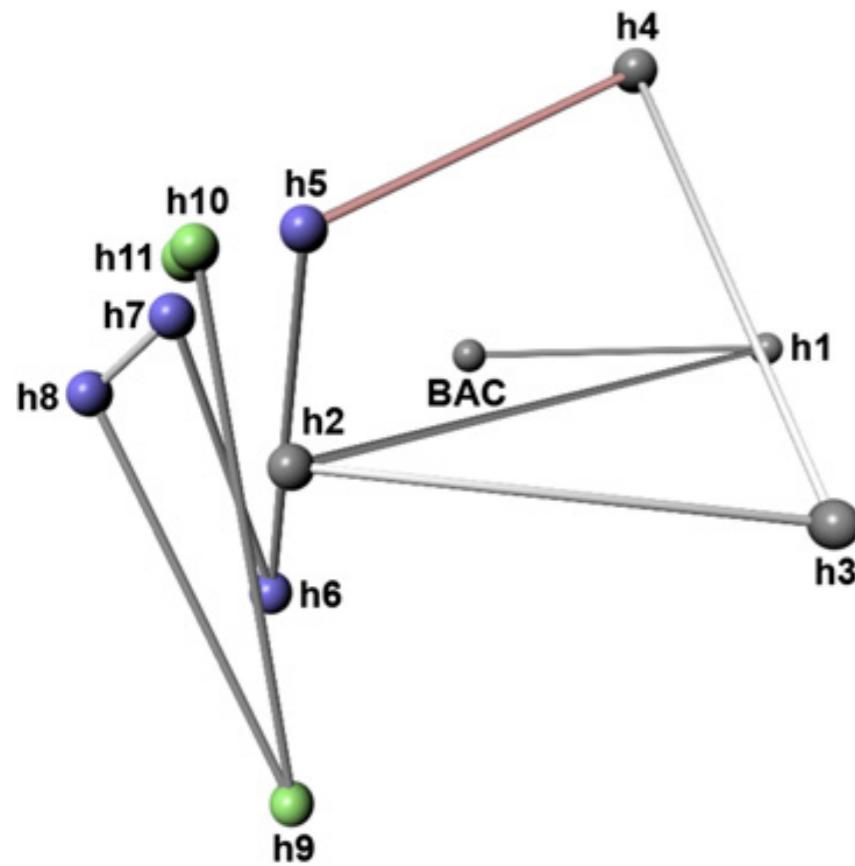


Genomic organization of the IgH locus

Adapted from Jhunjhunwala et al, (2008) Cell

The 3D Structure of the IgH-Chain Locus

Jhunjhunwala et al., (2008) Cell



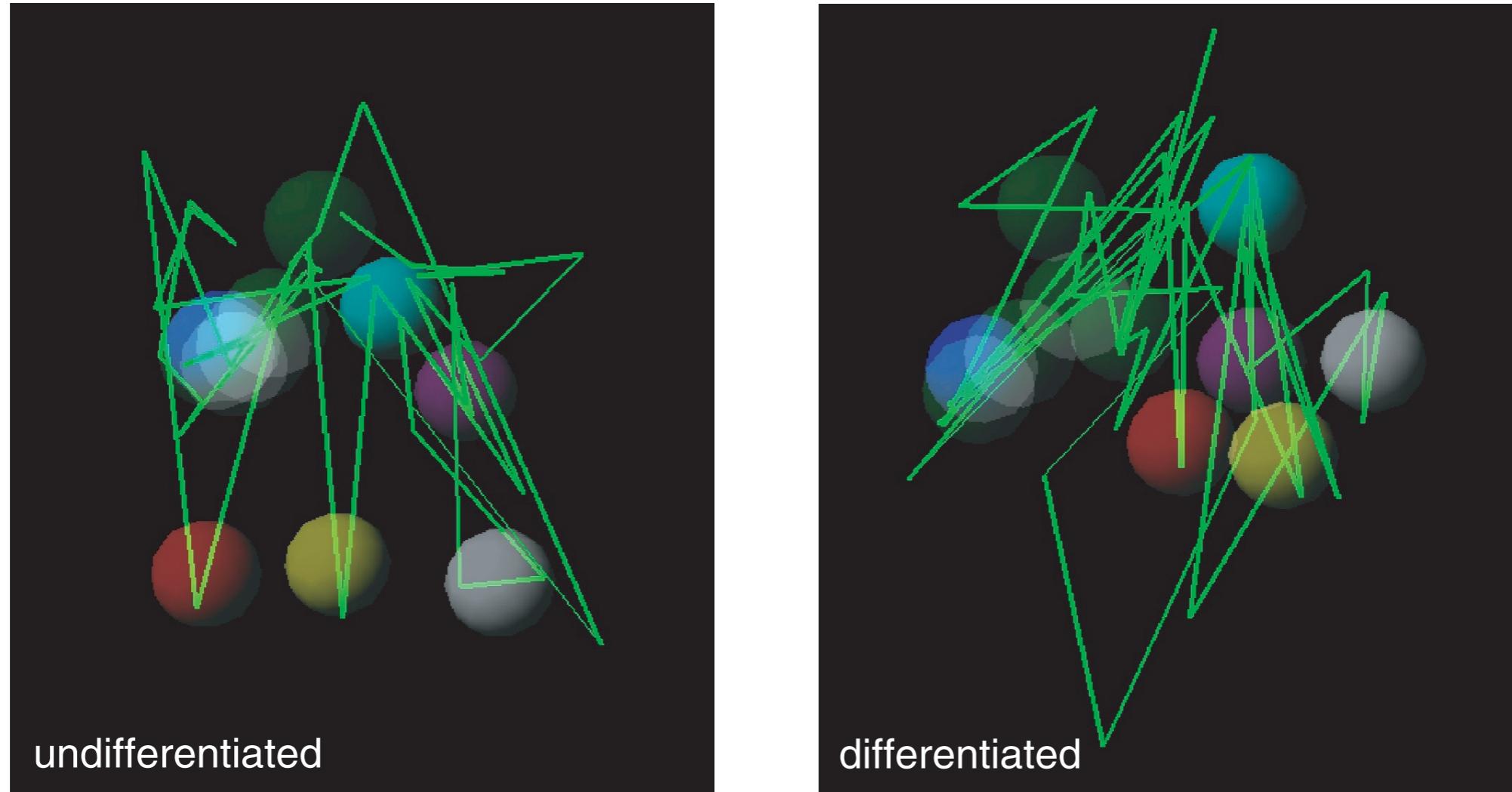
The 3D topology of the IgH locus in pro-B cells

- Distal Vh
- Proximal Vh
- Dh region
- Jh, Ch

Adapted from Jhunjhunwala et all, (2008) Cell

Chromatin conformation signatures of cellular differentiation

Fraser et al., (2009) Genome biology



● A1-5 ● A6 ● A7 ● A9 ● A10 ● A11 ● A13

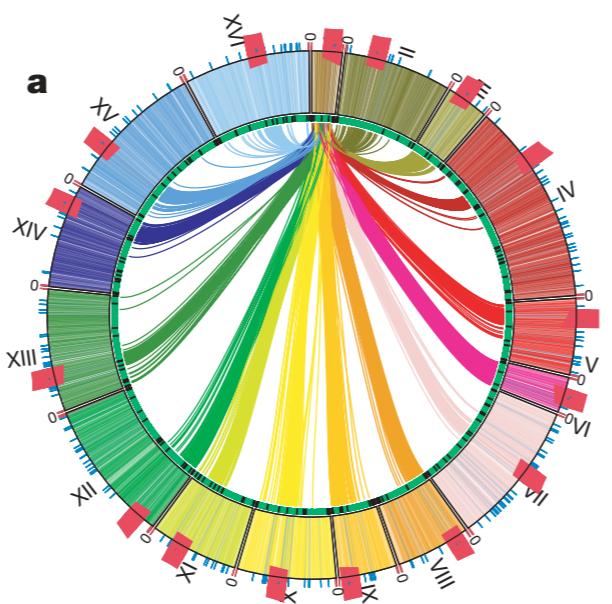
Three-dimensional models of the human *HoxA* cluster during cellular differentiation

Adapted from Fraser et al., (2009) Genome Biology

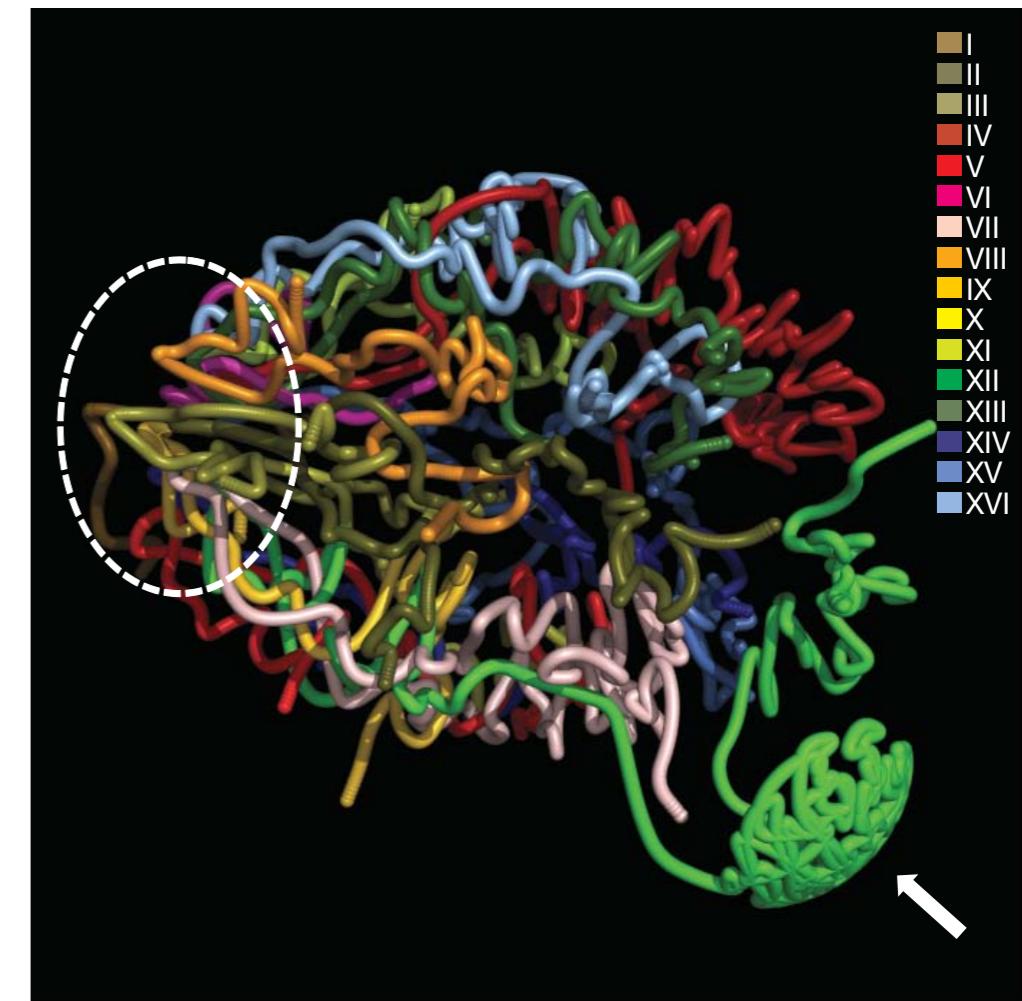
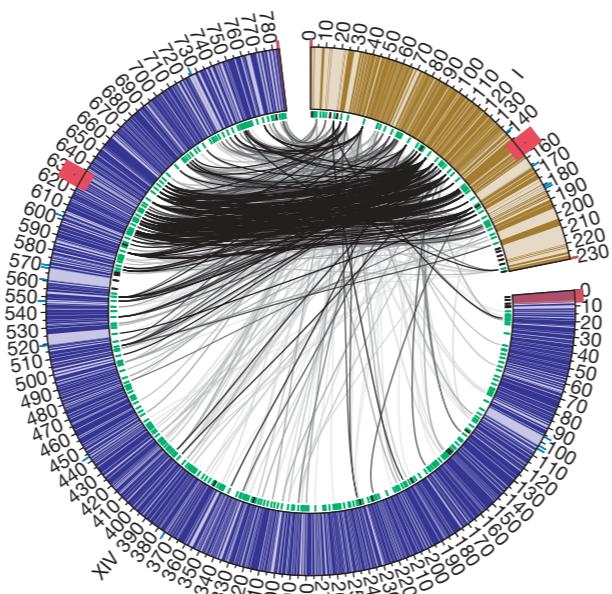
A 3D model of the yeast genome

Duan et all, (2010) Nature

Chromosome I
vs all

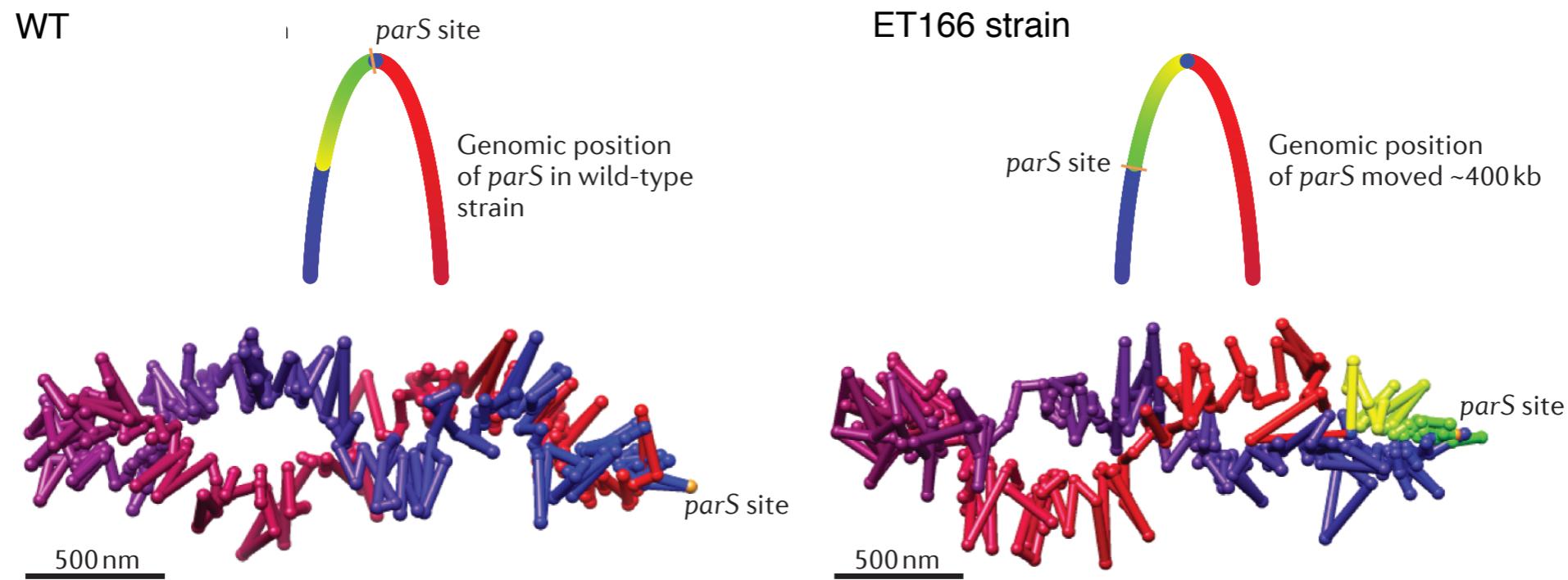
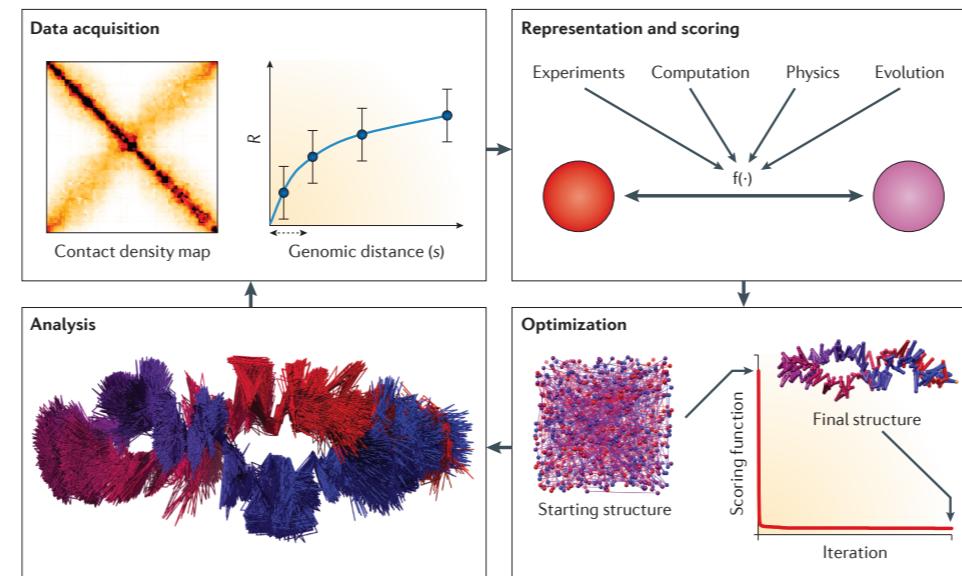


Chromosome XIV



Adapted from Duan et all, (2010) Nature

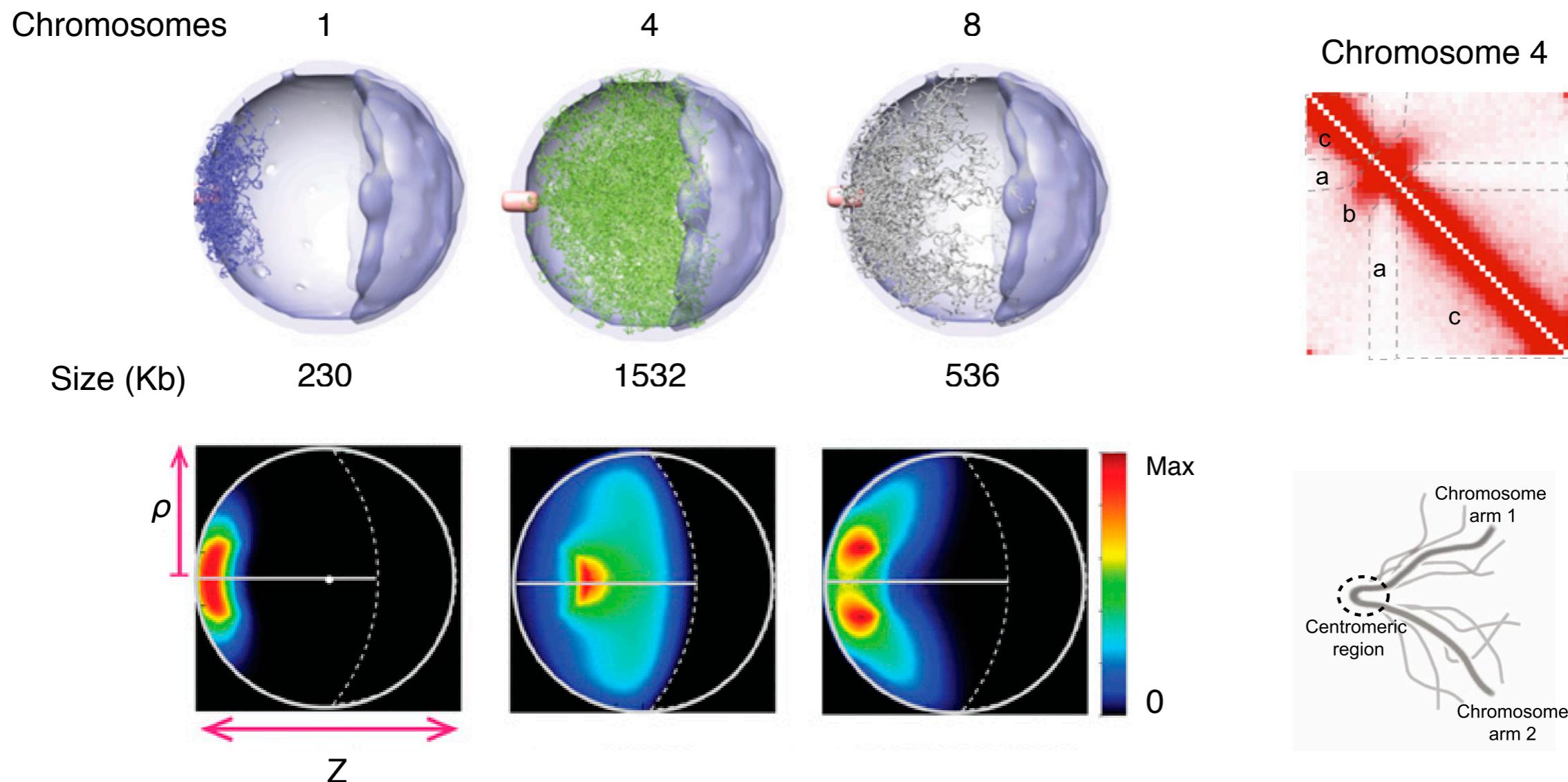
Restraint based models



Adapted from Dekker et al., (2013) Nat Rev Genetics

Physical tethering and volume exclusion determine higher-order genome organization in budding yeast

Tjong et al., (2012) Genome research

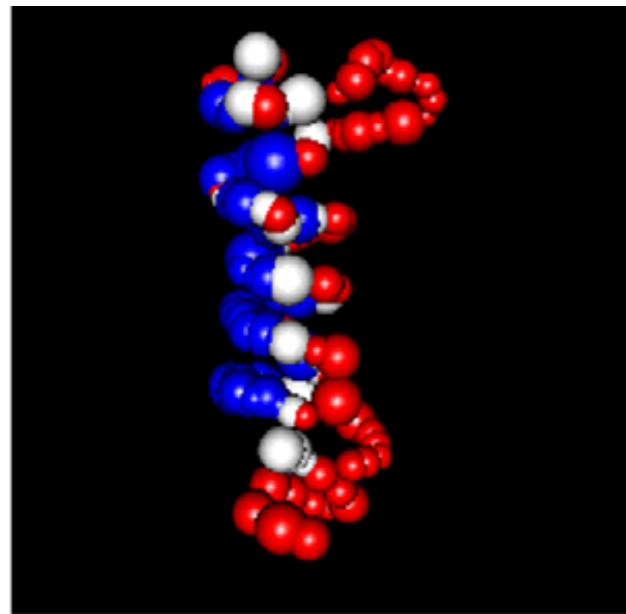


Adapted from Tjong et al., (2012) Genome research

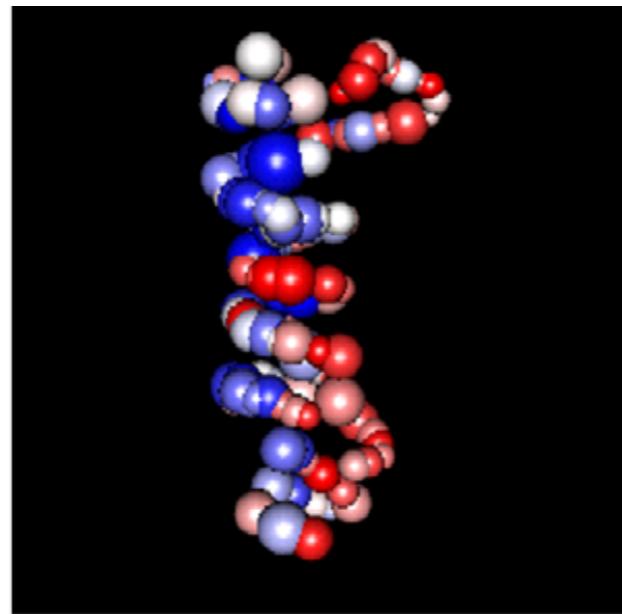
Bayesian Inference of Spatial Organizations of Chromosomes

Hu et al., (2013) PLoS computational biology

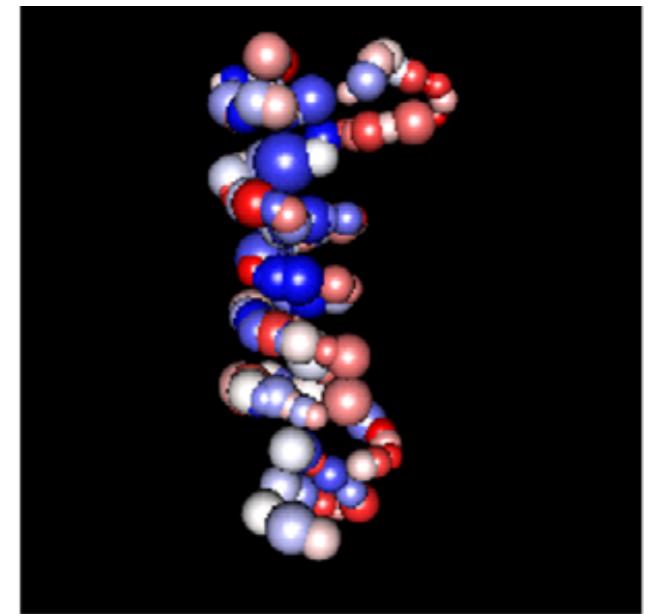
Compartment level



Gene density



Gene expression



Spatial organization of genomic and epigenetic features

Adapted from Hu et al., (2013) PLoS Comp Bio